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[Intervention Review]

Surgical interventions for treating hallux valgus and bunions

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ABSTRACT

Background

Hallux valgus (lateral angulation of the great toe towards the lesser toes, commonly known as bunions) presents in 23% to 35% of the population. This condition leads to poor balance and increases the risk of falling, adding to the difficulty in fitting into shoes and pain. Conservative (non-surgical) interventions treating pain rather than curing deformity are usually first-line treatments. When surgery is indicated, the overall best surgical procedure is an ever-evolving topic of discussion.

Objectives

To assess the benefits and harms of different types of surgery compared with placebo or sham surgery, no treatment, non-surgical treatments and other surgical interventions for adults with hallux valgus.

Search methods

We searched CENTRAL, MEDLINE, Embase and trial registries to 20 April 2023. We did not apply any language or publication restrictions.

Selection criteria

We included randomised controlled trials evaluating surgical interventions for treating hallux valgus compared to placebo surgery or sham surgery, no treatment, non-surgical treatment or other surgical interventions. The major outcomes were pain, function, quality of life, participant global assessment of treatment success, reoperation (treatment failure), adverse events and serious adverse events.

Data collection and analysis

Two review authors independently selected studies for inclusion, extracted data, and assessed risk of bias and the certainty of evidence using GRADE.

Main results

We included 25 studies involving 1597 participants with hallux valgus. All studies included adults and most were women. One study compared surgery (V-shaped osteotomy) with no treatment and with non-surgical treatment. Fifteen studies compared different surgical techniques, including a V-shaped osteotomy (Chevron osteotomy), to other types of osteotomy. Nine studies compared different simple osteotomy techniques to each other or to a mid-shaft Z-shaped osteotomy (Scarf osteotomy).

Most trials were susceptible to bias: in particular, selection (80%), performance (88%), detection (96%) and selective reporting (64%) biases.

Surgery versus no treatment

Surgery may result in a clinically important reduction in pain. At 12 months, mean pain was 39 points (0 to 100 visual analogue scale, 100 = worst pain) in the no treatment group and 21 points in the surgery group (mean difference (MD) −18.00, 95% confidence interval (CI) −26.14 to −9.86; 1 study, 140 participants; low-certainty evidence). Evidence was downgraded for bias due to lack of blinding and imprecision.

Surgery may result in a slight increase in function. At 12 months, mean function was 66 points (0 to 100 American Orthopedics Foot and Ankle Scale (AOFAS), 100 = best function) in the no treatment group and 75 points in the surgery group (MD 9.00, 95% CI 5.16 to 12.84; 1 study, 140 participants; low-certainty evidence). Evidence was downgraded for bias due to lack of blinding and imprecision.

Surgery may result in little to no difference in quality of life. At 12 months, mean quality of life (0 to 100 on 15-dimension scale, 100 = higher quality of life) was 93 points in both groups (MD 0, 95% CI −2.12 to 2.12; 1 study, 140 participants; low-certainty evidence). Evidence was downgraded for bias due to lack of blinding and imprecision.

Surgery may result in a slight increase in participant global assessment of treatment success. At 12 months, mean participant global assessment of treatment success was 61 points (0 to 100 visual analogue scale, 100 = completely satisfied) in the no treatment group and 80 points in the surgery group (MD 19.00, 95% CI 8.11 to 29.89; 1 study, 140 participants; low-certainty evidence). Evidence was downgraded for bias due to lack of blinding and imprecision.

Surgery may have little effect on reoperation (relative effect was not estimable), adverse events (risk ratio (RR) 8.75, 95% CI 0.48 to 159.53; 1 study, 140 participants; very low-certainty evidence), and serious adverse events (relative effect was not estimable), but we are uncertain.

Surgery versus non-surgical treatment

Surgery may result in a clinically important reduction in pain; a slight increase in function and participant global assessment of treatment success; and little to no difference in quality of life (1 study, 140 participants; low-certainty evidence). We are uncertain about the effect on reoperation, adverse events and serious adverse events (1 study, 140 participants; very low-certainty evidence).

Complex versus simple osteotomies

Complex osteotomies probably result in little to no difference in pain compared with simple osteotomies (7 studies, 414 participants; moderate-certainty evidence). Complex osteotomies may increase reoperation (7 studies, 461 participants; low-certainty evidence), and may result in little to no difference in participant global assessment of treatment success (8 studies, 462 participants; low-certainty evidence) and serious adverse events (12 studies; data not pooled; low-certainty evidence). We are uncertain about the effect of complex osteotomies on function and adverse events (very low-certainty evidence). No study reported quality of life.

Authors' conclusions

There were no trials comparing surgery to placebo or sham. Surgery may result in a clinically important reduction in pain when compared to no treatment or non-surgical treatment. Surgery may also result in a slight increase in function and participant global assessment of treatment success compared to no treatment or non-surgical treatment. There may be little to no difference in quality of life between surgery and no treatment or non-surgical treatment. We are uncertain about the effect of surgery on reoperation (treatment failure), adverse events or serious adverse events, when compared to no treatment or non-surgical treatment.

Complex and simple osteotomies demonstrated similar results for pain. Complex osteotomies may increase reoperation (treatment failure) and may result in little to no difference in participant global assessment of treatment success and serious adverse events compared to simple osteotomies. We are uncertain about the effect of complex osteotomies on function, quality of life and adverse events.

PLAIN LANGUAGE SUMMARY

Are surgical interventions better than no treatment or non-surgical interventions for treating hallux valgus (bunions)?

Key messages

– Surgery may result in an improvement in pain, and a slight improvement in function and satisfaction with treatment compared with no treatment or non-surgical treatment. However, complications of surgery, such as wound infection, or hardware irritation requiring additional surgery, need to be balanced against its benefits in pain and function improvement.

What is hallux valgus?

Hallux valgus is a bony lump that forms on the inside of the feet (known as bunions). The exact cause is unknown but it is aggravated by constant pressure on the front of the foot, such as with ill-fitting shoes and high-heeled shoes. Hallux valgus leads to poor balance and increased risk of falling. Patients may have difficulty fitting into standard shoes, and have pain on the bottom of the foot and big toe, and pain caused by breakdown of the joint. All of these are worse when weight-bearing (i.e. when standing).

People with hallux valgus want a painless foot when wearing conventional shoes; improvements in swelling, joint pain and size of the bunion; improved walking; less restriction of sports activities; less use of walking aids or splints/braces; improved cosmetic appearance and freedom from medications.

How is hallux valgus treated?

Treatments include non-surgical options such as splints, braces or taping and surgical procedures involving one cut (simple surgery) or two or more cuts (complex surgery) to the bone to align it back to its previous or expected position.

What did we want to find out?

We wanted to find out if surgery was better than no treatment or non-surgical treatments to improve pain, function, quality of life and whether the person considered the treatment successful.

We also wanted to find out if surgery was associated with any unwanted effects or the need for another operation (treatment failure).

What did we do?

We searched for studies that compared surgery versus no treatment or non-surgical treatment or different types of surgery in adults. We compared and summarised the results of the studies and rated our confidence in the evidence based on factors such as study methods and sizes.

What did we find?

We found 25 studies with 1597 adults aged 16 to 80 years. There were more women than men. Participants were monitored for an average of 20 months (ranging from five to 84 months). We found no studies comparing surgery versus placebo (a pretend treatment). One study compared surgery with no treatment and with non-surgical treatment, and 24 studies compared different types of surgery to each other.

Main results

Here, we limited reporting to the main comparison, surgery versus no treatment (1 study, 140 participants).

The study measured pain on a 0- to 100-point scale where lower scores mean less pain. At 12 months after surgery, pain may have reduced compared to no treatment (by 18 points).

– People who had no treatment rated their pain as 39 points.

– People who had surgery rated their pain as 21 points.

The study measured function on a 0- to 100-point scale where higher scores mean better function. At 12 months after surgery, function may have increased slightly compared to no treatment (by 9 points).

– People who received no treatment rated their function as 66 points.

– People who had surgery rated their function as 75 points.

The study measured quality of life on a 0- to 100-point scale where higher scores mean better quality of life. At 12 months after surgery, there may be little to no difference in quality of life between groups.

– People who received no treatment rated their quality of life as 93 points.

– People who had surgery rated their quality of life as 93 points.

The study measured satisfaction with treatment on a 0- to 100-point scale where higher scores mean better satisfaction. At 12 months after surgery, satisfaction may have slightly increased compared to no treatment (by 19 points).

– People who received no treatment rated their satisfaction as 61 points.

– People who had surgery rated their satisfaction as 80 points.

We are uncertain about the effects on unwanted effects or need for another operation between groups.

What are the limitations of the evidence?

All 25 studies had weaknesses that could have affected the reliability of their results. Generally, the studies had poor methods and low numbers of participants.

How up to date is the evidence?

The evidence is up to date to 20 April 2023.

SUMMARY OF FINDINGS

Summary of findings 1. Summary of findings table - Surgery compared to no treatment for hallux valgus

Surgery compared to no treatment for hallux valgus

Patient or population: hallux valgus
Setting: 1 training and research hospital in Spain
Intervention: surgery
Comparison: no treatment

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with no treatment	Risk with surgery				
Pain assessed with: VAS (lower is better) Scale from: 0 to 100 follow-up: mean 12 months[a]	The mean pain was **39** points	MD **18 points lower** (26.14 lower to 9.86 lower)	-	140 (1 RCT)[b]	⊕⊕⊝⊝ Low[c,d]	Surgery may result in a clinically important reduction in pain.
Function assessed with: AOFAS (higher is better) Scale from: 0 to 100 follow-up: mean 12 months[e]	The mean function was **66** points	MD **9 points higher** (5.16 higher to 12.84 higher)	-	140 (1 RCT)	⊕⊕⊝⊝ Low[c,d]	Surgery may result in a slight increase in function.
Quality of life assessed with: 15-D scale (higher is better) Scale from: 0 to 100 follow-up: mean 12 months[f]	The mean quality of life was **93** points	MD **0 points** (2.12 lower to 2.12 higher)	-	140 (1 RCT)	⊕⊕⊝⊝ Low[c,d]	Surgery may result in little to no difference in quality of life.
Participant global assessment of treatment success assessed with: VAS (higher is better) Scale from: 0 to 100 follow-up: mean 12 months[a]	The mean participant global assessment of treatment success was **61** points	MD **19 points higher** (8.11 higher to 29.89 higher)	-	140 (1 RCT)	⊕⊕⊝⊝ Low[c,d]	Surgery may result in a slight increase in participant global assessment of treatment success.
Reoperation (treatment failure) follow-up: mean 12 months	0 per 100	**0 per 100** (0 to 0)	Not estimable	140 (1 RCT)	⊕⊝⊝⊝ Very low[c,d,g]	We are uncertain about the effect of surgery on reoperation (treatment failure).

Adverse events follow-up: mean 12 months	0 per 100	**0 per 100** (0 to 0)	**RR 8.75** (0.48 to 159.53)	140 (1 RCT)	⊕⊖⊖⊖ Very low[c,d,g]	We are uncertain about the effect of surgery on adverse events.
Serious adverse events follow-up: mean 12 months	0 per 100	**0 per 100** (0 to 0)	Not estimable	140 (1 RCT)	⊕⊖⊖⊖ Very low[c,d,g]	We are uncertain about the effect of surgery on serious adverse events.

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

CI: confidence interval; **MD:** mean difference; **RR:** risk ratio

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

See interactive version of this table: https://gdt.gradepro.org/presentations/#/isof/isof_question_revman_web_440297197100616783.

[a] VAS: visual analogue scale
[b] RCT: randomised controlled trial
[c] The single study had methodological flaws. Blinding of participants, personnel and outcome assessors was absent. All outcomes were downgraded one level for serious risk of bias.
[d] The total number of participants was small. We downgraded the certainty of the evidence one level for serious imprecision.
[e] AOFAS: American Orthopedic Foot and Ankle Scale
[f] 15-D: 15-dimension generic health-related quality of life measure
[g] The total number of events was very small. We downgraded the evidence one level for serious imprecision.

Summary of findings 2. Summary of findings table - Surgery compared to non-surgical treatment for hallux valgus

Surgery compared to non-surgical treatment for hallux valgus

Patient or population: hallux valgus
Setting: 1 training and research hospital in Spain
Intervention: surgery
Comparison: non-surgical treatment

Outcomes	Anticipated absolute effects* (95% CI)	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments

	Risk with non-surgical treatment	Risk with surgery				
Pain assessed with: VAS (lower is better) Scale from: 0 to 100 follow-up: mean 12 months[a]	The mean pain was **41** points	MD **20 points lower** (27.62 lower to 12.38 lower)	-	140 (1 RCT)[b]	⊕⊕⊖⊖ Low[c,d]	Surgery may result in a clinically important reduction in pain.
Function assessed with: AOFAS (higher is better) Scale from: 0 to 100 follow-up: mean 12 months[e]	The mean function was **64** points	MD **11 points higher** (7.16 higher to 14.84 higher)	-	140 (1 RCT)	⊕⊕⊖⊖ Low[c,d]	Surgery may result in a slight increase in function.
Quality of life assessed with: 15-D scale (higher is better) Scale from: 0 to 100 follow-up: mean 12 months[f]	The mean quality of life was **93** points	MD **0 points** (2.04 lower to 2.04 higher)	-	140 (1 RCT)	⊕⊕⊖⊖ Low[c,d]	Surgery may result in little to no difference in quality of life.
Participant global assessment of treatment success assessed with: VAS (higher is better) Scale from: 0 to 100 follow-up: mean 12 months[a]	The mean participant global assessment of treatment success was **70** points	MD **10 points higher** (1.05 higher to 18.95 higher)	-	140 (1 RCT)	⊕⊕⊖⊖ Low[c,d]	Surgery may result in a slight increase in participant global assessment of treatment success.
Reoperation (treatment failure) follow-up: mean 12 months	0 per 1000	**0 per 1000** (0 to 0)	Not estimable	140 (1 RCT)	⊕⊖⊖⊖ Very low[c,d,g]	We are uncertain about the effect of surgery on reoperation (treatment failure).
Adverse events follow-up: mean 12 months	0 per 1000	**0 per 1000** (0 to 0)	**RR 8.75** (0.48 to 159.53)	140 (1 RCT)	⊕⊖⊖⊖ Very low[c,d,g]	We are uncertain about the effect of surgery on adverse events.
Serious adverse events follow-up: mean 12 months	0 per 1000	**0 per 1000** (0 to 0)	Not estimable	140 (1 RCT)	⊕⊖⊖⊖ Very low[c,d,g]	We are uncertain about the effect of surgery on serious adverse events.

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

CI: confidence interval; **MD:** mean difference; **RR:** risk ratio

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

See interactive version of this table: https://gdt.gradepro.org/presentations/#/isof/isof_question_revman_web_440297650615242109.

[a] VAS: visual analogue scale
[b] RCT: randomised controlled trial
[c] The single study had methodological flaws. Blinding of participants, personnel and outcome assessors was absent. All outcomes were downgraded one level for serious risk of bias.
[d] The total number of participants was small. We downgraded the certainty of the evidence one level for serious imprecision.
[e] AOFAS: American Orthopedic Foot and Ankle Scale
[f] 15-D: 15-dimension generic health-related quality of life measure
[g] The total number of events was very small. We downgraded the evidence one level for serious imprecision.

Summary of findings 3. Summary of findings table - Complex osteotomies compared to simple osteotomies for hallux valgus

Complex osteotomies compared to simple osteotomies for hallux valgus

Patient or population: hallux valgus
Setting: tertiary hospitals and orthopaedic centres
Intervention: complex osteotomies
Comparison: simple osteotomies

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with simple osteotomies	Risk with complex osteotomies				
Pain assessed with: standardised VAS or MUS score (lower is better) Scale from: 0 to 10 follow-up: mean 11 months[a,b]	The mean pain was **1.26** points	MD **0.06 points lower** (0.41 lower to 0.29 higher)	-	414 (7 RCTs)[c]	⊕⊕⊕⊖ Moderate[d]	Complex osteotomies probably result in little to no difference in pain.

Function assessed with: standardised AOFAS, ACFAS scale or MOXFQ scale (higher is better) Scale from: 0 to 100 follow-up: mean 20.7 months[e,f]	The mean function was **84.31** points	MD **1.6 points higher** (2.33 lower to 5.54 higher)	-	616 (10 RCTs)	⊕⊖⊖⊖ Very low[d,g]	We are uncertain about the effect of complex osteotomies on function.
Quality of life	The mean quality of life was **0**	Not pooled	-	(0 RCTs)	-	No study reported qualitative data on quality of life.
Participant global assessment of treatment success follow-up: mean 24.15 months	82 per 1000	**135 per 1000** (81 to 228)	**RR 1.66** (0.99 to 2.80)	462 (8 RCTs)	⊕⊕⊖⊖ Low[d,h]	Complex osteotomies may result in little to no difference in participant global assessment of treatment success.
Reoperation (treatment failure) follow-up: mean 26 months	38 per 1000	**78 per 1000** (39 to 158)	**RR 2.04** (1.01 to 4.11)	461 (7 RCTs)	⊕⊕⊖⊖ Low[d,h]	Complex osteotomies may increase reoperation (treatment failure) when compared to simple osteotomies.
Adverse events follow-up: mean 33.58 months	294 per 1000	**194 per 1000** (150 to 247)	**RR 0.66** (0.51 to 0.84)	787 (12 RCTs)	⊕⊖⊖⊖ Very low[d,h,i]	We are uncertain about the effect of complex osteotomies on adverse events. See sensitivity analysis for more information.
Serious adverse events follow-up: mean 33.58 months	Not pooled	Not pooled	Not pooled	(12 RCTs)	⊕⊕⊖⊖ Low[d,j]	Complex osteotomies may result in little to no difference in serious adverse events.

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

CI: confidence interval; **MD:** mean difference; **RR:** risk ratio

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

See interactive version of this table: https://gdt.gradepro.org/presentations/#/isof/isof_question_revman_web_440886566791250406.

[a] VAS: visual analogue scale
[b] MUS: painful foot evaluation scale of Maryland University
[c] RCT: randomised controlled trial

[d] All studies had methodological flaws. Blinding of participants, personnel and outcome assessors was either absent or not specified. We downgraded the evidence one level for serious risk of bias.
[e] AOFAS: American Orthopedic Foot and Ankle Scale
[f] ACFAS: American College of Foot and Ankle Surgeons
[g] There was considerable heterogeneity. We downgraded the certainty of the evidence two levels for very serious inconsistency.
[h] The confidence intervals were wide, thus bringing uncertainty about the magnitude of the effect. We downgraded the certainty of the evidence one level for serious imprecision.
[i] There was considerable heterogeneity. We downgraded the certainty of the evidence one level for serious inconsistency.
[j] The number of events was small. We downgraded the certainty of the evidence one level for serious imprecision.

BACKGROUND

Description of the condition

The hallux is the great toe of the foot and has distinct anatomy due to its specific function (Perera 2011). Together with the first metatarsal, it forms the first metatarsophalangeal (MTP) joint, with the main action being to propel the body forwards. The joint plays an important role in gait and balance when standing. The local muscle insertions occur distally to (away from) the joint. With no insertions onto the metatarsal head, the proximal (closer to) part of the joint is vulnerable to deviation created by extrinsic forces. Medial (inward) deviation of the metatarsal typifies the hallux valgus, and this occurs with lateral (outward) deviation (abduction/valgus) of the hallux. It is a complex deformity that involves changes in many structures surrounding the joint. The layperson more frequently calls the deformity 'bunions', particularly when there is a prominent, and often inflamed, metatarsal head area due to an overlying bursa. Such features are often associated with hallux valgus (Ferrari 2009a).

As hallux valgus progresses, the muscles around the MTP joint, which would normally stabilise the joint, add to the deforming forces and lead to a worsening of hallux valgus by pulling the hallux further laterally (Schneider 2013). Hallux valgus may lead to pain and disability in the foot with further local pathology occurring due to the abnormal load transfer from the first metatarsal to the more lateral metatarsals. Such pathology may include lesser toe deformities (caused by stretch or rupture of the soft tissue stabilisers around the lesser MTP joints) and metatarsalgia (defined by pain over the second to fifth metatarsal heads). The combination of pathologies adds to the aesthetic complaints reported by patients (Burns 2014; Schneider 2001).

Hallux valgus presents in 23% to 35% of the population (Nishimura 2014; Nix 2010; Roddy 2008), and this variation is due to differences in study populations, such as genetic predisposition and gender (Nishimura 2014; Nix 2010; Roddy 2008). The condition predominantly affects women (Nishimura 2014; Nix 2010; Roddy 2008; Vanore 2003), and there may be differences in aetiologies between genders, although the reason for such differences is still unclear and further investigation is needed (Ferrari 2002; Nguyen 2010). Poorly fitting footwear is associated with accelerating the process (Perera 2011). Hallux valgus presents in various degrees, varying from asymptomatic or painless up to leading to poor balance and increased risk of falling (Menz 2001). Patients may present with difficulty fitting their usual shoes (due to the medial prominence), plantar foot pain, medial first MTP joint pain and deep MTP pain from joint degeneration, all of which are worse when weight-bearing. Some common conditions have been associated, including knee osteoarthritis and pes planus (flat feet); however, studies have been inconsistent in finding an association between foot function and hallux valgus or other degenerative disorders (Hagedorn 2013; Nishimura 2014; Nix 2010).

Based on weight-bearing anterior–posterior radiographic studies, hallux valgus can be classified as mild, moderate or severe (Hecht 2014). Classification systems based on these radiographic studies or visual estimation of the hallux valgus angles (HVA) have not been validated, and they differ widely between reference angles (Coughlin 2014; Higashi 2017; Mann 1990). One validated classification system is the Manchester Scale, based on a photographic reference set (Menz 2005). A commonly used radiographic classification is based on the HVA, intermetatarsal angle (IMA), and tibial sesamoid subluxation degree (TSSD).

The HVA is considered normal when less than 16 degrees and the IMA is normal when less than 10 degrees. The TSSD is measured by the amount of medialisation of the bisection of the first metatarsal in relation to the tibial sesamoid bone and is considered normal when it is zero (i.e. the tibial sesamoid is medial to the bisection of the first metatarsal). Mild hallux valgus presents with one of the following: HVA between 16 and 20 degrees, IMA of 10 or 11 degrees or TSSD is at the first degree (i.e. the bisection of the metatarsal crosses less than 50% of the tibial sesamoid). Moderate hallux valgus is considered when the HVA is 20 to 40 degrees, the IMA is 12 to 16 degrees or the TSSD is at the second degree (i.e. the bisection of the metatarsal crosses more than 50% of the tibial sesamoid). A severe hallux valgus is defined by an HVA greater than 40 degrees, IMA greater than 16 degrees or a TSSD at the third degree (i.e. the bisection of the metatarsal is completely medial to the tibial sesamoid) (Coughlin 2014).

The classification systems are typically used to grade hallux valgus and do not limit, but rather guide treatment decision-making. Radiographic classification of hallux valgus have often failed to correlate significantly with patient-reported outcome measures (PROM) (Lewis 2022; Roman 2021).

Description of the intervention

Non-surgical interventions, including pain-relief medication, physical therapy and orthoses, are usually the first-line treatment for hallux valgus (du Plessis 2011). These are usually considered an attempt to control pain (Torkki 2001). Surgical intervention options include tightening or losing the soft tissues (tenorrhaphy, tenotomy, capsulorrhaphy or capsulotomy, depending on which tissue is cut or sutured); a cut to the bone (osteotomy); joint fusion (arthrodesis) or joint replacement (arthroplasty).

Soft tissue procedures

Soft tissue procedures to loosen the lateral tissues or tighten the medial tissues (or both) have traditionally been used, alone or associated with other procedures, such as osteotomies or bunionectomy (removal of a bunion) when only the medial prominence of the metatarsal head is removed (Choi 2016; Mann 1992; McBride 1967; Park 2011). Thus, the procedure types, their variants and combinations hugely outnumber available trials.

Osteotomy

The hallux valgus correction procedure can be performed on the first metatarsal bone (osteotomy) preserving the joint surfaces of all the neighbouring bones (i.e. the cuneiform, which is posterior to (behind) the metatarsal; the metatarsal joint surfaces at each end of the metatarsal bone; the phalangeal joint surface anterior to (in front of) the metatarsal head). Such procedures may be directed to the proximal, mid-shaft or distal part of the bone. Procedures may include other bony structures, such as the proximal phalanx or the medial cuneiform, or they may be performed on the local soft tissues (joint capsule, ligaments or tendons). Procedures may be carried out singularly or in combination.

Fusion or replacement of the joint

It has been suggested that joint-sparing procedures allow for easier reintervention in cases of recurrence or failure. In such cases, if

the deformity or arthritic changes are not severe, a subsequent osteotomy may still be an option (Baravarian 2014). Alternatively, the surgeon may choose not to preserve the joint structure and instead consider an arthrodesis (fusion) or an arthroplasty (joint replacement) procedure.

Open procedures

Most surgeries are performed through open reduction, involving a 4-cm to 6-cm skin incision on the dorsal or medial aspect of the foot, with the procedure to be taken on the bone being relatively consistent regardless of incision size. Mild-to-moderate deformities are usually treated with a distal or mid-shaft osteotomy involving translation (sliding), with or without rotation, of the distal section of bone (Harrison 2016). The surgeon cuts through the distal/mid-shaft section of metatarsal bone with a small bone saw and then translates the distal fragment laterally (i.e. slides the front section sideways), which may include a rotation in the coronal plane (this would create a clockwise or counterclockwise rotation around the length of the bone). The aim of this is to reduce the HVA to normal, realign the distal metaphyseal articular angle and revert the coronal plane rotation of the metatarsal and phalanx. Severe hallux valgus is a challenge to treat, usually requiring an osteotomy at the base of the metatarsal (Vernois 2016). The articular cartilage may be accessed through an arthroscopic approach if there is an intention to, for instance, remove the cartilage to perform a fusion.

Minimally invasive procedures

Minimally invasive (mini-invasive) or percutaneous surgery has been adopted with increasing frequency and can be used to treat any degree of hallux valgus, if the surgeon has undergone adequate training (Bia 2018; Brogan 2016; Lee 2017; Li 2016; Lu 2020; Vernois 2016). Percutaneous procedures (also known as minimally invasive surgery or MIS) are performed through a small incision and use x-ray guidance for the surgery as the surgeon does not open the skin wide enough to see all the underlying structures. The advantage of this method is, allegedly, reduced operative time and a smaller, more cosmetically acceptable scar (Liuni 2018).

Postoperative treatment

Postoperative treatment may also vary between studies but usually involves taping associated with padding to keep the toe aligned while it heals, and some type of protective orthosis to protect the forefoot, which may be associated with or replaced by non-weight-bearing in the early postoperative period (Avcu 2018; Buciuto 2014; Deenik 2007; Dragosloveanu 2022).

How the intervention might work

People with hallux valgus usually want outcomes that include a painless foot when wearing conventional shoes, improvements in bursitis and medial prominence (bunion), improved walking distance, less restriction of sports activities, less use of walking aids or orthotics, improved cosmetic appearance and being medication-free (Schneider 2001).

Why it is important to do this review

Hallux valgus is one of the most common causes of foot pain and may lead to long-term pain, deformity and disability (Torkki 2001; Vanore 2003). Despite its high prevalence, there is no consensus regarding the best approach to treat the condition (Wester 2016). This review reports on available evidence in the literature considering the resolution of pain and improvement of function, quality of life, resolution of deformity, participant global assessment of treatment success, reoperation (treatment failure) and adverse effects.

Reoperation (treatment failure) is defined as recurrence of hallux valgus (Raikin 2014) or iatrogenic hallux varus (overcorrection) (Davies 2014) requiring non-routine secondary intervention (reoperation). Adverse events include transfer metatarsalgia (when pain develops after the operation on any of the lesser (second to fifth) metatarsals) (Maceira 2014) and avascular necrosis (collapse of the bone due to disruption of the blood supply) (Rothwell 2013). Risk factors for complications have been described as anatomic (skeletal immaturity, local joint hypermobility, congruent joint, abnormal foot posture), systemic (generalised hypermobility, hypothyroidism, gout, neuromuscular conditions), social (smoking, non-compliance, continued wearing of high-heeled shoes) or surgical (incorrect surgery, undercorrection, insufficient technical skills or medical knowledge) (Goldberg 2014; Raikin 2014).

Before this current review, a previous Cochrane review evaluated different treatments for hallux valgus but found limited available evidence (Ferrari 2009a). Since that initial review, more trials, particularly surgical studies, have been added to the evidence base. Evidence suggests that conservative treatment only provides short-term relief compared to no treatment (Torkki 2001), and, compared to placebo taping (tape applied to the medial part of the foot without any stretch force) or no taping, which is only effective in instantly reducing the HVA, there is no long-term benefit (Akaras 2020). This review considered all types of treatment (surgical or non-surgical) to determine if there is sufficient evidence to establish the relative effects on the final outcomes of each procedure compared to the others.

OBJECTIVES

To assess the benefits and harms of different types of surgery compared with placebo or sham surgery, no treatment, non-surgical treatments and other surgical interventions for adults with hallux valgus.

METHODS

Criteria for considering studies for this review

Types of studies

We considered for inclusion any randomised controlled trial (RCT) or quasi-RCT (where the method of allocating participants to a treatment was not strictly random, e.g. by date of birth, hospital record number or alternation) that compared placebo, no treatment, non-surgical treatments and other surgical interventions to another surgical procedure or to a non-surgical procedure for the treatment of hallux valgus. We excluded biomechanics and gait studies, and those performed in the laboratory, which have no confirmed relationship to clinical outcomes. We included data from studies reported as full text only, and excluded those published as abstract only, unpublished data and ongoing studies. There were no language or date restrictions. We also excluded cluster and cross-over RCTs.

Types of participants

We included adults (aged over 18 years) who had been diagnosed with hallux valgus. We included studies of participants younger than 18 years of age if the proportion of participants of this age was less than 10% or if separate data were available. We also included people with a history of other foot injuries or concurrent foot injuries, provided there were separate data for this population or the numbers included were small and balanced between the two groups (Eccleston 2010). Since the diagnostic tools (such as radiographic measures and physical examination) frequently vary between studies, we used no specific definition of hallux valgus, other than a valgus deformity at the first metatarsal–phalangeal joint.

Types of interventions

Surgical procedures included soft tissue procedures with or without bony procedures; proximal, mid-shaft and distal metatarsal osteotomies; bony procedures involving neighbouring bones associated with hallux valgus, fusions (arthrodesis), arthroplasties and joint-sparing procedures; open, percutaneous and minimally invasive approaches. A description of the possible surgical interventions is given below.

- Techniques involving open reduction of the metatarsal bone or osteotomies in which the metatarsal was realigned in relation to the proximal phalanx, for example, Chevron (Austin 1981), Scarf (Weil 2000), or Wilson (Xarchas 2014) osteotomy.
- Techniques that fused the joint, such as an arthrodesis of the first tarsometatarsal joint (i.e. Lapidus procedure (Lapidus 1960)), or fusion of the first MTP joint (Little 2014), and those that replaced the joint (arthroplasty) by putting a false joint in situ, capsule interposition or excising the joint surface (Hamilton 1997). Procedures that preserved the joint were specifically evaluated against those that fuse or remove the joint.
- Procedures involving soft tissue correction with the primary bony procedure (Mann 1992) or without the primary bony procedure (McBride 1967) (such as a Chevron osteotomy with distal lateral soft tissue release). These procedures aim to realign the structures by releasing the contracted tissues (i.e. the lateral capsule, the adductor hallucis muscle and the lateral metatarsosesamoid ligament, which surround the MTP joint) or tightening the loosened tissues (i.e. the capsule, which is a fibrous structure that forms a cuff around the joint, becomes stretched and loose on the medial side of the joint).

We compared surgery with:

- placebo surgery (i.e. faked surgical intervention), where everything but the actual procedure was performed (Beard 2020);
- sham surgery (i.e. only small superficial incisions were performed or surgery was completely simulated) (Beard 2020);
- no treatment;
- non-surgical interventions (analgesics, physical therapy and orthoses);
- other surgical procedures (as described above)

Types of outcome measures

Timing of outcome measurement

We grouped time points as follows: immediately after the intervention (up to six weeks' follow-up), at six months' follow-up, at 12 months' follow-up (primary time point) and at 24 months' follow-up. When a study reported data at more than one time point within any of these time frames, we extracted data from the latest time point.

Major outcomes

- **Pain**, preferably measured using validated pain scales, such as the visual analogue scale (VAS) and the numerical rating scale (NRS) (Eccleston 2010; Farrar 2010; Moore 2010; Remérand 2014), or pain subscales of composite scales if separate pain scales are not reported, for example, the Manchester-Oxford Foot Questionnaire (MOXFQ) – Foot Pain component (Dawson 2011).
- **Function**, measured using the Foot Function Index (FFI) (Budiman-Mak 1991), which is widely used and validated (Hunt 2013), or composite outcome measures such as the American College of Foot and Ankle Surgeons (ACFAS) Forefoot scale (Cook 2011), the American Academy of Orthopaedic Surgeons (AAOS) outcomes instrument (Johanson 2004), the MOXFQ – Walking/Standing component (Dawson 2011), or the Medical Outcomes Study 36-item Short Form (SF-36) – Physical Component score (Patel 2007). The composite outcome measure American Orthopedic Foot and Ankle Scale (AOFAS) clinical rating system is the most frequently used scale (Hunt 2013); hence, it was included, even though it has not been validated (Hijji 2020; SooHoo 2003).
- **Quality of life**, measured using validated PROMs, such as the 36-item Short Form (SF-36) – Mental Component score (Patel 2007), the EuroQol instrument (EQ-5D) (Brooks 1996), and the MOXFQ – Social Interaction component (Dawson 2011).
- **Participant global assessment of treatment success**, as reported by the trial authors.
- **Reoperation** (treatment failure), or unplanned secondary surgery, defined as a need for a non-routine secondary surgical intervention for any reason, such as recurrence, under- or overcorrection.
- **Adverse events**, reported as the proportion of participants reporting one or more events (such as wound infection or dehiscence, avascular necrosis, transfer metatarsalgia, symptomatic non-union, malunion, broken or loose implant),
- **Serious adverse events** resulting in hospitalisation, disability or death, reported as the proportion of participants reporting one or more of these events.

Hierarchy of outcome measures

For multiple measures of the same outcome in the same article, we used the following hierarchy to denote the preferred measure:

- for pain, the NRS or VAS, followed by pain subscales of composite measures (i.e. MOXFQ);
- for function, the FFI, followed by AOFAS, ACFAS, AAOS, MOXFQ – Walking/Standing component, and SF-36 – Physical Component;
- for quality of life, the SF-36 – Mental Health component, followed by EQ-5D and MOXFQ – Social Interaction component.

Minor outcome

- **Radiological measurement of the hallux valgus angle**.

Search methods for identification of studies

Electronic searches

We searched the following electronic databases on 20 April 2023.

- Cochrane Central Register of Controlled Trials (CENTRAL, in the Cochrane Library; 2023, Issue 3)
- MEDLINE Ovid
- Embase Ovid

We searched ClinicalTrials.gov (clinicaltrials.gov) and the World Health Organization (WHO) ICTRP (www.who.int/ictrp/en/) for ongoing and recently completed studies on 20 April 2023. All databases were searched from their inception. There were no restrictions on the language of publication. The CENTRAL, MEDLINE and Embase search strategies are outlined in Appendix 1, Appendix 2, and Appendix 3.

Searching other resources

We checked the reference lists of included studies and reviews for possible relevant studies.

Data collection and analysis

The intended methodology for data collection and analysis was described in our published protocol (Dias 2020), which was based on the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2019). The main changes from the protocol are summarised in Differences between protocol and review.

Selection of studies

Two review authors (CGD, AG, both certified foot and ankle specialists) independently screened titles and abstracts of all the potential studies identified by the search and coded them as 'retrieve' (eligible or potentially eligible/unclear) or 'do not retrieve'. We retrieved the full-text reports, and two review authors (CGD, AG) independently screened them and identified studies for inclusion. We resolved any disagreement through discussion or, when required, we consulted a third person (JF). We identified and excluded duplicates and collated multiple reports of the same study so that each study, rather than each report, was the unit of interest in the review. We identified and recorded reasons for excluding ineligible studies. We recorded the selection process in sufficient detail to complete a PRISMA flow diagram.

Data extraction and management

We used a data collection form for study characteristics and outcome data, which was piloted in at least one study in the review. One review author (CGD) extracted study characteristics from the Included studies. A second review author (AG) spot-checked study characteristics for accuracy against the trial report. We extracted the following information.

- **Methods**: details of trial registration, study design, total duration of study, availability of a published protocol, number of study centres and surgeons, study setting, date of study, funding sources, declaration of interest and clear description of withdrawals.
- **Participants**: number of participants, mean age, age range, gender, disease duration, degree of hallux valgus (reported as described by each study or, if unavailable, based on the classification described in Description of the condition), diagnostic criteria; inclusion criteria and exclusion criteria.
- **Interventions**: timing, intervention procedure, compared procedure and concomitant (ideally identical) medications, rehabilitation or co-intervention.
- **Outcomes**: primary and secondary outcomes specified and collected, time points of data collection, reported losses.
- **Characteristics of the design of the trial**, as outlined in Assessment of risk of bias in included studies.

Two review authors (CGD, AG) independently extracted outcome data from included studies. We extracted the number of events and number of participants per treatment group for dichotomous outcomes, and means and standard deviations (SD) and number of participants per treatment group for continuous outcomes. We noted in the Characteristics of included studies table if outcome data were not reported in a usable way and when data were transformed or estimated from a graph. We resolved disagreements by consensus or by involving a third review author (JF). One review author (CGD) transferred data into Review Manager (RevMan 2024). We double-checked that data was entered correctly by comparing the data presented in the systematic review with the study reports.

We planned to use PlotDigitizer software to extract data from graphs or figures, though this was not necessary or applicable (PlotDigitizer).

Other predefined decision rules for data extraction included the following.

- If studies reported both final values and change scores for the same outcome, we extracted the final value.
- We extracted the unadjusted values for a given outcome in cases where studies reported both adjusted and unadjusted values.
- For outcomes assessing harms, we extracted data reported from both intention-to-treat and as-treated analyses. For outcomes assessing benefits, we extracted the data from the intention-to-treat sample only.
- Where studies reported multiple time points, we extracted those closest to our predetermined milestones (i.e. immediately after the intervention (up to six weeks' follow-up), at six months' follow-up, at 12 months' follow-up) and at 24 months' follow-up.

Main planned comparisons

Our primary comparison was supposed to be any surgical intervention versus placebo surgery (i.e. a faked surgical intervention, where a cut and everything but the actual procedure is performed) or sham surgery (i.e. only small superficial incisions are performed or surgery is completely simulated). However, the search found no placebo or sham-controlled trials, so the planned summary of findings table for this comparison was not created. We presented summary of findings tables for the following comparisons.

- Surgery compared to no treatment (i.e. watchful waiting)
- Surgery compared to non-surgical treatment (pain-relief medication, physical therapy and orthoses)

- One type of surgery versus another type of surgery (complex osteotomies compared to simple osteotomies)

Assessment of risk of bias in included studies

Two review authors (CGD, AG) independently assessed the risk of bias for each study using the RoB 1 tool and the criteria outlined in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2019). We resolved disagreements by discussion or involving another review author (JF). We assessed the risk of bias according to the following domains.

- Random sequence generation
- Allocation concealment
- Blinding of participants and personnel
- Blinding of outcome assessment
- Incomplete outcome data
- Selective outcome reporting
- Other biases (e.g. recruiting of additional participants from a subgroup showing more benefit and presence of prerandomisation intervention that could have changed the subsequent randomised intervention; unequal use of co-interventions)

We assessed each study at high, low or unclear risk of bias for each of the domains listed above, and we provided a quote from the study report together with a justification for our judgement in Risk of bias in included studies. We summarised the risk of bias judgements across different studies for each of the domains listed. We considered blinding separately for different key outcomes where necessary (e.g. unblinded outcome assessment may carry a different risk of bias than a blinded assessment of a participant-reported pain scale). In addition, we considered the impact of missing data on key outcomes.

Where information on the risk of bias related to unpublished data or correspondence with a trialist, we noted this in the risk of bias section in the Characteristics of included studies table. When considering treatment effects, we considered the risk of bias for the studies that contributed to that outcome. We presented the figures generated by the RoB 1 tool to provide summary assessments of the risk of bias.

Assessment of bias in conducting the systematic review

We conducted this review according to the published protocol (Dias 2020), and we reported any deviations from it in the Differences between protocol and review section of this systematic review.

Measures of treatment effect

We analysed dichotomous data as risk ratios (RR), or Peto odds ratios when an outcome was a rare event (approximately less than 10%), and 95% confidence intervals (CI). For continuous data where studies used the same scale to measure the outcome, we analysed data using the mean difference (MD) and 95% CI. Where studies used different scales, we use the standardised mean difference (SMD) and 95% CI. Whenever needed, we back-translated the SMD to a typical scale (e.g. 0 to 10 for pain) by multiplying the SMD by a typical among-person SD (e.g. the SD of the control group at baseline from the most representative trial), in accordance with Chapter 15 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Schünemann 2019). Data are presented as a scale with a consistent direction of effect across studies. We did not analyse time-to-event data as hazard ratios, because no studies provided this information.

We assumed a minimal clinically important difference (MCID) of 1.5 points on a 10-point scale for pain and 10 points on a 100-point scale for function or composite outcome measures.

For dichotomous outcomes, we calculated the absolute percent change from the difference in the risks between the intervention and control groups using GRADEpro GDT (GRADEpro GDT 2015), and expressed it as a percentage.

Unit of analysis issues

The unit of randomisation was the individual participant. This leads to a potential unit of analysis issue with composite outcomes, namely adverse events and serious adverse events, where studies may report numbers of participants with specific outcomes instead of numbers of participants with one or more outcomes. For example, a study might give the total number of adverse events instead of separate results for transfer metatarsalgia and symptomatic malunion (see Types of outcome measures).

To avoid double counting of cases, for these composite outcomes, we extracted the number of participants with one or more complications, as far as could be presumed from the study reports. Where the composite event rate was not clearly reported or could not be deduced, we reported the number of cases for each individual component event of the composite only. We extracted the number of participants with one of the component events as a proxy (we chose the component event with the most cases in each treatment group). We reported all decisions in the Characteristics of included studies table. Where studies reported multiple arms, we included only the relevant arms.

Dealing with missing data

We contacted investigators or study sponsors to verify key study characteristics and obtain missing numerical outcome data when possible (e.g. when a study was identified as an abstract only or when data were not available for all participants). When this was not possible, and the missing data were thought to introduce serious bias, we explored the impact of including such studies in the overall assessment of results using a sensitivity analysis. We clearly described any assumptions and imputations to handle missing data, and explored the effect of imputation using sensitivity analyses (see Sensitivity analysis).

For dichotomous outcomes (e.g. number of withdrawals due to adverse events), we analysed the worst-case scenario by using the number of participants randomly assigned as the denominator and assumed all missing participants at the end of treatment had a negative outcome (in the example given above, all the missing participants were assumed to have had an adverse event). The best-case scenario was analysed with the same denominator, ignoring the dropouts. We then compared the worst-case and best-case scenarios.

For continuous outcomes (e.g. mean change in pain score), we calculated the MD or SMD based on the number of participants analysed at that time point. If the number of participants analysed was not presented for each time point, we used the number of randomised participants in each group at baseline.

When possible, we computed missing SDs from other statistics such as standard errors, CIs or P values, according to the methods recommended in the *Cochrane Handbook for Systematic Reviews of Interventions* (Boutron 2019). We imputed SDs if they could not be calculated (e.g. from other studies in the meta-analysis).

Assessment of heterogeneity

We assessed clinical and methodological diversity in terms of participants, interventions, outcomes and study characteristics to determine whether a meta-analysis was appropriate. We did this by examining these data in the data extraction tables. We assessed statistical heterogeneity by visual inspection of the forest plot to assess for obvious differences in results between the studies, and by using the I^2 and Chi^2 statistical tests.

As recommended in the *Cochrane Handbook for Systematic Reviews of Interventions*, an I^2 statistic of 0% to 25% may represent low heterogeneity; 25% to 50% may represent moderate heterogeneity; 50% to 90% may represent substantial heterogeneity and 90% to 100% represents considerable heterogeneity (Deeks 2019). The importance of the I^2 statistic depends on the magnitude and direction of effects and the strength of evidence for heterogeneity. We used the Chi^2 test where a P value of 0.10 or less indicated evidence of statistical heterogeneity. Where we identified substantial heterogeneity, we reported it and investigated possible causes by following the recommendations in Section 10.10 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Deeks 2019).

Assessment of reporting biases

We created and examined a funnel plot to explore possible small-study biases. When interpreting funnel plots, we examined the possible reasons for funnel plot asymmetry and related this to the results of the review. Only in cases where we are able to pool more than 10 trials did we undertake formal statistical tests to investigate funnel plot asymmetry and follow the recommendations in Section 13.3 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Page 2019).

To assess outcome reporting bias, we checked trial protocols against the published reports. For studies published after 1 July 2005, we screened the WHO ICTRP for the trial protocol (apps.who.int/trialssearch). We evaluated whether selective reporting of outcomes was present.

Data synthesis

We undertook meta-analyses only in scenarios in which it was meaningful (i.e. when the type of treatment, participants and underlying clinical question were similar enough for pooling to make sense). We used a random-effects model, as we expected some diversity across populations, surgeries and rehabilitation management. When applicable, we performed a sensitivity analysis using the fixed-effect model. We performed analyses using Review Manager and produced forest plots for all analyses (RevMan 2024).

Subgroup analysis and investigation of heterogeneity

Some authors suggest that better outcomes can be achieved if the technique is decided based on the degree of hallux valgus (Cooper 2007; Dereymaeker 2000; Isham 1991; Prado 2020). Several studies investigated the use of minimally invasive or even percutaneous procedures to perform the same traditional osteotomies currently achieved through open surgery (Bia 2018; Brogan 2016; Lu 2020). Thus, we carried out subgroup analyses for the following factors.

- Degree of hallux valgus prior to treatment (i.e. mild, moderate or severe)
- Surgical access (i.e. open, minimally invasive or percutaneous)

We defined the degree of hallux valgus preferably by the IMA, obtained from load-bearing dorsoplantar radiography of the affected foot. The IMA is the angle formed by the axis of the first and the second metatarsals. Graduation milestones will be considered as follows: normal when greater than 8 degrees to less than 10 degrees; mild when 10 degrees to less than 12 degrees; moderate when 12 degrees to 16 degrees; and severe when greater than 16 degrees. When a study did not provide information on the IMA, we utilised subjective graduation based on the author's perspective or physical examination description.

We included the following outcomes in the subgroup analyses.

- Pain
- Function
- Reoperation (treatment failure)

We conducted the formal test for subgroup interactions in Review Manager (RevMan 2024), and exercised caution when interpreting subgroup analyses. We compared the magnitude of effects between subgroups by assessing the overlap of the CIs of summary estimates. Non-overlapping of the CIs indicates a difference between groups.

Sensitivity analysis

We carried out sensitivity analyses to investigate the robustness of the treatment effect to selection bias, detection bias and inclusion of imputed data. We included the outcomes of pain, function and reoperation (treatment failure). Thus, we considered the effect of excluding trials from the analysis with:

- imputed data and data based on assumptions;
- inadequate or unclear allocation concealment;
- inadequate or unclear blinding of participant and outcome assessor.

Summary of findings and assessment of the certainty of the evidence

We identified no placebo or sham-controlled trials, so the planned summary of findings table for this comparison was not created. We prepared summary of findings tables for the following comparisons: surgery compared to no treatment; surgery compared to non-surgical treatment; one type of surgery versus another type of surgery (complex osteotomies compared to simple osteotomies). We included data on the following outcomes, at the primary time point (12-month follow-up).

- Pain
- Function
- Quality of life
- Participant global assessment of treatment success
- Reoperation (treatment failure)
- Adverse events
- Serious adverse events

Two review authors (CGD, AG) independently assessed the certainty of the evidence. We used the five GRADE domains (study limitations, consistency of effect, imprecision, indirectness and publication bias) to assess the certainty of the body of evidence as it related to the studies that contributed data to the meta-analyses for the prespecified outcomes as high, moderate, low or very low. We used the methods and recommendations described in Chapter 9 and Chapter 15 of the *Cochrane Handbook for Systematic Reviews of Interventions* (McKenzie 2019; Schünemann 2019). We used GRADEpro GDT software to prepare the summary of findings tables (GRADEpro GDT 2015). We justified all decisions to downgrade the certainty of the evidence in the footnotes of the table, and made comments to aid the reader's understanding of the review when necessary.

RESULTS

Description of studies

See Characteristics of included studies and Characteristics of excluded studies tables.

Results of the search

The search for this review (updated to 20 April 2023) identified 2444 records from CENTRAL, MEDLINE and Embase. A total of 426 articles were excluded as duplicates, and we screened the remaining 2018 based on their title and abstract. Two records were identified from checking reference lists (Othman 2017; Palmanovich 2020). We excluded 13 records after analysis of the full text (Characteristics of excluded studies table). We included 25 studies (Avcu 2018; Buciuto 2014; Deenik 2007; Dragosloveanu 2022; Easley 1996; Elshazly 2018; Faber 2004; Giannini 2013; Glazebrook 2014; Kaufmann 2020; Klosok 1993; Lee 2015; Lee 2017; Mahadevan 2016; Othman 2017; Palmanovich 2020; Park 2013; Radwan 2012; Resch 1993; Sahin 2018; Saro 2007; Torkki 2003; Torrent 2021; Uygur 2016; Wester 2016), of which six had more than one publication (Deenik 2007; Faber 2004; Glazebrook 2014; Kaufmann 2020; Torkki 2003; Torrent 2021). A flow diagram summarising the study selection process is shown in Figure 1.

Figure 1.

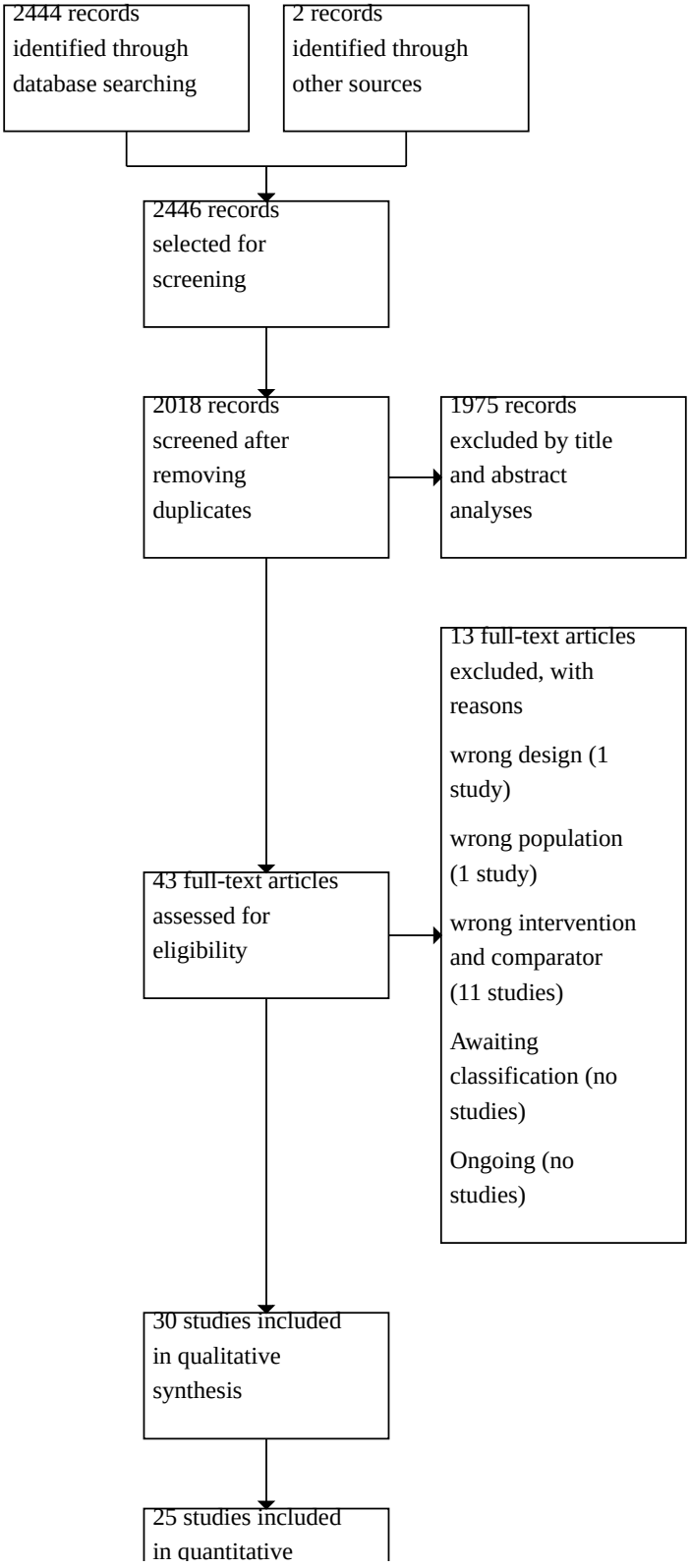
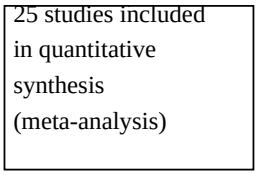


Figure 1. (Continued)



There were no ongoing studies found in the WHO ICTRP search portal and ClinicalTrials.gov. There are no studies awaiting classification.

Included studies

Details of the 25 included studies can be found in Characteristics of included studies table. No studies compared surgery with placebo or sham; one study compared surgery with no treatment (Torkki 2003); one study compared surgery with non-surgical treatment (Torkki 2003); and 24 studies compared different surgical techniques (Avcu 2018; Buciuto 2014; Deenik 2007; Dragosloveanu 2022; Easley 1996; Elshazly 2018; Faber 2004; Giannini 2013; Glazebrook 2014; Kaufmann 2020; Klosok 1993; Lee 2015; Lee 2017; Mahadevan 2016; Othman 2017; Palmanovich 2020; Park 2013; Radwan 2012; Resch 1993; Sahin 2018; Saro 2007; Torrent 2021; Uygur 2016; Wester 2016). We obtained adverse event numbers from Uygur 2016 by personal contact. Tada 2015 provided some information regarding the study, although this paper was not included in the analysis due to the inclusion of only participants with rheumatoid arthritis with severe hallux valgus and indication for arthrodesis. All studies were reported in English.

Design

All studies were parallel-group RCTs with two intervention groups, except for Torkki 2003, which had a three-group design. Torkki 2003 was conducted in four centres in Finland and Glazebrook 2014 in three centres in Canada. All others were single-centre studies. Studies took place in Turkey, Norway, the Netherlands, Romania, the USA, Egypt, Italy, Canada, Austria, the UK, South Korea, Australia, Sweden, Finland, Spain and Denmark.

The 25 studies enrolled 1597 participants. There were outcome data for 1475 participants (92.4% of those enrolled). The number of randomised participants in individual studies ranged from 36 (Palmanovich 2020) to 208 (Torkki 2003).

Three studies reported that they had been funded (Glazebrook 2014; Lee 2015; Torrent 2021); none of the sources were commercial or would have influenced the conduct and reporting of the trial. Glazebrook 2014 and Lee 2015 reported having received funding from a commercial entity for individual authors in support of the research; however, it was also made clear that the authors were not obliged to provide benefits to the commercial entity in relation to the research. The absence of external funding was either confirmed or likely in the other 22 studies.

Participants

All studies included adults aged between 18 and 80 years. Faber 2004, Mahadevan 2016, and Resch 1993 also included participants aged between 16 and 17 years. Overall, the review population included adults of a wide variety of ages. The mean age of participants in individual studies ranged from 41 years (Faber 2004) to 64 years (Torrent 2021). In all study populations, gender data provided for assigned or assessed participants showed that participants were almost exclusively female, with the proportion of women in individual studies ranging from 83% (Palmanovich 2020) to 100% (Uygur 2016).

All studies included only participants with hallux valgus and all used the radiographic evaluation to perform diagnosis. All studies excluded potential participants with rheumatoid arthritis, except for Klosok 1993 in which 9% of study participants had that associated condition. Deenik 2007, Elshazly 2018, Faber 2004, Mahadevan 2016, and Resch 1993 included any degree of hallux valgus (from 15 to 62 degrees of HVA). Avcu 2018, Buciuto 2014, Easley 1996, Glazebrook 2014, Kaufmann 2020, Lee 2015, Lee 2017, Park 2013, Torrent 2021, Sahin 2018, Saro 2007, and Wester 2016 excluded mild cases (HVA less than 20 degrees) from their trials. Giannini 2013, Othman 2017, Palmanovich 2020, Radwan 2012, and Torkki 2003 excluded severe cases (HVA greater than 40 degrees) from their trials. Finally, Dragosloveanu 2022, Klosok 1993, and Uygur 2016 included only moderate cases in their trials.

Interventions

Details of the interventions of the included studies can be found in the Characteristics of included studies table. There were no placebo or sham-controlled trials. Based on the treatment method (surgical or non-surgical), the included studies could be grouped into two comparisons: 1. Surgical intervention versus non-surgical intervention using orthosis (Torkki 2003); and 2. Surgical intervention versus no treatment (Torkki 2003). Follow-up data were available for 208 participants (71 with surgical intervention, 69 with non-surgical intervention and 68 with no treatment). Based on the shape of the osteotomy (bi- or tri-planar, V- or Z-shaped or uniplanar osteotomies) participants could be grouped into one additional comparison: complex osteotomies (i.e. the bone cut was performed in at least two connected planes) versus simple osteotomies (i.e. the bone cut was performed in only one plane) (Avcu 2018; Buciuto 2014; Giannini 2013; Glazebrook 2014; Klosok 1993; Othman 2017; Palmanovich 2020; Radwan 2012; Resch 1993; Saro 2007; Uygur 2016; Wester 2016). Outcome data were available for 787 participants (392 in the complex osteotomies group and 395 in the simple osteotomies group).

Outcomes

The studies varied in the timing of follow-up. Giannini 2013 conducted a maximum follow-up of 84 months. Saro 2007 reported follow-up data for 55 months. Most studies specified follow-up time points at one or two years. Glazebrook 2014, Palmanovich 2020, Sahin 2018, Torkki 2003, and Wester 2016 reported follow-up

data for one year. Deenik 2007, Easley 1996, Elshazly 2018, Faber 2004, Giannini 2013, Lee 2015, Radwan 2012, Torrent 2021, and Uygur 2016 presented data for two years. Buciuto 2014, Klosok 1993, Othman 2017, Park 2013, and Resch 1993 reported only long-term outcomes from 36 to 50 months. The follow-up period was very short (less than one year) in Lee 2017 (six months) and Avcu 2018 (five months). Kaufmann 2020 reported results for nine and 60 months, but we analysed the nine-month data because it was closer to the overall mean follow-up (20 months).

Major outcomes

Pain

Ten studies that assessed pain used a VAS, either ranging from 0 cm to 10 cm (with 0 indicating no pain and 10 indicating maximum pain) or 0 mm to 100 mm (100 indicating maximum pain) (Avcu 2018; Dragosloveanu 2022; Faber 2004; Glazebrook 2014; Kaufmann 2020; Lee 2017; Sahin 2018; Torkki 2003; Torrent 2021; Wester 2016). Six studies did not report pain on a VAS but with a subscale of AOFAS (0 (severe pain) to 40 (no pain)) (Deenik 2007; Easley 1996; Lee 2015; Park 2013; Radwan 2012; Saro 2007). We presented data on a 0- to 100-mm scale in our analyses. Eight studies did not evaluate pain (Buciuto 2014; Elshazly 2018; Giannini 2013; Klosok 1993; Mahadevan 2016; Othman 2017; Palmanovich 2020; Resch 1993). Avcu 2018 reported the VAS score results in a very short post-intervention period of only three weeks.

Function or disability

Apart from three studies (Klosok 1993; Mahadevan 2016; Resch 1993), all studies reported function on the AOFAS Composite outcome scale. Mahadevan 2016 assessed function or disability using the MOXFQ. Avcu 2018 reported the AOFAS score results in a very short postintervention period of only three weeks. Klosok 1993 and Resch 1993 did not assess function.

Quality of life

Two studies reported quality of life (Saro 2007; Torkki 2003). Saro 2007 used the EQ-5D; however, the means and SDs were not reported. Torkki 2003 reported quality of life using a generic health-related quality-of-life measure, the 15-D.

Participant global assessment of treatment success

Apart from six studies (Dragosloveanu 2022; Elshazly 2018; Glazebrook 2014; Sahin 2018; Torrent 2021; Wester 2016), all other studies reported the number of participants dissatisfied with treatment. Lee 2017 was the only study in which the number of dissatisfied participants was mentioned as zero in each group. Torkki 2003 assessed participant global assessment of treatment success using a questionnaire.

Reoperation (treatment failure)

Fourteen studies assessed reoperation (treatment failure) as the number of participants who underwent a non-routine secondary surgical intervention (excluding hardware removal, which was considered an adverse event) for recurrence, symptomatic non-union, malunion or other complications (Avcu 2018; Easley 1996; Elshazly 2018; Faber 2004; Glazebrook 2014; Kaufmann 2020; Klosok 1993; Mahadevan 2016; Othman 2017; Palmanovich 2020; Resch 1993; Saro 2007; Torrent 2021; Wester 2016).

Adverse events

All studies measured adverse events as the number of participants with an adverse outcome. Five studies counted recurrence as an adverse event as well as reoperation (Elshazly 2018; Mahadevan 2016; Saro 2007; Torrent 2021; Wester 2016). Details of adverse events are given for each study in the Characteristics of included studies table.

Serious adverse events

No study reported serious adverse events such as hospitalisation, disability, or death.

Excluded studies

We excluded 13 studies because they did not meet our inclusion criteria. Tada 2015 had an ineligible population (only participants with rheumatoid arthritis) and the other 12 studies had an ineligible comparator (they did not present at least two different anatomical sites or two different types of approaches to the osteotomy site) (DiGiorgio 2016; Irha 2016; Lazaro 2018; Martin 2012; Matricali 2014; Pentikainen 2015; Plaass 2018; Resch 1994; Riva 2012; Tonbul 2009; Windhagen 2013).

Studies awaiting classification

There were no studies awaiting classification.

Ongoing studies

There were no ongoing studies.

Risk of bias in included studies

All studies had methodological flaws, rendering them at high risk of bias (see Figure 2 and Figure 3).

Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

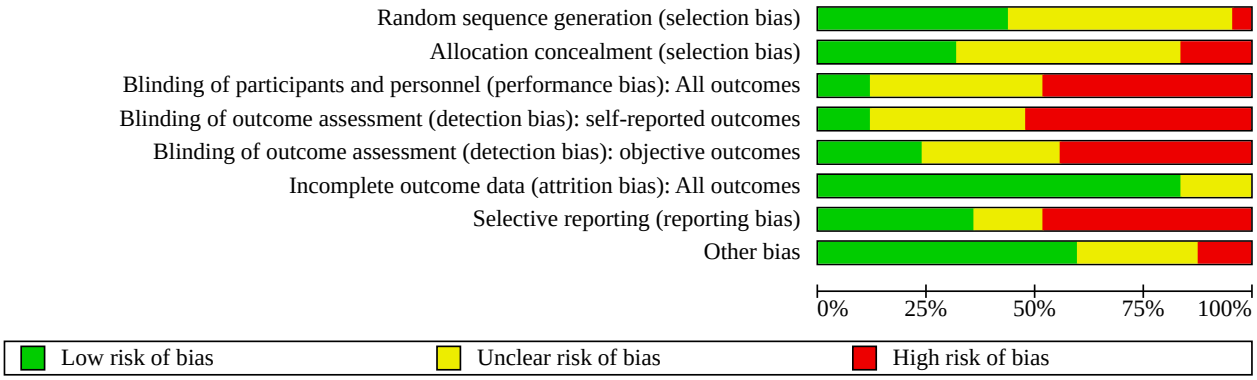


Figure 3. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

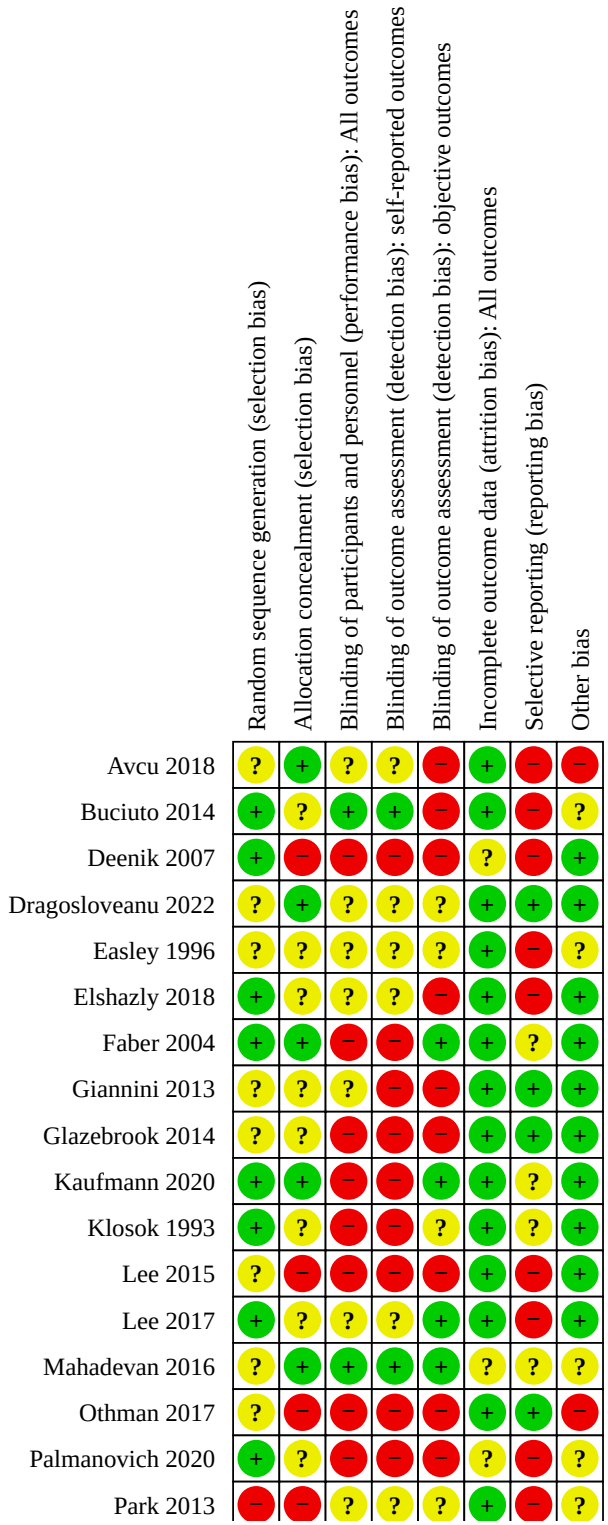
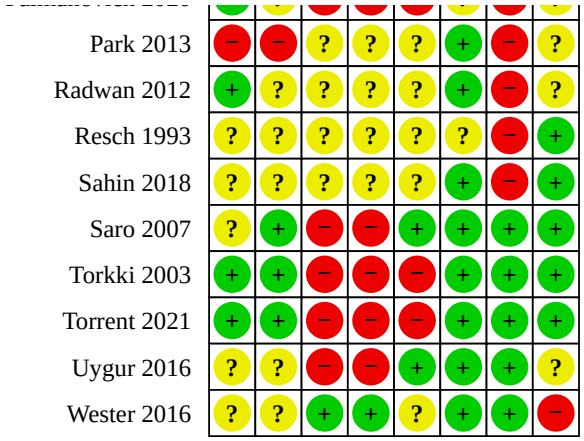


Figure 3. (Continued)



Allocation

Buciuto 2014, Deenik 2007, Elshazly 2018, Faber 2004, Kaufmann 2020, Klosok 1993, Lee 2017, Palmanovich 2020, Radwan 2012, Torkki 2003, and Torrent 2021 reported that they performed random sequence generation using a computer random number generator; thus, we judged them at low risk of selection bias. Park 2013 was quasi-randomised based on the participant's number on the registration list, thus, at high risk of bias for this item. The 12 remaining studies did not provide sufficient information about the sequence generation process to permit a judgement about bias; thus, we judged them as unclear for risk of bias for this item (Avcu 2018; Dragosloveanu 2022; Easley 1996; Giannini 2013; Glazebrook 2014; Lee 2015; Mahadevan 2016; Othman 2017; Resch 1993; Sahin 2018; Saro 2007; Uygur 2016; Wester 2016).

Concealment of allocation before the assignment was adequate for Avcu 2018, Dragosloveanu 2022, Faber 2004, Kaufmann 2020, Mahadevan 2016, Saro 2007, Torkki 2003, and Torrent 2021 (opaque and sealed envelopes); thus we judged them at low risk of selection bias. Buciuto 2014, Easley 1996, Elshazly 2018, Giannini 2013, Glazebrook 2014, Klosok 1993, Lee 2017, Palmanovich 2020, Radwan 2012, Resch 1993, Sahin 2018, Uygur 2016, and Wester 2016 did not describe their methods of allocation concealment or provided insufficient information to permit judgement. We judged these 13 studies at unclear risk of selection bias. There was no concealment of allocation in Deenik 2007, Lee 2015, Othman 2017 and Park 2013; we assessed these four studies at high risk of selection bias.

Blinding

No study included placebo or sham surgery as a comparison for surgical treatments for treating hallux valgus. Since Torkki 2003 compared surgery to no treatment or non-surgical treatment, blinding of the participants and personnel was unachievable; thus, we assessed this study at high risk of performance and detection biases. It may have been possible to blind participants, personnel and outcome assessors for most of the remaining 24 studies; however, only three studies mentioned the correct blinding of participants and personnel (Buciuto 2014; Mahadevan 2016; Wester 2016). Thus, for self-reported outcomes (function, pain, composite outcomes and participant global assessment of treatment success), there was a high risk of detection bias in 12 studies (Deenik 2007; Faber 2004; Giannini 2013; Glazebrook 2014; Kaufmann 2020; Klosok 1993; Lee 2015; Othman 2017; Palmanovich 2020; Saro 2007; Torrent 2021; Uygur 2016). Detection bias was unclear in nine studies because they did not provide complete information regarding the blinding of participants for self-reported outcomes (Avcu 2018; Dragosloveanu 2022; Easley 1996; Elshazly 2018; Lee 2017; Park 2013; Radwan 2012; Resch 1993; Sahin 2018).

Six studies mentioned the correct blinding of outcome assessors (Faber 2004; Kaufmann 2020; Lee 2017; Mahadevan 2016; Saro 2007; Uygur 2016). Thus, for objective outcomes (radiographic results, adverse events and reoperation), there was a high risk of detection bias in ten studies (Avcu 2018; Buciuto 2014; Deenik 2007; Elshazly 2018; Giannini 2013; Glazebrook 2014; Lee 2015; Othman 2017; Palmanovich 2020; Torrent 2021). Torkki 2003 compared surgery to no treatment or non-surgical treatment, so blinding of the outcome assessors was unachievable; thus, we assessed this study at high risk of detection biases. Detection bias was unclear in eight studies (Dragosloveanu 2022; Easley 1996; Klosok 1993; Park 2013; Radwan 2012; Resch 1993; Sahin 2018; Wester 2016).

Incomplete outcome data

We considered studies at low risk of bias if more than 80% of participants completed the follow-up, missing outcomes data were balanced across intervention groups and studies reported an intention-to-treat analysis for the primary outcomes. As a result, 21 studies were at low risk of attrition bias. We classified the remaining four studies at unclear risk of attrition bias (Deenik 2007; Mahadevan 2016; Palmanovich 2020; Resch 1993).

Torkki 2003 did not perform an intention-to-treat analysis at the two-year follow-up stage, so we used only the 12-month outcome. We judged Avcu 2018 at low risk despite data being available at five months postintervention for only radiographic outcomes, and they reported pain and function only at three weeks postoperative.

Selective reporting

Only two studies had the protocol available (Glazebrook 2014; Torrent 2021). We classified 12 studies at high risk of reporting bias (Avcu 2018; Buciuto 2014; Deenik 2007; Easley 1996; Elshazly 2018; Lee 2015; Lee 2017; Palmanovich 2020; Park 2013; Radwan 2012; Resch 1993; Sahin 2018). The reasons for this assessment can be found in the Characteristics of included studies table, the most

common being that failure of treatment was not reported, so we could not enter it in a meta-analysis.

We judged nine studies at low risk because, despite the study protocol not being registered, the outcomes of interest for this review were fully available (Dragosloveanu 2022; Giannini 2013; Glazebrook 2014; Othman 2017; Saro 2007; Torkki 2003; Torrent 2021; Uygur 2016; Wester 2016). Four studies were at unclear risk of reporting bias because they provided some outcomes with mean results but did not provide a measure of variance (such as SDs) (Faber 2004; Kaufmann 2020; Klosok 1993; Mahadevan 2016).

Other potential sources of bias

Fifteen studies were at low risk of other bias (Deenik 2007; Dragosloveanu 2022; Elshazly 2018; Faber 2004; Giannini 2013; Glazebrook 2014; Kaufmann 2020; Klosok 1993; Lee 2015; Lee 2017; Resch 1993; Sahin 2018; Saro 2007; Torkki 2003; Torrent 2021); three studies were at high risk of other potential threats to validity (Avcu 2018; Othman 2017; Wester 2016), and seven studies were at unclear risk (Buciuto 2014; Easley 1996; Mahadevan 2016; Palmanovich 2020; Park 2013; Radwan 2012; Uygur 2016). No study was judged at risk of bias relating to the inappropriate influence of funders.

The grade of the deformity was not used as a randomisation variable to guarantee a homogeneous distribution of participants in Buciuto 2014. In Easley 1996, although telephone interviews were possible, the study authors decided that such data would offer little significant information. The authors of Mahadevan 2016 reported that with an alpha error of 0.05, a power of 80% and an SD of 17.5 for the MOXFQ, sample size analysis indicated a minimum group size of 48 feet; however, this was not achieved. Park 2013 and Radwan 2012 did not specify time points of outcomes. Some information about complications in Uygur 2016 was gathered by contact with the main author (Esat Uygur) and used in the analysis.

In Avcu 2018, subgroup analysis between younger and older than 45 years gave the impression that Scarf osteotomy was superior to Mau osteotomy when the AOFAS results were compared at five-month follow-up. The results, regardless of this subgroup division, were not clear in the article. Othman 2017 presented different follow-up periods for each group; the reason for this difference was not specified in the text, and no protocol was published to clarify this decision. Palmanovich 2020 deliberately excluded 10 participants from analysis from the minimally invasive group declaring this was due to the surgeon's learning curve; however, this only imbalanced further the number of participants in each group, and separate data were not provided. Baseline demographic information was not given in detail in Wester 2016; thus, it was impossible to know if the population was homogeneous.

Effects of interventions

See: **Summary of findings 1** Summary of findings table - Surgery compared to no treatment for hallux valgus; **Summary of findings 2** Summary of findings table - Surgery compared to non-surgical treatment for hallux valgus; **Summary of findings 3** Summary of findings table - Complex osteotomies compared to simple osteotomies for hallux valgus

Surgery versus placebo or sham surgery

We found no studies comparing surgery versus no placebo or sham surgery.

Surgery versus no treatment

One study provided data for pain, function, quality of life, participant global assessment of treatment success and adverse events (Torkki 2003). We could not analyse data at 24-month follow-up because participants were allowed to switch groups after one year, and separate data for the remaining participants in each original group were not provided separately.

See Summary of findings 1.

Pain

Surgery may result in a clinically important improvement in pain. At 12 months, mean pain was 39 points (0 to 100 VAS, lower is better) with no treatment and 21 points with surgery (MD −18.00 points, 95% CI −26.14 to −9.86; 1 study, 140 participants; low-certainty evidence, downgraded one level for serious imprecision and one level for serious risk of bias; Analysis 1.1). The MCID of the VAS for foot and ankle is 9.3 on a scale from 0 to 100 (Saarinen 2021).

Function

Surgery may result in a slight increase in function. At 12 months, mean function was 66 points (0 to 100 AOFAS, higher is better) with no treatment and 75 points with surgery (MD 9 points, 95% CI 5.16 to 12.84; 1 study, 140 participants; low-certainty evidence, downgraded one level for serious imprecision and one level for serious risk of bias; Analysis 1.2). The MCID is 10 points on a 100-point scale for function.

Quality of life

Surgery may result in little to no difference in quality of life. At 12 months, mean quality of life was 93 points (0 to 100 15-D scale, higher is better) with no treatment and 93 points with surgery (MD 0 points, 95% CI −2.12 to 2.12; 1 study, 140 participants; low-certainty evidence, downgraded one level for serious imprecision and one level for serious risk of bias; Analysis 1.3). The MCID is 10 points on a 100-point scale for quality of life.

Participant global assessment of treatment success

Surgery may result in a slight increase in participant global assessment of treatment success. At 12 months, mean participant global assessment of treatment success score was 61 points (0 to 100 VAS, higher is better) with no treatment and 80 points with surgery (MD 19 points, 95% CI 8.11 to 29.89; 1 study, 140 participants; low-certainty evidence, downgraded one level for serious imprecision and one level for serious risk of bias; Analysis 1.4).

Reoperation (treatment failure)

We are uncertain about the effect of surgery on reoperation (treatment failure). There were no cases of reoperation in either group (RR not estimable; 1 study, 140 participants; Analysis 1.5).

Adverse events

We are uncertain about the effect of surgery on adverse events. There were four adverse events (5.63%) in the surgery group and

none in the no treatment group (corresponding risk of 0 per 100 in both groups) (RR 8.75, 95% CI 0.48 to 159.53; 1 study, 140 participants; very low-certainty evidence, downgraded two levels for very serious imprecision and one level for serious risk of bias; Analysis 1.6).

Serious adverse events

We are uncertain about the effect of surgery on serious adverse events. There were no cases of serious adverse events in either group (RR not estimable; 1 study, 140 participants; Analysis 1.7).

We found no studies comparing surgery versus no treatment that reported HVA.

Surgery versus non-surgical treatment

One study compared surgery versus orthosis (non-surgical treatment) (Torkki 2003). We could not include data from the 24-month follow-up from Torkki 2003 in the analysis because participants were allowed to switch groups after one year and separate data for the remaining participants in each original group was not provided separately.

See Summary of findings 2.

Pain

Surgery may result in a clinically important improvement in pain. At 12 months, mean pain was 41 points (0 to 100 VAS, lower is better) with orthosis and 21 points with surgery (MD −20.00, 95% CI −27.62 to −12.38; 1 study, 140 participants; low-certainty evidence, downgraded one level for serious imprecision and one level for serious risk of bias; Analysis 2.1). The MCID of the VAS for foot and ankle is 9.3 on a scale from 0 to 100 (Saarinen 2021), although it was defined as 15 in the protocol for the present review (Dias 2020), this was before the publication of Saarinen 2021 and the MD found in our analysis was still higher than that (MD −18.00).

Function

Surgery may result in a slight increase in function. At 12 months, mean function was 64 points (0 to 100 AOFAS, higher is better) with orthosis and 75 points with surgery (MD 11.00, 95% CI 7.16 to 14.84; 1 study, 140 participants; low-certainty evidence, downgraded one level for serious imprecision and one level for serious risk of bias; Analysis 2.2). The MCID is 10 points on a 100-point scale for function.

Quality of life

Surgery may result in little to no difference in quality of life. At 12 months, mean quality of life was 93 points (0 to 100 15-D scale, higher is better) with orthosis and 93 points with surgery (MD 0 points, 95% CI −2.04 to 2.04; 1 study, 140 participants; low-certainty evidence, downgraded one level for serious imprecision and one level for serious risk of bias; Analysis 2.3). The MCID was 10 points on a 100-point scale in the protocol (Dias 2020).

Participant global assessment of treatment success

Surgery may result in a slight increase in participant global assessment of treatment success. At 12 months, mean participant global assessment of treatment success score was 70 points (0 to 100 VAS, higher is better) with orthosis and 80 points with surgery (MD 10, 95% CI 1.05 to 18.95; 1 study, 140 participants; low-certainty evidence, downgraded one level for serious imprecision and one level for serious risk of bias; Analysis 2.4). The MCID is 10 points on a 100-point scale for composite outcome measures.

Reoperation (treatment failure)

We are uncertain about the effect of surgery on reoperation (treatment failure). There were no cases of reoperation in either group (RR not estimable; 1 study, 140 participants; Analysis 2.5).

Adverse events

We are uncertain about the effect of surgery on adverse events. There were four adverse events in the surgery group (5.63%) and none in the orthosis group (corresponding risk of 0 per 100 in both groups) (RR 8.75, 95% CI 0.48 to 159.53; 1 study, 140 participants; very low-certainty evidence, downgraded two levels for very serious imprecision and one level for serious risk of bias; Analysis 2.6), meaning there was no difference in the number of adverse events between surgery and orthosis (the RR interval crossed the 1 value), but the evidence is very uncertain.

Serious adverse events

We are uncertain about the effect of surgery on serious adverse events. There were no cases of serious adverse events in either group (RR not estimable; 1 study, 140 participants; Analysis 2.7).

We found no studies comparing surgery versus non-surgical treatment that reported HVA.

Complex osteotomies versus simple osteotomies

Twenty-four studies compared different surgical techniques, but only 12 could be included in meta-analyses (Avcu 2018; Buciuto 2014; Giannini 2013; Glazebrook 2014; Klosok 1993; Othman 2017; Palmanovich 2020; Radwan 2012; Resch 1993; Saro 2007; Uygur 2016; Wester 2016).

See Summary of findings 3.

Pain

Complex osteotomies probably result in little to no difference in pain compared with simple osteotomies at a mean follow-up of 11 months (MD −0.06 points, 95% CI −0.41 to 0.29; I^2 = 19%; MCID = 1.5; 7 studies, 414 participants; moderate-certainty evidence, downgraded one level for serious risk of bias; Analysis 3.1) (Avcu 2018; Glazebrook 2014; Palmanovich 2020; Radwan 2012; Saro 2007; Uygur 2016; Wester 2016).

Function

We are uncertain about the effect of complex osteotomies on function compared with simple osteotomies. Pooled data seemed to demonstrate little to no clinically important difference in function at a mean follow-up of 20.7 months, but the evidence is very uncertain (MD 1.6 points, 95% CI −2.33 to 5.54; I^2 = 90%; MCID = 10; 10 studies, 616 participants; very low-certainty evidence, downgraded one level for serious risk of bias and two levels for very serious inconsistency; Analysis 3.2) (Saro 2007; Radwan 2012; Buciuto 2014; Uygur 2016; Othman 2017; Palmanovich 2020; Giannini 2013; Avcu 2018; Wester 2016; Glazebrook 2014). All 10 studies expressed the functional results using the AOFAS.

Quality of life

We are uncertain about the effect of complex osteotomies on quality of life compared with simple osteotomies. Only one study reported quality of life using a validated measure (EQ-5D); however, this study did not provide quantitative data on the results, only qualitative information, stating that participants who were not satisfied with the results at the final follow-up had a lower EQ-5D value (P = 0.001) (Saro 2007).

Participant global assessment of treatment

Complex osteotomies may result in little to no difference in participant global assessment of treatment success compared with simple osteotomies (RR 1.66, 95% CI 0.99 to 2.80; I^2 = 0%; 8 studies, 462 participants; low-certainty evidence, downgraded one level for serious risk of bias and one level for serious imprecision; Analysis 3.4) (Avcu 2018; Giannini 2013; Othman 2017; Palmanovich 2020; Radwan 2012; Resch 1993; Saro 2007; Uygur 2016).

Reoperation (treatment failure)

Complex osteotomies may increase reoperation compared with simple osteotomies, but the effect size was small (RR 2.04, 95% CI 1.01 to 4.11; 7 studies, 461 participants; I^2 = 0%; low-certainty evidence, downgraded one level for serious risk of bias and one level for serious imprecision; Analysis 3.5) (Glazebrook 2014; Klosok 1993; Othman 2017; Palmanovich 2020; Resch 1993; Saro 2007; Wester 2016).

Adverse events

We are uncertain about the effect of complex osteotomies on adverse events compared with simple osteotomies. Pooled analysis for the number of adverse events (such as wound infection or dehiscence, hardware irritation requiring removal of the fixation device, or other complications such as symptomatic non-union of the osteotomy site) was very uncertain, revealing a higher rate of adverse events when performing simple osteotomies (RR 0.66, 95% CI 0.51 to 0.84; I^2 = 70%; 12 studies, 787 participants; very low-certainty evidence, downgraded one level for serious risk of bias, one level for serious imprecision and one level for serious inconsistency; Analysis 3.6) (Avcu 2018; Buciuto 2014; Giannini 2013; Glazebrook 2014; Klosok 1993; Othman 2017; Palmanovich 2020; Radwan 2012; Resch 1993; Saro 2007; Uygur 2016; Wester 2016). See sensitivity analysis for further information.

Serious adverse events

Complex osteotomies may result in little to no difference in serious adverse events compared with simple osteotomies (0 events in both groups; 12 studies, 787 participants; low-certainty evidence, downgraded one level for serious risk of bias and one level for serious imprecision; Analysis 3.7).

Radiological measurement of the hallux valgus angle (minor outcome)

Although not emphasised in a participant-centred evaluation, objective outcomes such as the HVA are usually considered when discussing an achievable correction and comparing techniques, always intending a normal value (less than 16 degrees) at the final follow-up.

The evidence is uncertain about the effect of a complex osteotomy compared to simple osteotomies (MD 1.29, 95% CI 0.08 to 2.51; I^2 = 79%; 12 studies, 767 participants; very low-certainty evidence, downgraded one level for serious risk of bias, two levels for very serious inconsistency and two levels for very serious indirectness; Analysis 3.8) (Avcu 2018; Buciuto 2014; Giannini 2013; Glazebrook 2014; Klosok 1993; Othman 2017; Palmanovich 2020; Radwan 2012; Resch 1993; Saro 2007; Uygur 2016; Wester 2016). A single study even demonstrated a substantial effect in benefit of the Wilson osteotomy (a type of distal simple osteotomy) when compared to the distal Chevron osteotomy at a mean 37 months' follow-up, but this evidence was also uncertain (MD 12.40, 95% CI 8.06 to 16.74; 1 study, 67 participants; very low-certainty evidence, downgraded one level for serious risk of bias, one level for serious imprecision and one level for serious indirectness) (Klosok 1993).

Subgroup analysis

Mild versus severe deformity before surgery

As defined per protocol, the main radiographical aspect for defining the severity of the deformity was the IMA; we divided the articles into three distinct groups: 1. articles that excluded severe cases (only IMA less than 16 degrees were included); 2. articles that excluded mild cases (only IMA greater than 12 were included) and 3. articles that did not place any restrictions on the preoperative IMA or included participants with variable IMA measurements.

Pain

Due to the small number of participants and studies, the evidence is very uncertain about the effect of complex versus simple osteotomies for treating mild to moderate or mild to severe (no restrictions) hallux valgus on the final score for pain.

The subgroup that included only moderate to severe cases (excluding participants with a preoperative IMA less than 12 degrees) revealed little to no difference in final pain score results (VAS) when comparing complex to simple osteotomies (MD −0.16 points, 95% CI −0.56 to 0.23; I^2 = 18%; 5 studies, 318 participants; moderate-certainty evidence, downgraded one level for serious risk of bias; Analysis 3.1) (Avcu 2018; Glazebrook 2014; Saro 2007; Uygur 2016; Wester 2016).

Function

Due to the small number of participants and studies, the evidence is very uncertain about the effect of complex versus simple osteotomies for treating mild to moderate or mild to severe (no restrictions) hallux valgus on the final score for function.

The subgroup that included only moderate to severe cases (excluding participants with a preoperative IMA less than 12 degrees) revealed little to no difference in final function score results (AOFAS) when comparing complex to simple osteotomies (MD −0.82 points, 95% CI −3.16 to 1.52; I^2 = 57%; 7 studies, 400 participants; moderate-certainty evidence, downgraded one level for serious risk of bias; Analysis 3.2) (Avcu 2018; Giannini 2013; Glazebrook 2014; Othman 2017; Saro 2007; Uygur 2016; Wester 2016).

Reoperation (treatment failure)

No study reported the reoperation (treatment failure) rate for mild to moderate cases of hallux valgus.

The subgroup that included only moderate to severe cases (excluding participants with a preoperative IMA less than 12

degrees) revealed an increase in the number of reoperation events in the complex osteotomies group compared with simple osteotomies (RR 2.72, 95% CI 1.14 to 6.49; I^2 = 0%; 5 studies, 345 participants; low-certainty evidence, downgraded one level for serious risk of bias and one level for serious imprecision; Analysis 3.5) (Glazebrook 2014; Klosok 1993; Othman 2017; Saro 2007; Wester 2016).

The subgroup that included participants without restriction based on the IMA revealed little to no difference in the number of reoperation events when comparing simple to complex osteotomies (RR 0.96, 95% CI 0.27 to 3.42; I^2 = 0%; 2 studies, 116 participants; low-certainty evidence, downgraded one level for serious risk of bias and one level for serious imprecision; Analysis 3.5) (Palmanovich 2020; Resch 1993).

Sensitivity analyses

We planned sensitivity analyses per protocol to be performed for the following reasons.

- Imputed data and data based on assumptions
- Selection bias (inadequate allocation concealment)
- Detection bias (inadequate or unclear blinding of participant and outcome assessor)

We found no reason to perform sensitivity analyses for selection or detection bias since most studies had methodological flaws and the evidence was already downgraded. For imputed data inconsistency, we noted that Buciuto 2014 found an unusual number of transfer metatarsalgia cases in the open simple transverse osteotomy group. When excluding this trial from the analysis for adverse events comparing simple versus complex osteotomies the resulting analysis showed no difference between the two groups of osteotomy (RR 0.96, 95% CI 0.73 to 1.26; I^2 = 33%; 11 studies, 667 participants; low-certainty evidence, downgraded one level for serious risk of bias and one level for serious inconsistency).

It is important to note that Buciuto 2014 compared a distal complex osteotomy (Chevron) to a distal simple osteotomy called Mitchell osteotomy, described by the study authors as a "double-transverse osteotomy", which may have a role in the final instability at the osteotomy site, leading to a more extended (dorsally deviated) and insufficient first ray.

DISCUSSION

Summary of main results

Our findings demonstrate that, compared to no treatment or non-surgical treatment, there is low-certainty evidence from one study that surgery may reduce pain, increase function slightly and increase the number of people who report treatment success slightly after 12 months of follow-up (Summary of findings 1; Summary of findings 2). There is low-certainty evidence that surgery may result in little to no difference in quality of life when compared to no treatment or non-surgical treatment (Summary of findings 1; Summary of findings 2). We are uncertain whether surgery decreases reoperation (treatment failure) or adverse events because the certainty of evidence was very low. Evidence was downgraded due to serious imprecision and suspected performance bias (as there was no blinding of the participants or personnel).

There is moderate-certainty evidence that complex osteotomies result in little to no difference in final pain scores up to 12 months after treatment compared to simple osteotomies (Summary of findings 3). There is low-certainty evidence that complex osteotomies may result in little to no difference in participant global assessment of treatment success and may increase the number of reoperation (treatment failure) cases when compared to simple osteotomies (Summary of findings 3). We are uncertain whether the shape of osteotomy improves function or decreases the number of adverse events because the certainty of evidence was very low. Evidence was downgraded due to imprecision, inconsistency and suspected performance bias (as only two studies correctly assessed the blinding of the participants and personnel). No studies comparing simple and complex osteotomies measured quality of life.

Overall completeness and applicability of evidence

The 25 RCTs in this review recruited 1597 participants, but data were not available from all participants for pooling. For our major outcomes, 554 participants from eight studies contributed data for pain at 12 months, 756 participants from 11 studies contributed data for function at 12 months and 601 participants from eight studies contributed data for reoperation (treatment failure). Overall, the participants were adults with a mean age per study between 41 years and 64 years and predominantly female. The included studies did not present outcome data to allow subgroup analysis based on the type of approach to the site of surgery (open or percutaneous). For the subgroup analyses, we were also unable to identify sufficient studies that included only one degree of deformity (i.e. mild, moderate or severe) and when trials described their inclusion criteria, frequently the classification was inconsistent between studies and with our review standards defined by the protocol.

We identified limitations of the review at the study level regarding a high rate of risk of bias, especially regarding the blinding of participants and outcome assessors. At the review level, the risk of incomplete identification of studies (publication bias) was avoided by the persistent search in the databases for new studies, but it is never completely mitigated.

Due to poor reporting of serious or rare adverse events, there was downgrading of the evidence for imprecision due to low event rates.

When pooling PROMs (pain and function) from studies, the most common score for pain was the VAS and for function was the AOFAS; when one of those scores was unavailable, we calculated the equivalent result for comparison (e.g. if the chosen score for pain was the AOFAS subscale for pain (0 is the worst pain, 40 is no pain) we divided the result by −0.4).

We had to make assumptions about the data in calculating the composite adverse event outcome. The studies counted several types of events, leading to a potential unit of analysis issue, as participants were likely to have had more than one complication. To minimise the risk of uncounted events, we aimed to extract the proportion of participants reporting one or more events (i.e. maximum number of participants with at least one of the individual events). There is some uncertainty about the effect estimates for this outcome.

Quality of the evidence

We used the GRADE criteria to assess the certainty of the evidence, which is shown in Summary of findings 1; Summary of findings 2; and Summary of findings 3.

All included trials had methodological flaws, thus downgrading every single outcome by at least one level due to serious risk of bias (i.e. the highest level of evidence found was of moderate certainty). The most common source of risk of bias issues was the absence or uncertainty of blinding of participants and personnel, although this could have been possible to achieve since all studies compared surgical procedures.

Surgery versus no treatment and non-surgical treatment

We downgraded the evidence for pain, function, quality of life and participant global assessment of treatment success to low certainty due to serious bias and serious imprecision. We downgraded the evidence for reoperation (treatment failure), adverse events and serious adverse events to very low certainty due to serious bias and very serious imprecision.

Complex versus simple osteotomies

We downgraded the evidence for pain to moderate certainty due to serious bias. We downgraded the evidence for participant global assessment of treatment success, reoperation (treatment failure) and serious adverse events to low certainty due to serious bias and serious imprecision. We downgraded the evidence for function to very low certainty, one level for serious risk of bias and two levels for very serious inconsistency. We downgraded the evidence for adverse events to very low certainty, one level due to serious bias, one due to serious inconsistency and one additional level due to serious imprecision.

Potential biases in the review process

An experienced information specialist developed the search strategy used in this review. Once the search strategy was conducted, two review authors (CGD and AG) independently analysed all abstracts and titles and performed bias and quality assessments. We reached a consensus through discussion and with a third-party expert (JF). As a result, we minimised errors in selection and abstraction. The main limitations of this review process were the small number of events for dichotomous outcomes (reoperation and adverse events) and the small number of studies in some subgroup analyses, with serious inconsistency or serious imprecision being applicable in most of the cases.

Agreements and disagreements with other studies or reviews

Five other systematic reviews have examined the effect of surgery for treating hallux valgus (bunions) (Bia 2018; Ferrari 2009b; Klugarova 2017; Malagelada 2019; Miranda 2021). Ferrari 2009b was broader in their inclusion methods (including prospective non-randomised studies), resulting in meta-analyses of surgical versus non-surgical treatments, different postoperative approaches (e.g. delayed or early weight-bearing) and osteotomies versus arthrodesis or arthroplasty. Ferrari 2009b found the same result as our meta-analysis regarding surgery versus non-surgical options. Bia 2018 and Miranda 2021 included non-randomised clinical trials, retrospective studies and case series in their analyses; they excluded studies that did not include a percutaneous procedure. Nonetheless, their results were compared to ours when applicable. Malagelada 2019 performed a meta-analysis of the results of 23 studies but focused their analyses on the radiographic outcomes of different percutaneous procedures; sometimes comparing one MIS to a similar modification (e.g. varying only in the type of material for osteosynthesis of the osteotomy). We excluded such studies from our analyses (see Characteristics of excluded studies table).

AUTHORS' CONCLUSIONS

Implications for practice

This systematic review included 25 randomised controlled trials (RCTs) including four modalities of treatment (no treatment, non-surgical treatment (orthosis), complex osteotomies and simple osteotomies) with 1597 participants. It compared surgery to no treatment, surgery to non-surgical treatment, and surgery to different surgical procedures for treating hallux valgus (bunions). The review findings provide a summary of evidence of the role of surgery in treating otherwise healthy adults with hallux valgus.

Compared to no treatment or non-surgical treatments, low-certainty evidence found that there may be a clinically important reduction in pain with surgery, as well as a slight improvement in function and participant global assessment of treatment success. We are uncertain about the effect on risk for reoperation (treatment failure), adverse events or serious adverse events. Low-certainty evidence suggests little to no difference in quality of life after 12 months when comparing surgery to no treatment or non-surgical treatments.

Moderate-certainty evidence showed that compared with simple osteotomies, complex osteotomies probably result in little to no difference in pain, and very low-certainty evidence showed that we are uncertain about its effects on function. Low-certainty evidence found that reoperation (treatment failure) may be more common when performing a complex osteotomy versus a simple osteotomy. We are uncertain about the effect of complex osteotomies on adverse events compared with simple osteotomies. While there was a higher rate of adverse events when performing simple osteotomies, the evidence was very low certainty. However, the sensitivity analysis, which excluded a study with an unusual number of transfer metatarsalgia cases in the simple osteotomy group, found that there may be no difference in the adverse event rates when comparing simple to complex osteotomies.

Careful consideration of the relative benefits and harms of each intervention and participant preferences must guide the choice of treatment option for each individual.

Implications for research

Studies of surgical interventions for hallux valgus lack unified and validated condition-specific, participant-reported outcome measures for pain, function, quality of life and participant global assessment of treatment success. In addition to providing comparable participant-reported measures for continuous outcomes, at minimum, it would be useful if all future studies collected pain data as a continuous outcome, as well as reoperation rates (treatment failure) and detailed adverse event numbers. Systematic data collection to assess short-, medium- and long-term outcomes after treatment (e.g. during the first month, six months and one year), is important.

Placebo-controlled trials are needed to further determine the efficacy of surgery for treating hallux valgus. More consideration in minimising the risk of bias, especially selection and detection biases will improve the certainty of evidence. In surgical trials, blinding personnel and participants is achievable and could be attempted when performing future RCTs, and blinding of outcome assessors should be standard. Publishing a protocol before writing the full article is also advisable, since this helps identify flaws in the final texts and could improve assertiveness in the process of the clinical trials. It would be useful if future RCTs adhere to providing full data (means and standard deviations) for continuous outcomes as well as totals for participants with adverse events.

Prioritisation of participant-reported outcome measures over objective outcomes, such as radiographic or range of motion assessments, is important. Further research could also help identify subgroups of the population with different preoperative degrees of hallux valgus that may benefit from different surgical interventions.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Avcu 2018

Study characteristics

Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: unknown to March 2017 **Protocol published before recruitment of participants**: no **DOI**: 10.18621/eurj.302186 **Date of trial registration**: 31 March 2019 **Recruitment started**: not specified **Details of trial registration**: EMBASE 626135738

Avcu 2018 *(Continued)*

	Main ID: CN-01792996 **Funding sources**: unknown
Participants	**Place of study**: 1 training and research hospital in Turkey **Number of participants assigned**: 40 feet of 40 participants (20 in each group) **Number of participants assessed for primary outcome (VAS)**: 40 feet of 40 participants (20 in each group) **Inclusion criteria**: moderate-to-severe hallux valgus; aged ≥ 18 years; informed consent **Exclusion criteria**: metatarsalcuneiform laxity; previously undergone surgical intervention for hallux valgus; diabetes mellitus; peripheral vascular disease; peripheral neuropathy; pes planus; inflammatory disease **Age** Scarf group: mean 41.25 (SD 13) years Mau group: mean 40.63 (SD 15) years **Gender of participants assigned (female/male)** Scarf group: 16/4 Mau group: 17/3 **Classification of the condition**: moderate to severe, according to the Mann and Coughlin classification
Interventions	**Timing of intervention**: symptomatic deformity of the foot **Type of surgical interventions** Scarf group: osteotomy was applied to the first metatarsal according to the method described by Coetzee and Rippstein (Coetzee 2007). A picture is provided demonstrating a Z-shaped osteotomy at the distal metatarsal and lateralisation of the distal fragment. Mau group: osteotomy was applied to the first metatarsal according to the method described by Easley (Easley 2012). A picture is provided (Figure 2 of the article) showing an oblique osteotomy at the mid-shaft portion of the metatarsal bone and lateralisation of the distal fragment. **Rehabilitation** Both groups: sutures were removed in the second week and in the third week the splint was removed and a hallux valgus night splint was applied. Partial weight-bearing was permitted as tolerated until there was bone union. **Any co-interventions**: distal lateral soft tissue release (modified McBride) was performed equally across all groups.
Outcomes	**Length of follow-up**: 3 weeks. 5 months was only for the radiological outcome measurements. Participants were evaluated preoperatively and after 3 weeks and 5 months of surgery. **Withdrawals**: 0 **Major outcomes** • VAS • AOFAS (AOFAS MTP-IP) • Adverse events ◦ Screw removal due to discomfort on the skin: 4 participants in the Scarf group, 2 in the Mau group

Avcu 2018 *(Continued)*

- Recurrence
- Delayed union
- First metatarsal elevation
- Insufficient correction
- Superficial infection
- Arthritis
- Deep vein thrombosis

Secondary outcomes

- Radiographic assessment (HVA, IMA, MCA, DMAA)
- Participant global assessment of treatment success (SFEF)
- Improvement in the congruity of the base of the proximal phalanx with the first MTP joint
- Fibular sesamoid subluxation rate (no difference was determined between the groups)

Notes	**Composite adverse events**: 9 participants in Scarf group, 13 in Mau group. Apart for the number of participants undergoing screw removal, the authors only provided a pooled number for participants with ≥ 1 of the remaining adverse events: 5 in the Scarf group and 11 in the Mau group.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not specified.
Allocation concealment (selection bias)	Low risk	Sealed envelope method for each participant.
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): self-reported outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): objective outcomes	High risk	Outcome personnel and participants were not blinded.
Incomplete outcome data (attrition bias) All outcomes	Low risk	0 participants were lost to follow-up.
Selective reporting (reporting bias)	High risk	Authors reported measures of variance (SD) for main and secondary outcomes. Nonetheless, the follow-up period was extremely short. 5 months was only for the radiological measurement, VAS and AOFAS were only analysed at 3 weeks postoperative.
Other bias	High risk	Subgroup analysis between younger and older than 45 years gave the impression that Scarf was superior to the Mau osteotomy when the AOFAS results were compared at 5 months' follow-up. The results of the participants regardless of this subgroup division were not clear in the article.

Buciuto 2014

Study characteristics	
Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: not specified **Protocol published before recruitment of participants**: no **Details of trial registration**: not specified **Funding sources**: unknown
Participants	**Place of study**: 1 university hospital in Norway **Number of participants assigned**: 120 participants (60 in open distal Mitchell group; 60 in open distal Chevron group) **Number of participants assessed for primary outcome (x-ray)**: 120 participants (60 in open distal Mitchell group; 60 in open distal Chevron group) **Inclusion criteria**: symptomatic mild-to-moderate hallux valgus **Exclusion criteria**: previous forefoot surgery; clinical or radiological signs of hallux rigidus; any type of metatarsalgia; symptomatic lesser toe pathology; neurological or rheumatological diseases **Age** Open distal Mitchell group: mean 54 years Open distal Chevron group: mean 50 years **Gender of participants assigned (female/male)** Open distal Mitchell group: 60/0 Open distal Chevron group: 60/0 **Classification of the condition**: mild-to-moderate hallux valgus defined by the HVA and IMA.
Interventions	**Timing of intervention**: not specified other than symptomatic deformity of the foot. **Type of surgical interventions** Open distal Mitchell group: longitudinal medial incision (extension not specified); L-shaped capsulotomy; double transverse osteotomy (distal incomplete cut and proximal complete cut); small wedge resected on the plantar side; lateralisation of distal fragment correcting the IMA; fixation with non-absorbable sutures through drill holes. Open distal Chevron group: longitudinal medial incision (extension not specified); L-shaped capsulotomy; V-shaped osteotomy with the apex 2–4 mm from the metatarsal's head cartilage; lateralisation and compression of the distal fragment; no fixation method was applied. **Rehabilitation** Open distal Mitchel group: postoperative plaster cast involving the ankle, mid-foot and hallux and maintaining its position; heel weight-bearing allowed with plaster for 6 weeks; unrestricted weight-bearing after 6 weeks. Open distal Chevron group: postoperative plaster cast involving the ankle, mid-foot and hallux and maintaining its position; heel weight-bearing allowed with plaster for 2 weeks; unrestricted weight-bearing after 6 weeks **Any co-interventions**: capsulorrhaphy was performed equally across both groups.

Buciuto 2014 *(Continued)*

Outcomes	**Length of follow-up**: 36 months
	
	Participants were evaluated preoperatively and after 2, 6 and 12 weeks; 12 months; and 3 years of surgery
	
	Withdrawals: 0
	
	Major outcomes
	
	• AOFAS functional score
	• Adverse events
	  ◦ Transfer metatarsalgia: 36 in Mitchell group; 5 in Chevron group
	  ◦ Symptomatic hammertoe of the second toe (lesser toe deformity): 6 in Mitchell group (associated with shortening of 6–8 mm of the first metatarsal in relation to the second metatarsal); 0 in Chevron group
	  ◦ Wound infection: 0
	  ◦ Deep vein thrombosis: 0
	  ◦ Delayed healing or non-union: no cases (all osteotomy sites showed radiological signs of healing within 6 weeks after surgery)
	  ◦ Loss of reduction (recurrence): no cases
	  ◦ Avascular necrosis: no cases
	
	Secondary outcomes
	
	• Radiographic assessment (HVA, IMA, first metatarsal length/shortening)
	• Ball circumference (participant standing with a measuring tape wrapped around the forefoot on the level of the MTP joints)
	• Mean length of sick leave for employed participants
	• First MTP range of motion

Notes	**Composite adverse events**: 42 participants in the Mitchell group, 5 in the Chevron group Most participants complained of postoperative tenderness and continuous swelling at the osteotomy/scar site, which caused shoe problems. The author declared that symptoms gradually resolved, but the resolution was not complete until about 1 year after surgery.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation on the day of the surgery.
Allocation concealment (selection bias)	Unclear risk	Not specified.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Surgeon was blinded to the randomisation process.
Blinding of outcome assessment (detection bias): self-reported outcomes	Low risk	Participants were blinded for self-reported outcomes.
Blinding of outcome assessment (detection bias): objective outcomes	High risk	Outcome personnel were not blinded.

Buciuto 2014 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	The authors did not report any missing data.
Selective reporting (reporting bias)	High risk	The authors failed to report any measure of variance (SD) for the main outcome scores or secondary outcome score (AOFAS); there was no predefined hierarchy of outcome scores and no information provided regarding pain (VAS or any subscale). Failure of treatment was not reported, so we could not enter it in a meta-analysis.
Other bias	Unclear risk	The grade of the deformity was not used as a randomisation variable to guarantee a homogeneous distribution of participants. Nonetheless, this is stated as a weakness of the study and all participants were treated as intended.

Deenik 2007

Study characteristics	
Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: August 1999 to June 2001 **Protocol published before recruitment of participants**: no **DOI**: not specified **Date of trial registration**: there is a registry from 7 May 2015, which is irrelevant for this review **Recruitment started**: August 1999 **Funding sources**: unknown
Participants	**Place of study**: 1 treatment centre in the Netherlands **Number of participants assigned**: 96 consecutive participants (total of 108 feet), 47 participants in the open Chevron group, 49 participants in the open Scarf group **Number of participants assessed for primary outcome (AOFAS)**: 83 participants (47 feet in the open Chevron group; 49 feet in the open Scarf group) **Inclusion criteria**: aged 18–65 years; painful bunion; hallux valgus; adequate range of motion **Exclusion criteria**: rheumatoid arthritis; failed previous hallux valgus surgery; arthritis of the first MTP joint **Age** Open Chevron group: mean 43 years Open Scarf group: mean 45 years **Gender of participants assigned (female/male)** Not specified, it is stated that there were no differences between groups. **Classification of the condition**: moderate to severe
Interventions	**Timing of intervention**: not specified other than symptomatic deformity of the foot **Type of surgical interventions**

Deenik 2007 *(Continued)*

Open Chevron group: medial incision centred over the first MTP joint; longitudinal capsulotomy; removal of medial eminence; transarticular lateral soft tissue release; 60-degree V-shaped osteotomy centred in the first metatarsal head; lateralisation of the distal fragment of a half to two-thirds of the width of the metatarsal head; fixation with a percutaneous Kirschner wire.

Open Scarf group: medial incision centred over the first MTP joint; longitudinal capsulotomy; removal of medial eminence; transarticular lateral soft tissue release; long Z-shaped osteotomy with an oscillating saw and completed proximally and distally with a small osteotome; lateralisation of the distal fragment a maximum of half of the width of the bone; in severe cases, the distal fragment was also rotated (this decreased the IMA in the cost of increasing the DMAA); fixation with 2 mini-screws.

Rehabilitation

Regular bandage; toe spacer and night splint for 3 months; weight-bearing allowed over the heel or flat foot during the first 6 weeks.

Any co-interventions: capsuloplasty with the resection of a horizontal strip of capsular tissue; after a primary analysis of the first 47 cases, avascular necrosis was noted in 3 of them; therefore, extra attention was given to the plantar osteotomy branch in the following cases; medial capsulorraphy. All co-interventions were performed equally across all groups.

Outcomes

Length of follow-up: 27 months (range 23–31 months)

Participants were evaluated preoperatively and at the final late postoperative time, no other time spans were specified.

Withdrawals: 9 withdrawals after randomisation. 3 additional participants were excluded because they were not operated on according to the study protocol.

Major outcomes

- AOFAS
- Adverse events
  - Symptomatic avascular necrosis: 2 participants in the Chevron group
  - Asymptomatic avascular necrosis: 1 participant in the Chevron group
  - Complex regional pain syndrome: 1 participant in the Chevron group, 4 in the Scarf group
  - Surgical site infection or implant discomfort: 2 participants in the Chevron group
- Treatment failure (no cases)
  - Recurrence of hallux valgus
  - Revision surgery

Secondary outcomes

- Radiographic assessment (HVA, IMA, DMAA and joint congruency)

Notes

Composite adverse events: 5 participants in the Chevron group, 4 in the Scarf group.

Asymptomatic avascular necrosis was not considered an adverse event.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Block randomisation was performed.
Allocation concealment (selection bias)	High risk	Participants were consecutively placed on the list upon inclusion.

Deenik 2007 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel were not blinded.
Blinding of outcome assessment (detection bias): self-reported outcomes	High risk	Participants were not blinded for self-reported outcomes.
Blinding of outcome assessment (detection bias): objective outcomes	High risk	Outcome personnel were not blinded.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	9 participants (9.3%) cancelled their operation after randomisation and 3 participants were excluded after surgery; this may have led to an overestimation of the benefits of the intervention.
Selective reporting (reporting bias)	High risk	Failure of treatment was not reported so we could not enter it in a meta-analysis.
Other bias	Low risk	Study appeared free of other potential sources of bias.

Dragosloveanu 2022

Study characteristics	
Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: October 2017 to December 2020 **Protocol published before recruitment of participants**: no **DOI**: 10.3390/medicina58030359 **Date of trial registration**: 5 February 2017 **Recruitment started**: 5 February 2017 **Details of trial registration**: number 1153/2017 **Main ID**: 1153/2017 **Funding sources**: unknown
Participants	**Place of study**: 1 training and research hospital in Romania **Number of participants assigned**: 50 feet of 50 participants (26 in open Chevron group and 24 in minimally invasive group). **Number of participants assessed for primary outcome (VAS)**: 40 feet of 40 participants (20 in each group) **Inclusion criteria**: moderate hallux valgus; aged ≥ 20 years; failed conservative treatment; informed consent **Exclusion criteria**: metatarsalcuneiform instability; previously undergone surgical intervention for hallux valgus; osteoarthritis of the MTP joint; systemic diseases (gout, rheumatoid arthritis, systemic lupus erythematosus, etc.) **Age**

Dragosloveanu 2022 *(Continued)*

	Open Chevron group: mean 55.3 (SD 13.6) years Percutaneous Chevron group: mean 49.4 (SD 15.3) years **Gender of participants assigned (female/male)** Open Chevron group: 24/2 Percutaneous Chevron group: 26/0 **Classification of the condition**: moderate, according to the Mann and Coughlin classification
Interventions	**Timing of intervention**: failed conservative treatment for symptomatic deformity of the foot **Type of surgical interventions** Open Chevron group: 5-cm dorsomedial incision, 60-degree V-shaped osteotomy with its tip positioned 2 mm proximal to the centre of the metatarsal head, lateral displacement of the head, fixation with 1 × 3-mm cannulated screw. Percutaneous Chevron group: 15-mm dorsomedial incision, 60-degree V-shaped osteotomy under fluoroscopic guidance with its tip positioned 2 mm proximal to the centre of the metatarsal head, lateral displacement of the head, fixation with 1 × 3-mm cannulated screw percutaneously applied. **Rehabilitation** Both groups: sutures were removed after 3 weeks. Full weight-bearing on the forefoot was avoided by wearing an orthosis for 6 weeks. **Any co-interventions**: distal lateral soft tissue release through the osteotomy for the open technique and through a 4-mm dorsal incision for the percutaneous group (modified McBride). All co-interventions were performed equally across all groups.

Outcomes	**Length of follow-up**: 12 months
	
	Participants were evaluated preoperatively and after 3 weeks, 6 weeks, 6 months and 12 months of surgery
	
	Withdrawals: 0
	
	Major outcomes
	
	• VAS
	• AOFAS
	• Adverse events
	  ◦ Screw removal: 3 participants in the minimally invasive group, 1 in the open Chevron group
	  ◦ Transfer metatarsalgia: 1 participant in the open Chevron group
	  ◦ Wound or septic complications (none recorded)
	
	Secondary outcomes
	
	• Radiographic assessment (HVA, IMA)
	• Mean radiological screen time (significantly longer for the percutaneous group)

Notes	**Composite adverse events**: 2 participants in the open Chevron group, 3 in the percutaneous Chevron group.

Risk of bias

Bias	Authors' judgement	Support for judgement

Dragosloveanu 2022 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Not specified.
Allocation concealment (selection bias)	Low risk	Sealed envelope method for each participant.
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): self-reported outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): objective outcomes	Unclear risk	Not specified.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No participants were lost to follow-up.
Selective reporting (reporting bias)	Low risk	Failure of treatment was not reported, so we could not enter it in a meta-analysis.
Other bias	Low risk	Study appeared free of other potential sources of bias.

Easley 1996

Study characteristics	
Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: 1992–1994 **Protocol published before recruitment of participants**: no **Details of trial registration**: not reported **Funding sources**: unknown
Participants	**Place of study**: 1 training and research hospital in the USA **Number of participants assigned**: 75 participants (97 feet) **Number of participants assessed for primary outcome (AOFAS)**: 66 participants (84 feet); 29 participants (41 feet) in open proximal Crescentic group; 37 participants (43 feet) in open proximal Chevron group **Inclusion criteria**: adults; IMA ≥ 13 degrees; HVA ≥ 30 degrees; persisting incapacitating symptoms despite non-operative treatment **Exclusion criteria**: not specified **Age** Open proximal Crescentic group: mean 50.4 years

Easley 1996 *(Continued)*

	Open proximal Chevron group: mean 51.5 years **Gender of participants assigned (female/male)** Open proximal Crescentic group: 27/2 Open proximal Chevron group: 36/1 **Classification of the condition**: moderate-to-severe hallux valgus
Interventions	**Timing of intervention**: incapacitating symptoms despite non-operative treatment (shoe wear modification, non-steroidal anti-inflammatory drugs, and restriction of activity) **Type of surgical interventions** Open proximal Crescentic group: 2 longitudinal incisions; the first over the medial aspect of the medial eminence for excision and capsular plication; the second dorsal overlying the proximal first metatarsal for the osteotomy; curved-blade crescentic osteotomy 1.5 cm distal to the TMT joint; distal fragment lateral rotation; fixation with 1 conventional screw (countersunk to avoid prominent hardware) and a Kirschner wire; if the bone stock was insufficient to provide support to the screw, fixation was performed with 3 Kirschner wires instead. Open proximal Chevron group: single medial longitudinal incision; medial eminence excision and capsular plication; medial proximal distally directed predrilled apex V-shaped osteotomy centred 1.5 cm distal to the TMT joint; distal fragment lateral translation and lateral tilt (to reduce the IMA); fixation with 2 Kirschner wires. **Rehabilitation** Both groups: compressive dressings to maintain the toe in the corrected position; full weight-bearing over a postoperative shoe after 7–10 days, maintained for 6 weeks; Kirschner wires removed after radiographic evidence of healing; accommodative shoe wear with toe separators and night splints after 6 weeks. **Any co-interventions**: distal lateral soft tissue release through a separate dorsal first web space incision; the transverse intermetatarsal ligament was not formally released; the adductor hallucis tendon was secured to the lateral capsule using a non-absorbable suture. All co-interventions were performed equally across all groups.

Outcomes	**Length of follow-up**: minimum 12 months (mean 24 months in open proximal Crescentic group; mean 20 months in open proximal Chevron group)
	
	Participants were evaluated preoperatively; biweekly until 12 weeks (2, 4, 6, 8, 10, 12 weeks); and after 12 months of surgery.
	
	Withdrawals: 9 (13 feet) withdrawals (5 moved from the region; 1 failed to keep follow-up appointment; 3 due to death by natural causes)
	
	Major outcomes
	
	• AOFAS
	• Adverse events
	  ◦ Transfer metatarsalgia: no cases
	  ◦ Recurrence of the deformity: 2 in each group
	  ◦ Persistent intractable plantar keratosis: no cases
	  ◦ Screw removal: no cases
	  ◦ Pin tract infection: 1 in open proximal Crescentic group; 2 in open proximal Chevron group
	  ◦ Deep infection: no cases
	  ◦ Hallux varus (overcorrection): 4 in open proximal Crescentic group; 5 in open proximal Chevron group
	• Treatment failure due to symptomatic (cosmetic) hallux varus (HVA of 10 degrees negative): 1 in each group

Easley 1996 *(Continued)*

	Secondary outcomes • Radiographic assessment (HVA, IMA and tibial sesamoid position) • Subjective assessment (percentage of participants satisfied, who would have the procedure again, who would recommend the procedure to a friend) • Radiographic shortening of the first metatarsal • Time to healing (bridging callus at the osteotomy site in anteroposterior and lateral planes) • Treatment cost (curved blade and screw insertion caused an increase in cost to the participant in the open proximal crescentic group)
Notes	Subgroup age analysis was performed for participants older and younger than 55 years and found no influence on the IMA correction.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not specified.
Allocation concealment (selection bias)	Unclear risk	Not specified.
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): self-reported outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): objective outcomes	Unclear risk	Not specified.
Incomplete outcome data (attrition bias) All outcomes	Low risk	9 participants were lost to follow-up; losses were balanced between groups (6; 3) and their reasons are not related to the intervention.
Selective reporting (reporting bias)	High risk	The study authors did not report any measure of variance (SD) for the main outcome scores.
Other bias	Unclear risk	Although telephone interviews were possible, the study authors decided that such data would offer little significant information.

Elshazly 2018

Study characteristics

Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: January 2013 to January 2015 **DOI**: 10.1016/j.fas.2018.02.017 **Protocol published before recruitment of participants**: no

Elshazly 2018 *(Continued)*

	Details of trial registration: not registered **Funding sources**: unknown
Participants	**Place of study**: 1 training and research hospital in Egypt **Number of participants assigned**: 48 participants (24 in open Scarf group; 24 in open long Chevron group). **Number of participants assessed for primary outcome (VAS)**: 43 participants (22 in open Scarf group; 21 in open long Chevron group). 5 were lost to follow-up. **Inclusion criteria**: symptomatic hallux valgus after 6 months of unsuccessful non-operative treatment; IMA 10–20 degrees; aged 18–80 years **Exclusion criteria**: MTP arthritis; rheumatoid arthritis; paralytic hallux valgus; people who were not a good match for surgery; people lost to follow-up **Age** Both groups: mean 36.0 (SD) 12.1 years **Gender of participants assigned (female/male)** Both groups: 24/19 **Classification of the condition**: IMA (cut-off points were defined as 14 and 20 degrees to separate mild, moderate and severe deformities).
Interventions	**Timing of intervention**: participants with painful hallux valgus after failed conservative treatment for 6 months **Type of surgical interventions** Open Scarf group: medial longitudinal incision from the base of the proximal phalanx to about 1 cm proximal to the first TMT joint; capsulotomy; Z-shaped osteotomy with the proximal apex 1.5 cm distal to the first TMT joint and the distal apex 1 cm proximal to the first MTP joint, both 5 mm from the plantar and dorsal borders, respectively; lateral translation until proper sesamoid correction; fixation with 2 × 2.7–3.0 mm screws. Open long Chevron group: medial longitudinal incision from the base of the proximal phalanx to about 1 cm proximal to the first TMT joint; capsulotomy; V-shaped osteotomy with the apex 3.5 mm superior to the centre of the metatarsal head (vertical dorsal cut and horizontal long plantar cut exiting at least 2.5 mm from the articular surface); distal fragment lateral translation until proper sesamoid correction; fixation with 2 × 2.7–3.0-mm screws. **Rehabilitation** Both groups: wrapping in the correct position using crepe bandage; weight-bearing on metatarsal offloading shoes from the second day postoperative; stitches removed at 2 weeks; load bearing on normal shoes with a rigid insole from week 6 to week 12; return to sports after 6 months. **Any co-interventions**: lateral capsular release with adductor hallucis tenotomy in cases of limited abduction of the first MTP joint under general anaesthesia examination; 4 cases in each group required additional Akin osteotomy fixed by 1 × 2.7–3.0-mm cannulated screw; removal of bone overhang and capsulorraphy. All co-interventions were performed equally across all groups.
Outcomes	**Length of follow-up**: 25.9 (range 24–30) months Participants were evaluated preoperatively and after 2 weeks; 1 month; 3 months; 6 months and 1 year of surgery **Withdrawals**: 5

Elshazly 2018 *(Continued)*

Major outcomes

- American College of Foot and Ankle Surgeons Scoring Scale
- Adverse events
  - Superficial infection with wound dehiscence: 1 in each group
  - Recurrence: 1 case in the open long Chevron group
  - Radiographic avascular necrosis of the metatarsal head
  - Other radiographic parameters: hardware failure or migration; signs of osteomyelitis; non-union

Secondary outcomes

- Radiographic assessment (HVA, IMA, DMAA, sesamoid position and first metatarsal declination angle; i.e. the angle formed between the long axis of the first metatarsal bone and the horizon in the lateral x-ray view)
- Operative time

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation list.
Allocation concealment (selection bias)	Unclear risk	Not specified.
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): self-reported outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): objective outcomes	High risk	Outcome personnel were not blinded.
Incomplete outcome data (attrition bias) All outcomes	Low risk	5 participants (10.4%) lost to follow-up; losses were balanced between groups (2 and 3).
Selective reporting (reporting bias)	High risk	The study did not provide an adequate tool for measuring pain and function. Results were pooled for different degrees of deformity but did not specify the technique for each outcome.
Other bias	Low risk	Study appeared free of other potential sources of bias.

Faber 2004

Study characteristics

Methods	**Study design**: single-centre, 2-group, parallel-design RCT

Faber 2004 *(Continued)*

	Duration of the study: October 1997 to July 2000 **Protocol published before recruitment of participants**: no **Details of trial registration**: not registered **Funding sources**: unknown
Participants	**Place of study**: 1 tertiary hospital in the Netherlands **Number of participants assigned**: 87 participants (101 feet; 14 bilateral; 50 feet in open Hohmann group; 51 feet in open Lapidus group) **Number of participants assessed for primary outcome (AOFAS)**: 87 participants (101 feet; 14 bilateral; 50 feet in open Hohmann group; 51 feet in open Lapidus group) **Inclusion criteria**: symptomatic hallux valgus **Exclusion criteria**: indication of a first MTP arthrodesis; aged < 15 years; aged > 65 years; rheumatoid arthritis; other inflammatory diseases; previous operation on the affected foot; osteoarthritis of the first TMT joint; moderate or severe osteoarthritis of the first MTP joint (defined by a total range of motion < 50 degrees or radiographic signs of advanced osteoarthritis) **Age** Open Hohmann group: mean 41 (range 16–63) years Open Lapidus group: mean 43 (range 16–63) years **Gender of participants assigned (female/male)** Total: 84/3 **Classification of the condition**: any degree (wide HVA and IMA angles range)
Interventions	**Timing of intervention**: symptomatic hallux valgus requiring surgery, other than a first MTP arthrodesis **Type of surgical interventions** Open Hohmann group: dorsomedial incision centred over the first MTP joint; capsulotomy; transverse osteotomy perpendicular to the first metatarsal shaft and a medial-plantar-based wedge-shaped piece of bone is removed (the size of the wedge depends on the extent of the deformity) – the plantar inclination performed by this technique aims to compensate for the small amount of shortening and prevent transfer metatarsalgia; lateral translation of the capital fragment of 4–5 mm; fixation with a Kirschner wire (left protruding through the skin distally); the capsule was sutured to the periosteum; below-the-knee splint after complete suturing and padding. Open Lapidus group: medial incision centred over the medial eminence; lateral capsulotomy and release of the adductor hallucis muscle through a separate dorsal incision over the first intermetatarsal space; resection of the medial eminence; excision of a 3-mm strip of the capsule; the TMT joint was exposed and cartilage removed with an oscillating saw; perforations of the subchondral bone; fixation with 2 × 3.5-mm lag screws; capsuloplasty; below-the-knee splint after complete suturing and padding. **Rehabilitation** Both groups: non-weight-bearing splint for 2 weeks; removal of stitches, movement of the great toe and weight-bearing cast started after 2 weeks for 6 more weeks; unprotected weight-bearing after 8 weeks (or when radiographs showed good bone healing). **Any co-interventions**: correction of hammer toe deformities, performed at the same time in 18 feet (8 feet in the open Lapidus group and 10 feet in the open Hohmann group) and an osteotomy of the fifth metatarsal in 1 foot in the open Lapidus group. Additional procedures in the long-term follow-up were

Faber 2004 *(Continued)*

	hammer toe deformities in 2 participants of the open Hohmann group. All co-interventions were performed equally across all groups.

Outcomes	**Length of follow-up**: 24 months
	
	Participants were evaluated preoperatively and after 6 months, 1 year and 2 years of surgery
	
	Withdrawals: 1 withdrawal of a participant who emigrated just before the 2-year follow-up visit. The results for that participant at the 1-year follow-up visit were considered the endpoint.
	
	Major outcomes
	
	• VAS
	• AOFAS
	• Adverse events
	  ◦ Deformities of the lesser toes
	  ◦ Superficial wound infection: 7 feet in the open Hohmann group; 2 feet in the open Lapidus group – all treated with oral antibiotics
	  ◦ Premature removal of the Kirschner wire due to superficial wound infection: 6 cases in the open Hohmann group
	  ◦ Deep infections: none occurred
	  ◦ Reflex sympathetic dystrophy: 2 participants in the open Lapidus group
	  ◦ Transient hypoesthesia of the deep peroneal nerve: 11 participants in the open Hohmann group; 7 in the open Lapidus group
	  ◦ Delayed union (absence of radiographic callus formation at the osteotomy site on the eighth week): 4 feet in the open Hohmann group – treated with prolonged cast immobilisation for 3 weeks
	  ◦ Reoperation due to symptomatic non-union (pain and mobility at clinical testing or absence of radiographic union after 6 months of surgery, or both): 1 participant in open Hohmann group; 1 in open Lapidus group
	  ◦ Reoperation due to undercorrection or recurrence: 2 participants in open Hohmann group; 1 in open Lapidus group
	  ◦ Bad result (low AOFAS score, pain, hallux varus, shortening and transfer metatarsalgia): the same participant of the reoperation due to non-union (1 participant in open Lapidus group)
	  ◦ Screw removal due to participant complaints: 7 feet in open Lapidus group
	  ◦ Iatrogenic hallux varus: the same participant of the reoperation due to non-union (1 in open Lapidus group)
	  ◦ Transfer metatarsalgia: 4 participants in open Hohmann group; 2 in open Lapidus group – successfully treated with a shoe insert
	
	Secondary outcomes
	
	• Radiographic measurements (HVA; IMA)
	• Clinical measurements of the HVA and forefoot width
	• First TMT joint mobility test
	• Participant global assessment of treatment success (6-point scale varying from 1 = very satisfied to 6 = very dissatisfied)

Notes	All participants were examined clinically by the same observer (Dr Faber), who performed or supervised all the operations. For the 14 bilateral cases, the procedures were performed at different times, and the randomisation procedure was followed again for the second foot. Asymptomatic non-union (absence of radiographic union after 6 months of surgery) was considered an adverse event by the study but was not included as such in our analysis since it has no clinical significance (4 feet in the open Lapidus group).
Risk of bias	

Faber 2004 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation list.
Allocation concealment (selection bias)	Low risk	Sealed envelopes.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel were not blinded.
Blinding of outcome assessment (detection bias): self-reported outcomes	High risk	Participants were not blinded for self-reported outcomes.
Blinding of outcome assessment (detection bias): objective outcomes	Low risk	Outcome assessor was blinded by taping the operated foot.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Withdrawals were balanced between groups (1 and 0).
Selective reporting (reporting bias)	Unclear risk	Outcome measures are adequate; range was provided so SD was presumed by rough estimation.
Other bias	Low risk	Study appeared free of other potential sources of bias.

Giannini 2013

Study characteristics	
Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: not specified **Protocol published before recruitment of participants**: no **Details of trial registration**: not registered **Funding sources**: unknown
Participants	**Place of study**: 1 orthopaedic institute in Italy **Number of participants assigned**: 20 participants (20 feet in SERI group; 20 feet in Scarf group) **Number of participants assessed for primary outcome (AOFAS)**: 20 participants (20 feet in SERI group; 20 feet in Scarf group) **Inclusion criteria**: aged 20–70 years; bilateral hallux valgus, similar in severity in both feet; HVA 15–40 degrees; IMA < 20 degrees; adequate range of motion of the MTP joint; pain and difficulty in wearing shoes; no benefit from conservative treatment **Exclusion criteria**: rheumatoid arthritis; other inflammatory diseases; previous hallux valgus surgery; interphalangeal hallux valgus; symptomatic or radiographic evidence of arthritis of the MTP joint; associated deformities in other joints of the foot; first ray hypermobility

Giannini 2013 *(Continued)*

	Age Percutaneous SERI group: mean 53 (SD 11) years Open Scarf group: mean 53 (SD 11) years **Gender of participants assigned (female/male)** Percutaneous SERI group: 20/0 Open Scarf group: 20/0 **Classification of the condition**: moderate-to-(slightly) severe (hallux valgus was classified according to the degree of HVA).
Interventions	**Timing of intervention**: bilateral hallux valgus similar in severity after failed non-operative treatment **Type of surgical interventions** Percutaneous SERI group: 1-cm medial incision just proximal to the medial eminence through the skin and subcutaneous, down to the bone; percutaneous transverse osteotomy guided by fluoroscopy; insertion of a 2-mm Kirschner wire adjacent to the distal fragment and out of the skin medial to the tip of the great toe, 5 mm below the medial border of the nail; percutaneous correction with a small-grooved lever; stabilisation obtained by inserting the same Kirschner wire backwards into the diaphyseal channel; a small wedge of the medial bone stump was removed if prominent. Open Scarf group: 3-cm medial incision; capsulotomy; Z-shaped osteotomy; lateralisation of the distal fragment to a degree that depended on the pathoanatomy of the deformity; stabilisation with 2 × 3-mm screws; a small wedge of the medial bone stump was removed if prominent. **Rehabilitation** Both groups: gauze bandage; ambulation allowed immediately using talus shoes for 30 days. Normal shoes, cycling and swimming were advised after 1 month. **Any co-interventions**: manual stretching of the adductor hallucis performed forcing the big toe into a varus position; in some cases, the distal fragment was slightly dislocated plantarly to reduce metatarsalgia (2 cases in the SERI group and not specified in the open Scarf group); 5th ray varus (bunionette) was corrected in some cases, as we can assume by the x-rays shown in the article, but this was not mentioned in the text or subtitles of the pictures. All co-interventions were performed equally across groups.
Outcomes	**Length of follow-up**: 2–7 years Participants were evaluated preoperatively and after 24 months and 7 years of surgery. **Withdrawals**: 0 **Major outcomes** • AOFAS • Adverse events: pin tract infection, nerve injury, avascular necrosis of the metatarsal head (none occurred) **Secondary outcomes** • Radiographic assessment (HVA, IMA and DMAA) • Duration (time, in minutes) of the procedure: percutaneous SERI procedure was significantly faster than the open Scarf method (mean: 3 as opposed to 17 minutes; $P < 0.0005$) • Range of motion: reduction was observed in 3 participants of each group. There was 1 case of severe reduction of ROM due to arthritis, thus being considered a composite adverse event • Cosmetic results: subjective evaluation of the scar

Giannini 2013 *(Continued)*

- Asymptomatic non-union or delayed union: all osteotomies had healed properly by the 6 months of radiographic control

Notes	The study authors did not evaluate pain with any available scale. Subjective preference: 8 participants expressed their preference for the percutaneous SERI procedure because of the less-evident scar. **Composite adverse events**: 2 participants in the open Scarf group had to have hardware removed due to intolerance and 1 poor AOFAS score result was also in the open Scarf group (61 points) due to arthritis and severely reduced range of motion of the first MTP joint with transfer metatarsalgia; this participant refused revision surgery.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not specified.
Allocation concealment (selection bias)	Unclear risk	Not specified.
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): self-reported outcomes	High risk	Participants were not blinded for self-reported outcomes.
Blinding of outcome assessment (detection bias): objective outcomes	High risk	Outcome personnel were not blinded.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No participants were lost to follow-up. Participants were treated as intended.
Selective reporting (reporting bias)	Low risk	Pain score or subscore and failure of treatment were not reported, so we could not enter it in a meta-analysis.
Other bias	Low risk	Study appeared free of other potential sources of bias.

Glazebrook 2014

Study characteristics

Methods	**Study design**: multicentre RCT (3 centres) **Duration of the study**: April 2007 to June 2012 **Protocol published before recruitment of participants**: yes **DOI**: 10.2106/JBJS.M.00231 **Date of trial registration**: 11 February 2013

Glazebrook 2014 *(Continued)*

	Recruitment started: April 2007 **Details of trial registration**: ClinicalTrials.gov **Main ID**: NCT01791634 **Funding sources**: unrestricted research grant from Arthrex (this company is the distributor of the plate used for stabilising the open wedge osteotomy) – conditioned to unrestricted publication of data and conclusions.
Participants	**Place of study**: recruitment and management in Halifax, Toronto and Ottawa. 3 centres in Canada **Number of participants assigned**: 75 participants (40 in proximal opening wedge group; 35 in proximal Chevron osteotomy group) **Number of participants assessed for primary outcome (VAS)**: 73 participants (38 in proximal opening wedge group; 35 in proximal Chevron osteotomy group) **Inclusion criteria**: aged > 18 years; HVA > 20 degrees; IMA > 10 degrees; persistent incapacitating symptoms despite non-operative treatment **Exclusion criteria**: degenerative arthritis of the first MTP joint; neuropathy; diabetes mellitus; peripheral vascular disease; previous surgery on the ipsilateral first metatarsal, hallux or MTP joint; active or recent infection involving the foot; current participation in another clinical trial; workers' compensation claim; TMT instability **Age** Proximal opening wedge group: mean 50.5 (SD 12.5) years Proximal Chevron osteotomy group: mean 52.9 (SD 12.1) years **Gender of participants assigned (female/male)** Proximal opening wedge group: 36/2 Proximal Chevron osteotomy group: 34/1 **Classification of the condition**: any grade hallux valgus (HVA > 20 degrees or IMA > 10 degrees)
Interventions	**Timing of intervention**: persistent incapacitating symptoms despite non-operative treatment (shoewear modification, orthotics, non-steroidal anti-inflammatory drugs, restricted activity) **Type of surgical interventions** Proximal opening wedge group: 2–3 cm medial longitudinal incision, transverse osteotomy (perpendicular to the sagittal metatarsal axis and leaving the lateral cortex intact to serve as a hinge); opening of the wedge and correction of the angle through fluoroscopy; appropriate sized wedge (each millimetre of which corresponding to approximately 3 degrees of correction for the IMA) plate selection and fixation; 1 cm^3 of autograft or bone-graft substitute was placed into the osteotomy site to fill the void. Proximal Chevron osteotomy group: 2- to 3-cm medial longitudinal incision, proximal chevron osteotomy performed from the medial aspect of the first metatarsal. The apex of the chevron was directed proximally. The distal fragment was translated laterally and positioning was confirmed with the use of intraoperative fluoroscopy. The osteotomy site was stabilised with 2 × 3.0-mm cannulated screws. Cancellous bone from the removed prominent medial aspect of the proximal fragment was packed into the osteotomy site if any gaps were apparent. **Rehabilitation** Both groups: dressing and plaster cast in the operating room. Restricted to non-weight-bearing for 4–6 weeks. Progressive weight-bearing for 2–4 weeks until full weight-bearing was tolerated. **Any co-interventions**: distal soft-tissue procedure and exostectomy, 2–3 cm longitudinal dorsal incision over the first webspace and detachment of adductor hallucis tendon; the transverse metatarsal

Glazebrook 2014 *(Continued)*

	ligament was also released. Lateral arthrotomy to allow corrective sesamoid sling translation. Another 2–3 cm longitudinal incision over the medal MTP joint, distally based V-shaped MTP capsulotomy was performed to allow exostectomy and capsular plication. All co-interventions were performed equally across all groups.

Outcomes	**Length of follow-up**: 12 months
	
	Participants were evaluated preoperatively and after 3, 6 and 12 months of surgery
	
	Withdrawals: 2
	
	Major outcomes
	
	• SF-36
	• AOFAS
	• VAS
	• Adverse events
	  ◦ Postoperative hallux varus (2 participants, which were revised to a first MTP fusion or contracture release, 1 in each group)
	  ◦ Ongoing late pain (2 participants, which were revised to a first MTP fusion, 1 in each group)
	  ◦ Lateral sesamoiditis (1 participant, which was treated non-operatively with an off-loading orthotic, in the proximal opening wedge group)
	  ◦ Plantar flexion deformity of the first metatarsal (1 participant, treated with an extension osteotomy of the first metatarsal, in the proximal Chevron osteotomy group)
	  ◦ Peri-implant irritation (1 participant, which was treated with screw removal, in the proximal Chevron osteotomy group)
	  ◦ Fracture as a result of a fall postoperatively, osteochondral defect secondary to osteonecrosis and delayed wound-healing (3 participants, no other information was given regarding the treatment of these cases, in the proximal Chevron osteotomy group)
	
	Secondary outcomes
	
	• Radiographic evaluation (HVA, IMA, lateral talar-first metatarsal angle – Meary, relative first metatarsal angle, osteotomy union/bridging callus)
	• Demographics (body mass index, age, laterality, gender, height and weight)
	• Operative times (no difference between groups)

Notes	**Composite adverse events**: complications were separated as described above, but could be separated by group as follows: Proximal opening wedge group: 3 complications, 2 needed revision surgery, 1 was conservative. Proximal Chevron osteotomy group: 7 complications, 4 needed revision surgery, 3 were not specified.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not specified.
Allocation concealment (selection bias)	Unclear risk	Sequentially numbered, opaque, sealed envelopes. There was unequal allocation to each group (40 participants vs 35 participants).
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel were not blinded.

Glazebrook 2014 *(Continued)*

Blinding of outcome assessment (detection bias): self-reported outcomes	High risk	Participants were not blinded for self-reported outcomes.
Blinding of outcome assessment (detection bias): objective outcomes	High risk	Outcome personnel were not blinded.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Only 2 participants were lost to follow-up, coincidentally in the most populated group, so data were balanced.
Selective reporting (reporting bias)	Low risk	Data and measure of variance (SD) for the main outcome scores were adequate.
Other bias	Low risk	Study appeared free of other potential sources of bias.

Kaufmann 2020

Study characteristics	
Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: January 2012 to January 2013 **Protocol published before recruitment of participants**: no **DOI**: 10.2106/JBJS.19.00981 **Date of trial registration**: not specified **Recruitment started**: people scheduled to undergo distal Chevron osteotomy between January 2012 and August 2013 **Details of trial registration**: ctc.tirol-kliniken at registry identifier: 20200215-2202 **Main ID**: UN4674 **Funding sources**: unknown
Participants	**Place of study**: 1 centre from Innsbruck, Austria **Number of participants assigned**: 47 participants (22 in the open Chevron group; 25 in the MIS group) **Number of participants assessed for primary outcome (VAS)**: 39 participants (20 in the open Chevron group; 19 in the MIS group) **Inclusion criteria**: people on a waiting list for a distal Chevron osteotomy for hallux valgus; failed conservative treatment **Exclusion criteria**: aged < 18 years; previous osteotomy or soft tissue intervention for hallux valgus deformity; instability of the first TMT joint (abnormal painful motion in this joint); osteoarthritis of the first MTP joint; preoperative HVA < 20 degrees; preoperative IMA < 10 degrees or > 15 degrees; additional operative treatment of the second ray **Age** Open Chevron group: mean 47 (SD 14.3) years MIS group: mean 54 (SD 15.2) years

Kaufmann 2020 *(Continued)*

	Gender of participants assigned (female/male) Open Chevron group: 19/3 MIS group: 21/4 **Classification of the condition**: moderate hallux valgus, classified according to the degree of the IMA
Interventions	**Timing of intervention**: after failed conservative treatment **Type of surgical interventions** Open Chevron group: 4 cm long dorsomedial incision; V-shaped osteotomy (apex 1–2 cm superior to the centre of the metatarsal head, 60–90 degrees between the arms); fixation with 1 cannulated 3-mm or 2.5-mm screw; lateral soft tissue release through the same incision; T-shaped capsulotomy to allow reposition of the sesamoid. MIS group: 3–5-mm dorsomedial incision, 8000 revolutions per minute reamer percutaneously directed toward the centre of the third metatarsal head with plantarisation of 5–10 degrees; fixation with 1 × 1.2-mm Kirschner wire cut with an overhang of 3–5 mm; lateral soft tissue release through a separate lateral incision of 3–5 mm. No capsuloplasty was performed. Slight varus rotation to realign the joint line. **Rehabilitation** Both groups: immediate weight-bearing over a custom-made shoe; suture removal at 2 weeks; wound cover reduced to allow full range of motion at 2 weeks; surgical shoe discarded at 6 weeks. **Any co-interventions**: lateral soft tissue release was performed equally across all groups; capsuloplasty was performed only in the open Chevron group (20 participants). When additional deformity of proximal phalangeal bone was present, an Akin osteotomy was performed (8 cases in the open Chevron group, 13 in the MIS group).

Outcomes	**Length of follow-up**: > 5 years
	
	Participants were evaluated preoperatively and after 6 and 12 weeks, 9 months and ≥ 5 years of surgery
	
	Withdrawals: 8 (2 moved from country, 6 did not mention their reasons for declining to continue in the study).
	
	Major outcomes
	
	• VAS
	• AOFAS
	• Adverse events
	  ◦ Reoperation due to soft tissue irritation caused by the Kirschner wire: 16 feet (MIS group)
	  ◦ Reoperation for cannulated screw removal: 4 feet (open Chevron group)
	  ◦ Infection: no cases
	  ◦ Fracture: no cases
	  ◦ Loss of fixation: no cases
	  ◦ Avascular necrosis: no cases
	
	Secondary outcomes
	
	• Radiographic assessment (DMAA, HVA, presence of osteoarthritis after 5 years by the Kellgren-Lawrence grade)
	• Participant global assessment of treatment success (1. very satisfied; 2. satisfied; 3. don't know; 4. not satisfied)

Notes	**Composite adverse events**: there were no cases of infection, fracture, loss of fixation or avascular necrosis. 1 case of subclinical hallux varus was identified in the open Chevron group; 3 feet in the open Chevron group (1 of which reported low AOFAS and participant global assessment of treatment success

Kaufmann 2020 *(Continued)*

scores and HVA > 30 degrees) and 2 in the MIS group presented mild recurrence of deformity. None of those needed a revision until the conclusion of the study.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation was performed by lot using random.org software.
Allocation concealment (selection bias)	Low risk	Sequentially numbered and sealed envelopes, inside opaque box.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel were not blinded.
Blinding of outcome assessment (detection bias): self-reported outcomes	High risk	Participants were not blinded for self-reported outcomes.
Blinding of outcome assessment (detection bias): objective outcomes	Low risk	Measurements were made by 1 blinded observer.
Incomplete outcome data (attrition bias) All outcomes	Low risk	8 losses to follow-up were justified and balanced between groups.
Selective reporting (reporting bias)	Unclear risk	Adequate measuring tool was provided with interquartile range, lacking SD. IMA radiological outcome was incomplete.
Other bias	Low risk	Study appeared free of other potential sources of bias.

Klosok 1993

Study characteristics

Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: not specified **Protocol published before recruitment of participants**: no **Details of trial registration**: not specified **Funding sources**: unknown
Participants	**Place of study**: 1 training and research hospital in England **Number of participants assigned**: 51 participants (26 in open distal Wilson group; 25 in open distal Chevron group) **Number of participants assessed for primary outcome (VAS)**: 45 participants (23 in open distal Wilson group; 22 in open distal Chevron group) **Inclusion criteria**: unilateral or bilateral hallux valgus

Klosok 1993 *(Continued)*

	Exclusion criteria: not specified. Rheumatoid arthritis was not an exclusion criterion, but data were given separately. **Age** Open distal Wilson osteotomy: mean 45 (SD 11.4) years Open distal Chevron osteotomy: mean 45 (SD 8.6) years **Gender of participants assigned (female/male)** Total: 44/7 **Classification of the condition**: mild-to-moderate hallux valgus
Interventions	**Timing of intervention**: participants complaining of plantar callosities, metatarsalgia, discomfort from the exostosis or cosmetic issues **Type of surgical interventions** Open distal Wilson osteotomy: 5–8 cm dorsomedial incision; centred over the first MTP joint; joint was not exposed (the joint was not exposed and exostectomy was not routine); double-oblique (plantar and distal directed) 45 degree osteotomy; distal fragment lateralisation. Open distal Chevron osteotomy: 5–8 cm dorsomedial incision; centred over the first MTP joint; V-shaped capsulotomy; exostectomy; V-shaped osteotomy; distal fragment lateral displacement and rotation; no fixation method; capsuloplasty. **Rehabilitation** Open distal Wilson osteotomy: below-knee plaster with an extension to the hallux to maintain the corrected position with a walking heel added 48 hours after surgery; plaster was removed after 6 weeks. Open distal Chevron osteotomy: no plaster was used, weight-bearing on the heel was allowed 48 hours after surgery; dressings helping maintain the corrected position were changed after 2 weeks and discarded at 4 weeks. **Any co-interventions**: when necessary, the bony spike of the osteotomy was trimmed in the Chevron group (22 participants), exostectomy was not routine in the Wilson group (23 participants).

Outcomes	**Length of follow-up**: 38 months.
	
	Participants were evaluated preoperatively and 6 months, 12 months and 2–3 years postsurgery
	
	Withdrawals: 6
	
	Major outcomes
	
	• Adverse events
	  ◦ Central metatarsalgia (or new central callosities) development
	  ◦ Hallux varus (overcorrection): 2 participants in Wilson group only
	  ◦ Slow healing of the wound: 1 participant in Wilson group, 2 in Chevron group
	  ◦ Recurrence (of the bunion): 1 participant in Chevron group only
	  ◦ Dorsal spike (arthritis): 3 participants in Wilson group only
	  ◦ Stress fracture of the third metatarsal: 1 participant in Chevron group only
	  ◦ Sensitivity (dysaesthesia or hyperaesthesia): 4 participants in each group
	  ◦ Comminuted osteotomy: 1 participant in each group
	  ◦ Early swelling: 7 participants in Wilson group, 8 in Chevron group
	• Treatment failure
	  ◦ Clinical recurrence: 7 participants in the Chevron group
	  ◦ Transfer metatarsalgia due to excessive shortening of the first metatarsal bone: 3 participants in the Wilson group, 5 in the Chevron group

Klosok 1993 *(Continued)*

- Stiffness of all MTP joints: 4 participants in the Chevron group

Secondary outcomes

- Radiographic assessment (HVA; IMA and shortening of the first metatarsal)
- Subjective participant assessment of outcome (better appearance; pain relief; better shoe-fitting): study declared that 20% of all participants were dissatisfied with the results; no further description
- Range of motion
- Time to return to work
- Distribution of weight on the feet (using footprints)

Notes	**Composite treatment failure events**: 8 participants in the Chevron group experienced treatment failure (9 feet) compared to 3 participants in the Wilson group (5 feet). 1 participant in each group had preoperative rheumatoid arthritis and had poor outcomes due to, according to the study author, poor clinical selection. Because 6 participants were unwilling to attend the hospital, they were examined at home, and radiographs were not taken.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation list.
Allocation concealment (selection bias)	Unclear risk	Not specified.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel were not blinded.
Blinding of outcome assessment (detection bias): self-reported outcomes	High risk	Participants were not blinded for self-reported outcomes.
Blinding of outcome assessment (detection bias): objective outcomes	Unclear risk	Not specified.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses to follow-up were balanced between groups (3 and 3).
Selective reporting (reporting bias)	Unclear risk	SDs were successfully described, but report lacked subjective measurements such as pain, AOFAS or self-reported outcome measurements.
Other bias	Low risk	Study did not exclude rheumatoid arthritis from the design, but data were given separately.

Lee 2015

Study characteristics

Lee 2015 *(Continued)*

Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: May 2005 to December 2009 **Protocol published before recruitment of participants**: no **Details of trial registration**: not registered **Funding sources**: supported by a grant from Chonnam National University Hospital Biomedical Research Institute. The author or 1 or more authors received or will receive benefits for personal or professional use from a commercial party related directly or indirectly to the subject of this article.
Participants	**Place of study**: The National University Medical School and Hospital in Gwangju, Korea **Number of participants assigned**: 50 participants (each participant had both surgeries performed on both feet, 50 feet in group 1 and 50 feet in group 2) **Number of participants assessed for primary outcome (AOFAS)**: 46 participants (each participant had both surgeries performed on both feet, 46 feet in group 1 and 46 feet in group 2) **Inclusion criteria**: symptomatic bilateral moderate-to-severe hallux valgus with pain; failed trial of non-operative treatment with modification of shoes; difficulty wearing shoes; HVA > 20 degrees; IMA > 14 degrees; incongruent first MTP joint **Exclusion criteria**: inflammatory arthropathy; ankle deformity; gastrocnemius contracture; mid-foot arthritis; previous failed hallux valgus surgery; pre-existing radiological evidence of substantial degenerative arthritis of the first MTP joint; hallux rigidus; severe instability of the first TMT joint; symptomatic progressive collapsing foot deformity **Age** Open proximal Chevron osteotomy group: mean 53.8 years Open distal Chevron osteotomy group: mean 53.8 years **Gender of participants assigned** 50 females (100 feet, 50 in each group) **Classification of the condition**: moderate to severe; hallux valgus was classified according to the degree of HVA and IMA.
Interventions	**Timing of intervention**: people undergoing simultaneous bilateral correction of hallux valgus. **Type of surgical interventions** Open proximal Chevron osteotomy group: medial incision from the base of the proximal phalanx to the TMT joint; reverse 60-degree V-shaped osteotomy with the apex 10 mm distal to the TMT joint; lateral slide and tilt of the distal fragment; fixation performed with 2 medially placed, proximal to distal, 1.6-mm K wires. Open distal Chevron osteotomy group: medial incision from the mid-portion of the proximal phalanx extending 2 cm proximal to the medial eminence; standard 60 degree V-shaped osteotomy with the apex centred on the first metatarsal head; lateral slide of 6–9 mm of the capital fragment; manual impaction of the head against the neck; fixation performed with 2 medially placed 1.4-mm K wires. **Rehabilitation** Both groups: gauze dressing taking care not to pronate the great toe; weight-bearing on the heel allowed with a postoperative shoe; removal of sutures after 2 weeks; at 6 weeks K wires were removed and soft shoes were allowed.

Lee 2015 *(Continued)*

	Any co-interventions: distal lateral soft tissue release; medial eminence resection and capsuloplasty (plantar flap was pulled dorsally to reposition the sesamoid and redundant tissue was excised); excision of remaining overhanging edges. All co-interventions were performed equally across all groups.

Outcomes	**Length of follow-up**: ≥ 24 months
	
	Participants were evaluated preoperatively and 3, 6 and 12 months and annually after, up to at least 24 months minimum (mean duration of follow-up 40.2 months) after surgery.
	
	Withdrawals: 4
	
	Major outcomes
	
	• AOFAS
	• Adverse events
	  ○ Delayed union or non-union: no cases
	  ○ Deep infection: no cases
	  ○ Avascular necrosis (subchondral lucencies, cysts, bony collapse, fragmentation, and joint space narrowing): no cases
	  ○ First MTP arthritis (joint space narrowing): no cases
	  ○ Recurrent asymptomatic hallux valgus: 3 in open proximal Chevron osteotomy group, 1 in open distal Chevron osteotomy group
	  ○ Numbness across the medial side of the great toe and superficial infection: 1 in each group
	  ○ First MTP joint stiffness: 3 in open distal Chevron osteotomy group
	  ○ Persistent bunion pain: 1 in each group
	
	Secondary outcomes
	
	• Radiographic assessment (HVA, IMA and sesamoid position)
	• Participant global assessment of treatment success (very satisfied, satisfied, improved or dissatisfied)
	• Joint stiffness (< 30 degrees of range of motion)
	• Displacement after fixation
	• Radiographic short hallux (> 2.5 mm of metatarsal shortening) using the Hardy and Clapham method (Hardy 1951)

Notes	The study design aimed to compare the outcomes of 2 techniques in people undergoing a simultaneous bilateral correction, thereby compensating for the variability introduced by differences in demographic aspects. Nonetheless, the authors did not specify their protocol of randomisation; it seems like they randomised which technique would be performed at each side (i.e. each foot), but this was unclear in the final text. This is the same group of authors and hospitals as Park 2013; also, the same techniques were used in both groups, but the participants were different because 1 study evaluated bilateral simultaneous deformity and the other assessed only severe unilateral cases. **Composite adverse events**: 11 adverse events occurred, 6 in open proximal Chevron osteotomy group and 5 in the open distal Chevron osteotomy group.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported other than "block randomization was used".
Allocation concealment (selection bias)	High risk	All participants were submitted to simultaneous bilateral surgery, 1 procedure of interest in each foot.

Lee 2015 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	High risk	All participants were submitted to simultaneous bilateral surgery, 1 procedure of interest in each foot.
Blinding of outcome assessment (detection bias): self-reported outcomes	High risk	All participants were submitted to simultaneous bilateral surgery.
Blinding of outcome assessment (detection bias): objective outcomes	High risk	All participants were submitted to simultaneous bilateral surgery.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Since all participants received both procedures, losses were balanced.
Selective reporting (reporting bias)	High risk	Failure of treatment was not reported, so we could not enter it in a meta-analysis.
Other bias	Low risk	Study appeared free of other potential sources of bias.

Lee 2017

Study characteristics	
Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: April 2012 to May 2015 **Protocol published before recruitment of participants**: no **Details of trial registration**: DOI 10.1177/1071100717704941 **Funding sources**: unknown
Participants	**Place of study**: North Shore Private Hospital (Sydney, Australia) **Number of participants assigned**: 50 participants (25 cases in each group) **Number of participants assessed for primary outcome (VAS)**: 50 participants (25 cases in each group) **Inclusion criteria**: aged > 20 years; painful bunion; failure of > 3 months of conservative treatment, including shoe modification, pad, and oral medications; HVA > 20 degrees and IMA > 12 degrees; written informed consent form **Exclusion criteria**: systemic disease affecting the musculoskeletal system (e.g. rheumatoid arthritis, gout, ankylosing spondylitis, seronegative rheumatoid arthritis, and systemic lupus erythematosus); first MTP joint arthritis; first metatarsocuneiform joint instability; infection; need for simultaneous lesser toe procedure; history of prior surgery on the foot and ankle. **Age** Percutaneous Chevron/Akin group: mean 52.6 years Open Scarf/Akin group: mean 53.4 years **Gender of participants assigned (female/male)**

Lee 2017 *(Continued)*

	Percutaneous Chevron/Akin group: 23/2 Open Scarf/Akin group (female/male): 22/3 **Classification of the condition**: moderate-to-severe hallux valgus deformity classified according to the degree of HVA and IMA
Interventions	**Timing of intervention**: people undergoing correction of hallux valgus after failure of conservative treatment for ≥ 3 months **Type of surgical interventions** Percutaneous Chevron/Akin group: the dorsal and plantar outline of the first metatarsal was drawn. A beaver blade was used to perform 3–5-mm incisions over the mid-point of said lines at the medial aspect of the first MTP joint, at the base of the flare of the medial eminence and at the medial aspect of the TMT joint. V-shaped osteotomy using a 2 – 20-mm Shannon burr, removing approximately 2–3 mm of bone. Displacement was performed with a 2-mm K wire and aimed to direct the distal fragment medially, anteriorly and plantarly. Fixation was performed with 2 × 3-mm headless cannulated screws. Open Scarf/Akin group: not described in this article (refer to Barouk 2000). Standard open Scarf procedure: medial incision; a longitudinal cut connected to a dorsal-distal cut and a plantar-proximal cut; displacement of the distal fragment to obtain alignment checked by fluoroscopy; and fixation with cannulated screws. **Rehabilitation** Both groups: non-adherent dressing (such as Adaptic), dry gauze, bandage **Any co-interventions**: Akin was performed either using a percutaneous method (percutaneous Chevron/Akin group) or prolongation of the incision (Scarf group) and fixation was performed with cannulated screws. All co-interventions were performed equally across all groups.

Outcomes	**Length of follow-up**: 6 months
	
	Participants were evaluated preoperatively, at immediate postoperative day, and at 2 weeks, 6 weeks and 6 months postoperatively.
	
	Withdrawals: 0
	
	Major outcomes
	
	• VAS
	• AOFAS
	• Adverse events
	  ◦ Wound complication: no cases
	  ◦ Secondary metatarsalgia: 2 in the open Scarf group
	  ◦ Removal of the screws because of prominence under the skin: 6 in percutaneous Chevron group
	
	Secondary outcomes
	
	• Radiographic assessment (HVA and IMA)
	• Participant global assessment of treatment success (excellent, good, fair or poor)
	• Scar length
	• Mean radiation screen time

Notes	The senior author preferred to use a pneumatic tourniquet on the proximal thigh even though some surgeons do not recommend tourniquet use in order to allow a cooling effect from blood flow (verbal communication, Joel Vernois, MD, David J Redfern, FRCS (Tr&Orth), August 2013).

Risk of bias

Lee 2017 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Stratified permuted block randomisation was performed by a blinded biostatistician.
Allocation concealment (selection bias)	Unclear risk	Not specified.
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): self-reported outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): objective outcomes	Low risk	Outcome assessors were blinded for objective outcomes.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up.
Selective reporting (reporting bias)	High risk	Failure of treatment was not reported, so we could not enter it in a meta-analysis.
Other bias	Low risk	Study appeared free of other potential sources of bias.

Mahadevan 2016

Study characteristics	
Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: January 2006 to December 2012 **Protocol published before recruitment of participants**: no **Details of trial registration**: not registered **Funding sources**: unknown
Participants	**Place of study**: 1 tertiary orthopaedic centre in the UK **Number of participants assigned**: 96 participants (121 feet); 50 in open modified Chevron group; 46 in open Scarf group **Number of participants assessed for primary outcome (x-ray)**: 84 participants (109 feet); 46 participants (60 feet) in open long plantar limb (modified) Chevron group; 38 participants (49 feet) in open Scarf group **Inclusion criteria**: IMA 10–21 degrees **Exclusion criteria**: aged < 16 years; IMA > 21 degrees; previous first metatarsal surgery; hallux valgus interphalangeus; instability of the first TMT joint; arthrosis of the first MTP or TMT joint; people requiring additional procedures to the foot or ankle, including the Akin osteotomy

Mahadevan 2016 *(Continued)*

	Age Study population, not specified by group: mean 50.7 (SD 14.1) years **Gender of participants assigned (female/male)** Total: 75/9 **Classification of the condition**: mild-to-moderate deformities; hallux valgus was classified according to the degree of the IMA
Interventions	**Timing of intervention**: people with hallux valgus requesting surgical correction because of discomfort, pain or difficulty with shoe wear. **Type of surgical interventions** Open modified Chevron group: medial incision; apex of the osteotomy was centred 3–5 mm superior to the geometric centre of the metatarsal head, and the plantar cut was made more horizontal than a traditional Chevron, directed slightly plantar in the medial to lateral direction; also, the dorsal cut was more vertical and perpendicular to the second metatarsal in the axial plane; osteotomy was displaced to correct the alignment checked by simulating weight-bearing on a flat surface; fixation with a single 3.0-mm cannulated (Barouk) screw or an AO 4-mm partially threaded cancellous bone screw at the surgeon's discretion. Open Scarf group: medial incision; 1 longitudinal cut directed slightly plantar (both medial-to-lateral and distal-to-proximal directions); dorsal step-cut 5 mm proximal to the articular surface and perpendicular to the second metatarsal in the axial plane; plantar step-cut at the proximal metaphyseal flare and parallel to the dorsal one; displacement of the distal fragment to obtain alignment checked by simulating weight-bearing on a flat surface; fixation with 2 × 3.0-mm cannulated (Barouk) screws (distal screw into the metatarsal head and proximal screw into the proximal limb of the distal fragment). **Rehabilitation** Both groups: soft-dressings and immediate heel weight-bearing in orthopaedic postoperative shoes; suture removal at 2 weeks followed by a hallux-splint for another 4 weeks; splint and shoe were discarded at 6 weeks postoperative. **Any co-interventions**: Y-shaped capsulotomy; excision of the medial eminence; lateral soft-tissue release through a separate lateral incision or intra-articular technique to improve the sesamoid position if needed; medial capsulorraphy. All co-interventions were performed equally across all groups.

Outcomes	**Length of follow-up**: 12 months
	
	Participants were evaluated preoperatively and after 6 weeks and 1 year of surgery.
	
	Withdrawals: 37 feet for participant satisfaction outcome and 34 feet for MOXFQ outcome
	
	Major outcomes
	
	• MOXFQ
	• Adverse events
	  ◦ Symptomatic hallux varus (cosmetic complaint of overcorrection): 1 participant in the open modified Chevron group (HVA of 2 degrees negative and MOXFQ-Index of 38) reported a moderate outcome but declined surgery
	  ◦ Fracture: no cases
	  ◦ Loss of fixation: no cases
	  ◦ Avascular necrosis: no cases
	
	Secondary outcomes
	
	• Radiographic assessment (IMA, HVA, DMAA and tibial sesamoid position)
	• Asymptomatic hallux varus (overcorrection): 1 participant in open Scarf group (HVA of 3 degrees negative and MOXFQ-Index of 3)

Mahadevan 2016 *(Continued)*

	• Participant global assessment of treatment success
Notes	Not all primary outcomes were assessed fully for every participant • Radiographic assessment – 109/109 feet (100%) • MOXFQ – 75/109 feet (70% open modified Chevron; 67% open Scarf) • Participant global assessment of treatment success – 72/109 feet (68% open modified Chevron; 63% open Scarf) Asymptomatic hallux varus was not considered an adverse event since it has no clinical significance.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported.
Allocation concealment (selection bias)	Low risk	Sequentially numbered, opaque, sealed envelopes.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Participants were not informed of which osteotomy they had received.
Blinding of outcome assessment (detection bias): self-reported outcomes	Low risk	Self-reported outcome measurements were assessed by letter (participants were blinded).
Blinding of outcome assessment (detection bias): objective outcomes	Low risk	Outcome assessment was recorded by an independent surgeon who did not perform any of the procedures.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	No losses are described for radiographic assessment, but data were missing for participant global assessment of treatment success and functional outcomes.
Selective reporting (reporting bias)	Unclear risk	Study did not provide adequate units of measure such as SD for pain scale or subscale (MOXFQ). MOXFQ was comparable to other composite outcome studies.
Other bias	Unclear risk	With an alpha error of 0.05, a power of 80% and an SD of 17.5 for the MOXFQ, sample size analysis indicated a minimum group size of 48 feet, which was not achieved.

Othman 2017

Study characteristics

Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: January 2009 to September 2014 **Protocol published before recruitment of participants**: no **Details of trial registration**: not specified

Othman 2017 *(Continued)*

	Main ID: not specified **Date of registration**: not specified **Funding sources**: unknown
Participants	**Place of study**: 1 hospital in Egypt **Number of participants assigned**: 58 feet in 41 participants (17 in the open Chevron group and 24 in the minimally invasive group) **Number of participants assessed for primary outcome (VAS)**: 58 feet in 41 participants (17 in the open Chevron group and 24 in the minimally invasive group). **Inclusion criteria**: painful mild-to-moderate hallux valgus; deformity not responding to conservative measures **Exclusion criteria**: recurrent deformity after previous surgery; severe hallux valgus (HVA > 40 degrees); osteoarthritis of the first MTP joint; associated deformity or abnormality in the foot and ankle **Age** Open Chevron group: mean 39.2 (SD 7) years Percutaneous group: mean 40.6 (SD 6.5) years **Gender of participants assigned (female/male)** Open Chevron group: 16/1 Percutaneous group: 22/2 **Classification of the condition**: moderate, according to the Mann and Coughlin classification
Interventions	**Timing of intervention**: failed conservative treatment for symptomatic deformity of the foot **Type of surgical interventions** Open Chevron group: short medial incision, 60 degrees V-shaped osteotomy, lateral displacement of the head, no lateral release or fixation were performed. Percutaneous group: 1 cm medial incision over the first metatarsal neck, elevation of the periosteum, osteotomy performed perpendicular to the long axis of the shaft of the first metatarsal, lateral displacement by introducing small forceps into the medullary canal, fixation with a retrograde K wire driven from the skin through the first metatarsal shaft and into the first TMT joint. **Rehabilitation** Open Chevron group: below-knee cast until healing of the osteotomy. Percutaneous group: padding included an elastic bandage to counteract pronation of the big toe. Participants were allowed to weight-bear when tolerated, K wire removal after radiological healing. Range of motion exercises were carried out after the K wire removal. **Any co-interventions**: tourniquet, x-ray control and ultrasound-guided regional anaesthesia. All co-interventions were performed equally across all groups.
Outcomes	**Length of follow-up**: 18–69 months and varied between groups. Participants were evaluated preoperatively and after 1 day, every 2 weeks until healing and then every 3 months after surgery. **Withdrawals**: 0 **Major outcomes**

Othman 2017 *(Continued)*

- AOFAS;
- Adverse events
  - Wound complications (3 participants in the percutaneous group developed pin tract infection)
  - Deep venous thrombosis (1 case in the open Chevron group);
  - Deep infection treated by systemic antibiotics (1 case in the open Chevron group)
  - Recurrence of the deformity with HVA greater than 25 degrees with no further surgeries because of participant refusal (1 case in the open Chevron group)

Secondary outcomes

- Radiographic assessment (HVA, IMA, DMAA, tibial sesamoid position, healing time, shortening of the first metatarsal)
- Participant global assessment of treatment success
- Mean operation time (significantly shorter for the percutaneous group)

Notes	**Composite adverse events**: the 3 cases of pin tract infection needed K wire removal before radiological healing and treatment with antibiotics (not specified). All participants in the minimally invasive group underwent pin removal after bone healing in the outpatient clinic.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not specified.
Allocation concealment (selection bias)	High risk	Group sizes were unbalanced.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel were not blinded.
Blinding of outcome assessment (detection bias): self-reported outcomes	High risk	Participants were not blinded for self-reported outcomes.
Blinding of outcome assessment (detection bias): objective outcomes	High risk	Outcome personnel was not blinded.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No participants were lost to follow-up.
Selective reporting (reporting bias)	Low risk	Adequate measuring tool was provided with range.
Other bias	High risk	Study presented different follow-up periods for each group; the reason for this difference was not specified in the text and no protocol was published to clarify this decision.

Palmanovich 2020

Study characteristics	
Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: 2014–2015 **Protocol published before recruitment of participants**: no **Details of trial registration**: not specified **Main ID**: not specified **Date of registration**: not specified **Funding sources**: unknown
Participants	**Place of study**: 1 hospital in Israel **Number of participants assigned**: 36 participants (15 in the open Chevron group and 21 in the minimally invasive group) **Number of participants assessed for primary outcome (VAS)**: 36 participants (15 in the open Chevron group and 21 in the minimally invasive group) **Inclusion criteria**: mild-to-moderate hallux valgus; no previous surgical treatment; IMA > 9 and < 13 degrees **Exclusion criteria**: existing foot deformities The first 10 participants were excluded due to the learning curve of the surgeon. **Age** Open Chevron group: mean 49.2 (SD 18.9) years Percutaneous group: mean 38.7 (SD 23) years **Gender of participants assigned (female/male)** Open Chevron group: 12/3 Percutaneous group: 18/5 **Classification of the condition**: mild to moderate, according to the Mann and Coughlin classification
Interventions	**Timing of intervention**: no previous surgical treatment, on the waiting list for surgery **Type of surgical interventions** Open Chevron group: distal dorsomedial incision, V-shaped osteotomy, lateral displacement of the head, fixation with 3.5-mm cannulated screw. Percutaneous group: manual insertion of a 1.8-mm K wire, medial incision over the first metatarsal neck, periosteum stripping, osteotomy was oriented at 10–15 degrees in a plantar direction and perpendicular to the long axis of the shaft of the first metatarsal. Osteotomy was completed by manual fracturing of the lateral cortex, lateral displacement by introducing a small-grooved lever into the medullary canal, fixation with the introduction of the same 1.8 retrograde K wire into the metatarsal shaft. **Rehabilitation** Both groups: immediate weight-bearing with an orthopaedic shoe for 4–6 weeks or until signs of bone healing on radiographs. Wound was examined and redressed every 2 weeks. K wire was routinely removed for the participants in the minimally invasive group after 4–5 weeks.

Palmanovich 2020 *(Continued)*

	Any co-interventions: local anaesthesia, ankle block, intravenous antibiotics, iodine solution-soaked gauze padding. All co-interventions were performed equally across all groups.

Outcomes	**Length of follow-up**: 12 months
	
	Participants were evaluated preoperatively and at 3, 6 and 12 weeks postoperatively.
	
	Withdrawals: 0
	
	Major outcomes
	
	• AOFAS
	• Adverse events
	  ○ Avascular necrosis of the metatarsal head or osteoarthritis (no cases)
	  ○ Wound complications (3 participants in the percutaneous group developed pin tract issues, treated with K wire removal, antibiotics or watchful waiting)
	  ○ Dorsal bunion due to elevation of the metatarsal head (i.e. malunion) in 1 participant in the minimally invasive group
	  ○ Toe cross-over developed in 1 participant in the minimally invasive group, treated with a silicon pad
	• Treatment failure: reoperation was performed in 3 participants in the minimally invasive group and in 4 participants in the open Chevron group
	
	Secondary outcomes
	
	• Radiographic assessment (HVA, IMA, DMAA)

Notes	**Composite adverse events**: 8 participants in the minimally invasive group and 4 participants in the open Chevron group.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated list.
Allocation concealment (selection bias)	Unclear risk	Participants were alternately allocated to either group on the day of surgery.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel were not blinded.
Blinding of outcome assessment (detection bias): self-reported outcomes	High risk	Participants were not blinded for self-reported outcomes.
Blinding of outcome assessment (detection bias): objective outcomes	High risk	Outcome personnel were not blinded.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Group sizes were unbalanced, formal consent was not required for participating in the study.
Selective reporting (reporting bias)	High risk	Study lacked preoperative data. Main outcome data were incomplete (pain).

Palmanovich 2020 *(Continued)*

Other bias	Unclear risk	Study group deliberately excluded 10 participants from analysis from the minimally invasive group declaring this was due to the surgeon's learning curve; separate data were not provided.

Park 2013

Study characteristics	
Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: March 2006 to December 2009 **Protocol published before recruitment of participants**: no **Details of trial registration**: not registered **Funding sources**: unknown
Participants	**Place of study**: 1 hospital and medical school in Korea **Number of participants assigned**: 120 participants (60 in group P; 60 in group D) **Number of participants assessed for primary outcome (AOFAS)**: 110 participants (56 in group P; 54 in group D) **Inclusion criteria**: painful hallux valgus; difficulty wearing shoes; no history of previous hallux valgus surgery; preoperative severe hallux valgus **Exclusion criteria**: previous failed hallux valgus surgery; post-traumatic hallux valgus; pre-existing arthritis; radiological evidence of severe instability of the first TMT joint (defined by a displacement of 8–10 mm). **Age** Group P: mean 54 years Group D: mean 53 years **Gender of participants assigned (female/male)** Group P: 56/0 Group D: 54/0 **Classification of the condition**: severe deformity, defined by a HVA > 40 degrees and IMA > 17 degrees.
Interventions	**Timing of intervention**: symptomatic hallux valgus after a failed trial of non-operative management consisting of modification of footwear. **Type of surgical interventions** Group P: medial incision from the base of the proximal phalanx to the TMT joint; reverse 60 degree V-shaped osteotomy with the apex 10 mm distal to the TMT joint; lateral slide and tilt of the distal fragment; fixation performed with 2 medially placed, proximal to distal, 1.6-mm K wires. Group D: medial incision from the mid-portion of the proximal phalanx extending 2 cm proximal to the medial eminence; standard 60 degree V-shaped osteotomy with the apex centred on the first metatarsal head; lateral slide of 6–9 mm of the capital fragment; manual impaction of the head against the neck; fixation performed with 2 medially placed 1.4-mm K wires. **Rehabilitation**

Park 2013 *(Continued)*

	Both groups: weight-bearing allowed over the heel on a protective shoe; early stretching exercises were encouraged; sutures were removed after 2 weeks; the elastic bandage was then used for additional 2 weeks. K wires removed after 6–8 weeks. **Any co-interventions**: distal lateral soft tissue release; medial eminence resection and capsuloplasty (plantar flap was pulled dorsally to reposition the sesamoid and redundant tissue was excised); excision of remaining overhanging edges. All co-interventions were performed equally across all groups.

Outcomes	**Length of follow-up**: mean 38 (range 24–54) months
	
	Participants were evaluated preoperatively and at the final follow-up.
	
	Withdrawals: 10
	
	Major outcomes
	
	• AOFAS
	• Adverse events
	  ○ Avascular necrosis: no cases
	  ○ Shortening of the hallux: no cases
	  ○ Delayed union: no cases
	  ○ Non-union: no cases
	  ○ Displacement after fixation: no cases
	  ○ Superficial infection: 1 in group D
	  ○ Deep infection: no cases
	  ○ First MTP joint arthritis: no cases
	  ○ Asymptomatic hallux varus: 1 in group D
	• Treatment failure
	  ○ Overcorrection (hallux varus): 2 in group P (1 was corrected with a reverse distal Chevron osteotomy and 1 was not reoperated)
	  ○ Recurrent hallux valgus: 1 reoperation in group P
	
	Secondary outcomes
	
	• Radiographic assessment (hallux valgus and IMA; tibial sesamoid position; DMAA)
	• Participant global assessment of treatment success (very satisfied, satisfied, improved or dissatisfied)
	• Asymptomatic first MTP joint stiffness (range of motion < 30 degrees): 2 in group P; 4 in group D
	• Amount of lateral translation of the distal fragment compared to the width of the metatarsal at the osteotomy site

Notes	**Composite adverse events**: 6 participants in group D and 5 in group P

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Odd versus even number on the operation registration list.
Allocation concealment (selection bias)	High risk	Allocation was performed manually by an independent study co-ordinator, applying odd and even numbers directly onto the operation registration list.
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not specified.

Park 2013 *(Continued)*

Blinding of outcome assessment (detection bias): self-reported outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): objective outcomes	Unclear risk	Not specified.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Missing data were balanced between groups.
Selective reporting (reporting bias)	High risk	Failure of treatment was not reported, so we could not enter it in a meta-analysis.
Other bias	Unclear risk	Time points of outcomes were not prespecified.

Radwan 2012

Study characteristics	
Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: not specified **Protocol published before recruitment of participants**: no **Details of trial registration**: not specified **Funding sources**: unknown
Participants	**Place of study**: 1 training and research hospital in Egypt **Number of participants assigned**: 53 participants (64 feet); 31 feet in percutaneous distal transverse osteotomy group; 33 feet in open distal Chevron group **Number of participants assessed for primary outcome (AOFAS)**: 49 participants (29 in percutaneous distal transverse osteotomy group; 31 in open distal Chevron group) **Inclusion criteria**: HVA < 37 degrees; IMA < 20 degrees; refractory to conservative treatment **Exclusion criteria**: rheumatoid arthritis; failed previous hallux valgus surgery; severe foot and ankle deformities; generalised joint laxity; hypermobility of the first TMT joint; neuromuscular disorders; severe osteoarthritis of the first MTP joint **Age** Percutaneous distal transverse group: mean 32.7 (SD 7.4) years Open distal Chevron group: mean 35.7 (SD 6.9) years **Gender of participants assigned (female/male)** Percutaneous distal transverse group: 25/4 Open distal Chevron group: 28/3 **Classification of the condition**: mild-to-severe hallux valgus, classified according to the degree of HVA or IMA

Radwan 2012 *(Continued)*

Interventions	**Timing of intervention**: symptomatic hallux valgus refractory to conservative treatment **Type of surgical interventions** Percutaneous distal transverse group: 1–2 cm longitudinal medial incision; positioning of a 1.6-mm K wire guide with a slight distal tilt (to compensate for shortening); transverse osteotomy at the level of the neck of the first metatarsal with a low-speed burr; lateral displacement of the distal fragment with curved artery forceps inserted into the medullary canal; fixation with 1 × 1.8–2.0-mm K wire from distal to proximal (entering 2–3 mm medial to the medial corner of the nail through the metatarsal head and into the medullary canal) fixed to the base of the metatarsal. Open distal Chevron group: 5 cm longitudinal medial incision centred over the first MTP joint; inverted L-shaped capsulotomy; medial eminence excision; 60 degree V-shaped osteotomy; manual lateral translation and compression of the distal fragment; fixation with a 1.6-mm K wire; capsulorrhaphy. **Rehabilitation** Both groups: compressive dressing and elastic bandage with a suitable spacer in the first web space; posterior splint from day 2 to the second week with non-weight-bearing mobilisation; sutures removed, and below-knee walking cast applied after 2 weeks. Percutaneous distal transverse group: full range of motion exercises started after the adequate radiographic union was documented, with K wire removal. Open distal Chevron group: range of motion exercises were encouraged to prevent stiffness and full extension was expected within 4 weeks. **Any co-interventions**: no

Outcomes	**Length of follow-up**: minimum 12 (range 12–36) months
	
	Participants were evaluated preoperatively and after 1 year of surgery.
	
	Withdrawals: 4
	
	Major outcomes
	
	• Pain subscale of AOFAS score
	• AOFAS
	• Adverse events
	  ◦ Superficial wound dehiscence: 1 participant in Chevron group
	  ◦ Pin tract infection: 1 in Chevron group, 2 in percutaneous group
	  ◦ Transient diminished sensation over the medial aspect of the hallux: 4 participants in the open distal Chevron group
	  ◦ Hallux varus (overcorrection): no cases
	  ◦ Non-union: no cases
	  ◦ Avascular necrosis: no cases
	• Treatment failure (due to recurrence): no cases
	
	Secondary outcomes
	
	• Radiographic assessment (HVA, IMA, sesamoid position)
	• First MTP range of motion (total, flexion, extension). Asymptomatic reduction of range of motion (< 30 degrees): 3 in Chevron group, 2 in percutaneous group
	• Operative time (minutes)
	• Time to radiographic union (weeks)
	• Participant global assessment of treatment success

Notes	**Composite adverse events**: 6 participants in the open Chevron group, 2 in the percutaneous transverse osteotomy group.

Radwan 2012 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation list.
Allocation concealment (selection bias)	Unclear risk	Not specified.
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): self-reported outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): objective outcomes	Unclear risk	Not specified.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Missing information was balanced between groups.
Selective reporting (reporting bias)	High risk	Failure of treatment was not reported, so we could not enter it in a meta-analysis.
Other bias	Unclear risk	Time points of outcomes were not prespecified.

Resch 1993

Study characteristics

Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: November 1986 to March 1988 **Protocol published before recruitment of participants**: no **Details of trial registration**: not registered **Funding sources**: unknown
Participants	**Place of study:** 1 orthopaedic institute in Sweden **Number of participants assigned**: 79 participants (93 feet) **Number of participants assessed for primary outcome (AOFAS)**: 68 participants (43 feet in group 1; 37 feet in group 2) **Inclusion criteria**: any degree of hallux valgus **Exclusion criteria**: osteoarthritis of the first MTP joint; people with disturbed peripheral circulation **Age**

Resch 1993 *(Continued)*

	Both groups: mean 49 (range 16–78) years **Gender of participants assigned (female/male)**: Both groups: 61/7 **Classification of the condition**: any degree of hallux valgus
Interventions	**Timing of intervention**: participants with foot pain or discomfort wearing shoes **Type of surgical interventions** Distal Chevron group: V-shaped osteotomy through a medial incision, 3–4 mm translation of the distal fragment, capsule suture and no internal fixation. Proximal closing wedge osteotomy group: a wedge of approximately 3–4 mm was taken laterally, 10 mm distal to the metatarsal I-cuneiform I joint; certain compensation for shortening and dorsalisation was done by widening the wedge on the plantar aspect. 45-degree angulation to allow the use of a small cancellous compression screw. **Rehabilitation (both groups)** Immobilisation for 3–6 weeks and associated physiotherapy. Heel and lateral edge weight-bearing were encouraged and full weight-bearing was allowed when possible. **Any co-interventions**: no

Outcomes	**Length of follow-up**: final mean follow-up 42 (range 12–58) months for 54 feet with separate measurements described.
	
	Participants were evaluated preoperatively and after 12 weeks and 12 months postoperatively.
	
	Withdrawals: 11 withdrawals (13 feet) during follow-up. 1 died of unrelated causes, 2 (1 bilateral) demanded reoperation before final follow-up, 2 emigrated, and 6 (1 bilateral) refused follow-up
	
	Major outcomes
	
	• Pain (subjective assessment)
	• Adverse events
	  ◦ Paraesthesia: 5 participants in the proximal closing wedge group
	  ◦ Metatarsalgia: 6 participants in the proximal closing wedge group (5 did not require reoperation)
	  ◦ Asymptomatic stress fracture: 2 participants in each group
	  ◦ Wound infection: 1 participant in the distal Chevron group
	• Treatment failure: 1 participant in the proximal closing wedge osteotomy required reoperation
	
	Secondary outcomes
	
	• Radiographic assessment (HVA, IMA and relative 1–2 metatarsal length)
	• Participant global assessment of treatment success (subjective pain, appearance and mobility)
	• Improvement with regard to the use of shoes
	• Total range of motion

Notes	The authors did not evaluate pain with any available scale. **Composite adverse events**: 11 participants in proximal closing wedge osteotomy group (including 1 reoperation); 1 wound infection in Chevron group Asymptomatic stress fracture of the second metatarsal (2 in each group) was not considered an adverse event.
Risk of bias	

Resch 1993 *(Continued)*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not specified.
Allocation concealment (selection bias)	Unclear risk	Not specified.
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): self-reported outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): objective outcomes	Unclear risk	Not specified.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	The authors did not specify the groups of the participants who were excluded after randomisation.
Selective reporting (reporting bias)	High risk	Adequate measuring tool was provided with SD only for radiographic outcomes.
Other bias	Low risk	Study appeared free of other potential sources of bias.

Sahin 2018

Study characteristics	
Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: October 2012 to September 2014 **Protocol published before recruitment of participants**: no **Details of trial registration**: not registered **Funding sources**: unknown
Participants	**Place of study**: 1 training and research hospital in Turkey **Number of participants assigned**: 61 participants, 64 feet **Number of participants assessed for primary outcome (VAS)**: 57 participants (27 in the open proximal crescentic osteotomy group; 30 in the open Scarf group) **Inclusion criteria**: aged > 18 years; HVA > 30 degrees; IMA > 13 degrees; symptomatic hallux valgus deformity **Exclusion criteria**: degenerative osteoarthritis of the first MTP joint; diabetes mellitus; rheumatoid arthritis; neurological diseases; vascular diseases; previous foot surgery; body mass index > 30 **Age**

Sahin 2018 *(Continued)*

	Open proximal crescentic osteotomy group: mean 43.0 (SD 14.5) years Open Scarf group: mean 40.9 (SD 12.6) years **Gender of participants assigned (female/male)** Open proximal crescentic osteotomy group: 22/5 Scarf group 23/7 **Classification of the condition**: hallux valgus was classified according to the degree of HVA or IMA or sesamoid deviation degree.
Interventions	**Timing of intervention**: not specified other than symptomatic deformity of the foot. **Type of surgical interventions** Open proximal crescentic osteotomy group: dorsomedial incision; longitudinal capsular exposure; crescentic osteotomy with a crescentic blade 10 mm distal to the proximal end of the first metatarsal; reduction of the IMA under fluoroscopy control; fixation with 2 K wires. Open Scarf group: dorsomedial incision; longitudinal capsular exposure; z-shaped osteotomy; translation and rotation of the plantar-distal part under fluoroscopy control to reduce the IMA; fixation with 2 × 3.5-mm headless titanium screws; proximal and distal residual prominences were cut to provide a flush medial border. **Rehabilitation** Both groups: below knee splint with 20 kg weight-bearing allowed for 3 weeks; toe alignment splint and ambulation as tolerated after 3 weeks; crutches were allowed for 6 weeks. Sutures were removed after 14 days of the procedure; a toe alignment splint was used until the 9th week after the surgical procedure. **Any co-interventions**: distal lateral soft tissue release (attachment of the adductor hallucis muscle, transverse intermetatarsal ligament, lateral collateral ligament and capsule with lateral metatarsosesamoid suspensory ligament), bunionectomy and medial capsular reefing were performed equally across all groups.

Outcomes	**Length of follow-up**: 12 months
	
	Participants were evaluated preoperatively and after 1 year of surgery.
	
	Withdrawals: 0 during follow-up. 4 participants declined to participate before allocation.
	
	Major outcomes
	
	• VAS
	• AOFAS
	• Adverse events
	  ◦ Wound site complication with the Kirschner wires (3 participants in the open proximal crescentic osteotomy group)
	  ◦ Medial displacement and impaction (1 participant in the open proximal crescentic osteotomy group)
	  ◦ Malunion: no cases
	  ◦ Fracture: no cases
	  ◦ Loss of motion in the MTP joint: no cases
	
	Secondary outcomes
	
	• Radiographic assessment (HVA, IMA, DMAA, first metatarsal length, MTP joint congruence and lateral sesamoid position in relation to the first metatarsal neck)

Notes	All the radiological evaluations and measurements were made by 1 orthopaedic resident.

Sahin 2018 *(Continued)*

The lateral sesamoid subluxation level was evaluated as mild (0–25%), moderate (25–50%) or severe (50–100%).

In this study, 2 surgeons performed both surgeries, and were assigned randomly.

Radiographic assessment was documented in more time spans than clinical evaluations; this led to the perception that the radiographic correction in the HVA and IMA obtained in the sixth postoperative week was partially lost in the first year, especially in participants with high preoperative DMAA.

DMAA did not change in the open proximal crescentic osteotomy group.

High rates of shortness were observed in the open proximal crescentic osteotomy group.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not specified.
Allocation concealment (selection bias)	Unclear risk	Not specified.
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): self-reported outcomes	Unclear risk	Not specified.
Blinding of outcome assessment (detection bias): objective outcomes	Unclear risk	Not specified.
Incomplete outcome data (attrition bias) All outcomes	Low risk	4 participants declined to participate before allocation; no other losses to follow-up were declared.
Selective reporting (reporting bias)	High risk	Failure of treatment was not reported, so we could not enter it in a meta-analysis.
Other bias	Low risk	Study appeared free of other potential sources of bias.

Saro 2007

Study characteristics

Methods

Study design: single-centre, 2-group, parallel-design RCT

Duration of the study: January 1990 to February 2002

Protocol published before recruitment of participants: no

Details of trial registration: not specified

Funding sources: unknown

Saro 2007 *(Continued)*

Participants	**Place of study**: 1 university hospital in Sweden **Number of participants assigned**: 100 participants (50 in open distal Lindgren group; 50 in open distal Chevron group) **Number of participants assessed for primary outcome (AOFAS)**: 90 participants (44 in open distal Lindgren group; 46 in open distal Chevron group) **Inclusion criteria**: aged 16–80 years; HVA 20–44 degrees; IMA ≤ 20 degrees; DMAA ≤ 25 degrees **Exclusion criteria**: arthritis of the first MTP joint; previous operation on the affected foot; diabetes; peripheral vascular disease; peripheral neuropathy; rheumatoid arthritis; other inflammatory diseases **Age** Both groups: mean 48 (SD 14) years **Gender of participants assigned (female/male)** Both groups: 94/6 **Classification of the condition**: hallux valgus was classified according to the degree of HVA or IMA or DMAA.
Interventions	**Timing of intervention**: not specified other than symptomatic deformity of the foot. **Type of surgical interventions** Open distal Lindgren group: dorsomedial incision over the distal part of the first metatarsal, medial to the extensor hallucis longus tendon; longitudinal capsulotomy; subcapital transverse osteotomy at a distal oriented 30 degree angle from the long axis of the metatarsal shaft; distal fragment displaced laterally (8–10 mm); slightly plantar; and derotation (to correct pronation); fixation with 1 × 2.7 mm proximal to distal, medial to lateral lag screw. Open distal Chevron group: longitudinal medial incision; U-shaped capsulotomy; V-shaped horizontal osteotomy; lateralisation of approximately 4–6 mm (depending on the metatarsal head width); impaction of osteotomy; no rigid fixation; capsulorrhaphy. **Rehabilitation** Both groups: standard dressing with supported strapping for maintaining correction for 3 weeks, along with full weight-bearing as tolerated in a postoperative shoe. **Any co-interventions**: no

Outcomes	**Length of follow-up**: mean 4.7 (range 3–6) years
	
	Participants were evaluated preoperatively and after 1 year and at the last follow-up at a mean 4.7 years after surgery
	
	Withdrawals: 10, 1 of which was due to a revision procedure at the 6-month evaluation.
	
	Major outcomes
	
	• AOFAS
	• VAS
	• EuroQol 5-dimension quality of life/health questionnaire (EQ-5D)
	• Adverse events
	  ◦ Pain from motion of the first MTP joint: no cases
	  ◦ Presence of callosities: 8 in the Lindgren group, 10 in the Chevron group
	  ◦ Transfer metatarsalgia: 12 in the Lindgren group, 10 in the Chevron group
	  ◦ Hallux varus (overcorrection): no cases
	  ◦ Non-union: no cases

Saro 2007 *(Continued)*

- Osteonecrosis: no cases
- Treatment failure
  - Reoperation due to recurrence: 1 participant in Chevron group
  - Unresolved metatarsalgia: no cases

Secondary outcomes

- Radiographic assessment (HVA, IMA, sesamoid position)
- Degree of pronation of the first toe relative to the horizontal axis (0: no rotation; 1: < 25 degrees; 2: 25–45 degrees; 3: > 45 degrees)
- Range of motion (good, with mild limitation or stiff)
- Radiographic joint congruency
- Shortening of the first metatarsal (in relation to the second metatarsal's length, pre and postoperatively)
- Asymptomatic delayed union: 1 participant in open distal Lindgren group at 6-month follow-up, healed before 1 year postoperative

Notes	Participant global assessment of treatment success was rated for: 1. the outcome of the operative treatment; 2. participant's perception of cosmetic appearance; 3. pain relief; 4. ability to wear preferred shoes. **Composite adverse events**: 11 participants in the open Chevron group, 12 in the open Lindgren group Callosities without transfer metatarsalgia and asymptomatic delayed union were not considered adverse events.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not specified.
Allocation concealment (selection bias)	Low risk	Sealed unmarked envelopes.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel were not blinded. All procedures were performed by a single surgeon.
Blinding of outcome assessment (detection bias): self-reported outcomes	High risk	Participants were not blinded for self-reported outcomes.
Blinding of outcome assessment (detection bias): objective outcomes	Low risk	1 physical therapist, who was unaware of the self-reported questionnaire data, examined the participants preoperatively and at follow-up.
Incomplete outcome data (attrition bias) All outcomes	Low risk	1 participant decided not to participate after allocation to open distal Chevron group; 9 other participants refused further participation after surgery; losses seemed to be balanced between groups (6/3).
Selective reporting (reporting bias)	Low risk	Adequate measuring tool was provided with SD.
Other bias	Low risk	Study appeared free of other potential sources of bias.

Torkki 2003

Study characteristics	
Methods	**Study design**: multicentre RCT (4 centres) **Duration of the study**: 1997–1998 **Protocol published before recruitment of participants**: no **Details of trial registration**: not specified **Funding sources**: unknown
Participants	**Place of study**: 4 general community hospitals in Finland **Number of participants assigned**: 209 participants (71 in surgery group; 69 in orthosis group; 69 in control group) **Number of participants assessed for primary outcome (AOFAS)**: 197 participants (68 in surgery group; 66 in orthosis group; 63 in control group) **Inclusion criteria**: painful bunion; HVA < 35 degrees; IMA < 15 degrees **Exclusion criteria**: previous hallux valgus (bunion) surgery; hallux rigidus; hallux limitus; rheumatoid disease; use of foot orthosis; pregnancy; aged > 60 years **Age** Surgery group: mean 48 (SD 10) years Orthosis group: mean 49 (SD 10) years Control group: mean 47 (SD 9) years **Gender of participants assigned (female/male)** Surgery group: 66/5 Orthosis group: 61/8 Control group: 66/3 **Classification of the condition**: mild-to-moderate hallux valgus, based on the HVA and IMA.
Interventions	**Timing of intervention**: > 80% had ≥ 6 months of foot pain **Type of interventions** Surgery group (Chevron procedure): medial longitudinal incision; capsulotomy; intra-articular release of the adductor hallucis tendon; no fixation was used routinely. Orthosis group: functional foot orthoses made by 1 laboratory in California, USA. Control group: avoid surgical treatment and foot orthotic therapy during the follow-up period. **Rehabilitation** Surgery group (Chevron procedure): abduction splint (toe hold) for 6 weeks; weight-bearing allowed on the heel and lateral part of the foot immediately after surgery; after 2 weeks, plantigrade walking was allowed and active exercises of the great toe were started. Work was resumed after 6 weeks for employed participants. Orthosis and control group: participants were advised to contact the group if their foot pain worsened.

Torkki 2003 *(Continued)*

	Any co-interventions: no

Outcomes	**Length of follow-up**: 12 months
	
	Participants were evaluated at baseline (before any treatment or randomisation) and after 6 and 12 months of randomisation.
	
	Withdrawals: 0
	
	Major outcomes
	
	• AOFAS
	• VAS
	• Adverse events
	  ◦ Superficial wound infection: 1 case in the surgery group
	  ◦ Stress fracture of the second metatarsal bone: 1 case in the surgery group
	  ◦ Transient peroneal nerve paralysis: 1 case in the surgery group
	• Treatment failure
	  ◦ Recurrence of hallux valgus: 1 case in the surgery group
	
	Secondary outcomes
	
	• Radiographic assessment in the surgery group
	• Ability to work
	• Cosmetic disturbance
	• Footwear problems
	• Health-related quality of life index (15-D)
	• Participant global assessment of treatment success
	• Costs related to foot care

Notes	**Composite adverse events**: 4 cases in the surgery group All 211 participants wished to be operated on at baseline, despite that, as much as one-third of the participants in the non-operative treatment groups did not want to have surgery after 1-year follow-up. If the participant had a bilateral deformity, both outcome characteristics denoting the foot problem were recorded separately. In those cases, the foot with worse symptoms (lower AOFAS score) was selected for data analysis. After the first year of treatment, 43 participants in the orthosis group and 48 in the control group (no treatment) received surgery. Therefore, the outcome for the randomised data (intention to treat) was only accessible for the 12-month follow-up and the primary reference chosen for this study is Torkki 2001 (see under Torkki 2003).

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated block randomisation list (size = 15).
Allocation concealment (selection bias)	Low risk	Sequentially numbered, opaque, sealed envelopes.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel were not blinded. MT (the first author) was an independent observer during the entire study period.

Torkki 2003 *(Continued)*

Blinding of outcome assessment (detection bias): self-reported outcomes	High risk	Participants were not blinded for self-reported outcomes.
Blinding of outcome assessment (detection bias): objective outcomes	High risk	Outcome personnel were not blinded.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No participants were lost to follow-up; of note: all participants knew they would undergo surgery sooner or later if they remained on the list.
Selective reporting (reporting bias)	Low risk	Adequate measuring tool was provided with SD for pain and composite outcome measure. Measurements are not provided for radiographic outcomes.
Other bias	Low risk	Study appeared free of other sources of bias.

Torrent 2021

Study characteristics	
Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: January 2017 to September 2018 **Protocol published before recruitment of participants**: yes (ISRCTN) **DOI**: 10.1186/ISRCTN13631918 **Date of trial registration**: 20 November 2020 (retrospective registration) **Recruitment started**: October 2017 **Details of trial registration**: yes **Main ID**: ISRCTN13631918/IRB number 10.04.2017 **Funding sources**: Hospital Universitari Mutua Terrassa (Spain)
Participants	**Place of study**: 1 training and research hospital in Mutua Terrassa (Spain) **Number of participants assigned**: 58 participants (30 in percutaneous group; 28 in open group) **Number of participants assessed for primary outcome (VAS)**: 58 participants (30 in percutaneous group; 28 in open group) **Inclusion criteria**: people with the indication of Scarf osteotomy at the time of treatment **Exclusion criteria**: IMA > 20 degrees; deficit of first MTP motion; radiological signs of first MTP joint arthritis; concomitant procedures performed to the lesser metatarsals or first TMT **Age** Percutaneous group: mean 60.7 (range 42–80) years Open group: mean 64.2 (SD 46–78) years **Gender of participants assigned (female/male)** Percutaneous group: 28/2

Torrent 2021 *(Continued)*

	Open group: 28/0 **Classification of the condition**: hallux valgus was classified according to the classification of Coughlin and Shurnas and only grade 1 were included.
Interventions	**Timing of intervention**: participants with the indication of Scarf osteotomy at the time of treatment **Type of surgical interventions** Percutaneous group: mid-foot nerve block without tourniquet; 3 × 0.5 cm incisions were made (medial incision centred at the metatarsal head, lateral incision at the first web space for lateral release and another medial incision for Akin osteotomy); bunionectomy; distal and dorsal transverse cut, longitudinal cut, proximal and plantar transverse cut; reduction and fixation with 1 × 3-mm cannulated headless compression screw through a final dorsal incision. Open group: spinal anaesthesia, thigh tourniquet, mid-foot block for postoperative pain control; medial approach from mid-proximal phalanx to mid-first metatarsal bone; bunionectomy; first MTP Scarf osteotomy as described by Barouk 2000; transmetatarsal lateral release; reduction and fixation with 1 or 2 cannulated screws, proximal phalanx Akin with another cannulated screw; medial capsulorraphy. **Rehabilitation** Both groups: day case outpatient surgery; analgesics, heparin and non-steroidal anti-inflammatory drugs during the first week; tramadol as needed; dressing was changed weekly for the first 2 weeks; next, an elastic bandage was used to hold the position for the 3 following weeks. Mobilisation was encouraged and immediate full weight-bearing was permitted with a postoperative flat shoe for the first 5 weeks. **Any co-interventions**: antibiotic prophylaxis (cefazolin 2 g); distal lateral soft tissue release. All co-interventions were performed equally across all groups. Lesser toe deformities were treated in an equilibrated number of participants between groups (30 participants in total, 17 in percutaneous group and 13 in the open group).

Outcomes	**Length of follow-up**: 21 months
	
	Participants were evaluated preoperatively, 24 hours after the procedure, and at final follow-up at 21 (range 12–38) months
	
	Withdrawals: 0
	
	Major outcomes
	
	• VAS
	• AOFAS
	• Adverse events
	  ◦ Screw removal: 1 participant in the percutaneous group
	  ◦ Hallux varus: no cases
	  ◦ Troughing on the osteotomy site: no cases
	  ◦ Hypertrophic scar formation: 2 participants in the open group
	  ◦ Transfer metatarsalgia: no cases
	• Treatment failure
	  ◦ Recurrence of the HVA: 2 participants in the percutaneous group, without reoperation
	
	Secondary outcomes
	
	• Radiographic assessment (angular correction of the IMA, HVA and DMAA)
	• Radiation exposure (was 14 times higher in the percutaneous group)
	• Operative time (faster in the percutaneous group)
	• Use of tramadol tablets
	• Radiological bony healing at final follow-up (all cases positive)

Torrent 2021 *(Continued)*

Notes	**Composite adverse events**: 3 participants in the percutaneous group, 0 cases in the open group

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation list was performed by a system with envelopes and a box.
Allocation concealment (selection bias)	Low risk	Equal allocation to each group was achieved using opaque envelopes.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel were not blinded.
Blinding of outcome assessment (detection bias): self-reported outcomes	High risk	Participants were not blinded for self-reported outcomes.
Blinding of outcome assessment (detection bias): objective outcomes	High risk	Outcome personnel were not blinded.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No missing information or incomplete outcome data were found.
Selective reporting (reporting bias)	Low risk	Range and P values were given.
Other bias	Low risk	Study appeared free of other potential sources of bias. Funding was granted by the hospital.

Uygur 2016

Study characteristics

Methods	**Study design**: single-centre, 2-group, parallel-design RCT **Duration of the study**: January 2010 to February 2012 **Protocol published before recruitment of participants**: no **Date of trial registration**: not specified **Recruitment started**: January 2010 **Details of trial registration**: no **Main ID**: not specified **Funding sources**: unknown
Participants	**Place of study**: 1 training and research hospital in Istanbul, Turkey

Uygur 2016 *(Continued)*

	Number of participants assigned: 70 participants (35 in the open Lindgren-Turan group and 35 in the open Chevron group) **Number of participants assessed for primary outcome (AOFAS)**: 66 participants (32 in the open Lindgren-Turan group; 34 in the open Chevron group). **Inclusion criteria**: moderate deformity (HVA 20–40 degrees or IMA 14–20 degrees, or both); persistent complaints despite ≥ 6 months of non-operative treatment; congruent MTP joint **Exclusion criteria**: incongruent MTP joint; degenerative arthritis; peripheral vasculopathy; diabetes mellitus; inflammatory arthritis; fracture or history of foot surgery **Age** Open Lindgren-Turan group: mean 46.9 (SD 15.5) years Open Chevron group: mean 45.8 (SD 13.1) years **Gender of participants assigned (female/male)** Open Lindgren-Turan group: 32/0 Open Chevron group: 34/0 **Classification of the condition**: preoperative moderate hallux valgus, classified according to the degree of HVA or IMA as described above.
Interventions	**Timing of intervention**: ≥ 6 months of non-operative treatment **Type of surgical interventions** Open Lindgren-Turan group: dorsomedial incision, transverse osteotomy 1.5 cm distant from the metatarsal head and 30 degrees oblique to the joint surface. Fixation was performed with 1 dorsomedial 3.5-mm screw. Open Chevron group: medial incision, V-shaped osteotomy with the apex 1 cm proximal from the joint surface and fixation with 1 dorsomedial 3.5-mm screw. **Rehabilitation** In both groups, the hallux was bandaged for 3 weeks to support neutral alignment and weight was borne on special hallux valgus shoes as much as the participants could tolerate. **Any co-interventions**: bunionectomy and capsuloplasty were performed by tunnelling No. 2 polyglactin suture material. All co-interventions were performed equally across all groups.

Outcomes	**Length of follow-up**: 26 (range 19–34) months
	
	Participants were evaluated preoperatively, 3 days after surgery and at a mean of 26 months postoperative (referred to as mid-term).
	
	Withdrawals: 4
	
	2 participants moved to another city, 1 had an ankle fracture and 1 had a total hip arthroplasty. They did not specify the losses within each group, but only 1 of those was in the open Chevron group and 3 in the open Lindgren-Turan group, as we can assume based on the final number of assessed participants.
	
	Major outcomes
	
	• AOFAS
	• Maryland University Painful Foot Evaluation
	• Adverse events
	  ◦ Screw extraction procedure was a common problem that occurred 4–6 months after surgery
	  ◦ Skin necrosis: 2 participants in total

Uygur 2016 *(Continued)*

- Reflex sympathetic dystrophy 2 participants in total

Secondary outcomes

- Radiographic resolution of the deformity (HVA, IMA and sesamoid position)
- Improvement in participants' footwear habits: 58% of all participants reported that they were able to wear any shoes of their choosing; most participants reported that they were not wearing narrow or high-heels shoes any more

Notes	**Composite adverse events**: we contacted the main author for further information in regard to the number of adverse events and the answer was 2 participants in each group. All participants from each group were operated on by a single different surgeon from the other group (the second author performed all the open Lindgren-Turan technique surgeries of group 1, while the third author performed all the open Chevron technique surgeries of group 2). AOFAS score was evaluated by a separate author (first author) who did not perform any surgery.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not specified.
Allocation concealment (selection bias)	Unclear risk	Not specified.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants were not blinded.
Blinding of outcome assessment (detection bias): self-reported outcomes	High risk	Participants were not blinded for self-reported outcomes.
Blinding of outcome assessment (detection bias): objective outcomes	Low risk	Both surgeons assessed the AOFAS score unaware of the procedure and the final result was a mean of both measurements.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Missing information was balanced between groups.
Selective reporting (reporting bias)	Low risk	Failure of treatment was not reported, so we could not enter it in a meta-analysis.
Other bias	Unclear risk	Some information about complications was sought by contacting the main author (Esat Uygur) and used in the analysis.

Wester 2016

Study characteristics

Methods	**Study design**: single-centre, 2-group, parallel-design RCT

Wester 2016 *(Continued)*

	Duration of the study: January 2009 to January 2011 **Protocol published before recruitment of participants**: no **Details of trial registration**: not registered **Funding sources**: unknown
Participants	**Place of study**: 1 University Hospital in Denmark **Number of participants assigned**: 45 participants (23 in open crescentic group; 22 in open proximal open wedge group) **Number of participants assessed for primary outcome (VAS)**: 45 participants (23 in open crescentic group; 22 in open proximal open wedge group) **Inclusion criteria**: aged 15–70 years; HVA > 35 degrees; IMA > 15 degrees **Exclusion criteria**: rheumatoid arthritis; osteoarthritis of the first MTP joint; spasticity of any type; vascular diseases; pregnancy **Age**: mean 52 (range 19–70) years **Gender of participants assigned (female/male)**: 42/4 (details on age and gender were not specified for each group) **Classification of the condition**: severe deformity; hallux valgus was classified according to the degree of HVA or IMA.
Interventions	**Timing of intervention**: not specified other than symptomatic severe deformity of the foot **Type of surgical interventions** Open crescentic group: proximal crescentic osteotomy about 15 mm distal to the TMT joint (concavity pointing proximally); fixation with 3-mm cannulated screw from proximal medial dorsal to distal lateral plantar; fluoroscopy confirmation. Open proximal open wedge group: transverse proximal osteotomy 15 mm distal to the TMT joint (leaving the lateral cortex and periosteum intact); lateralisation of the distal portion resulting in an opening of the medial cortex of 3–5 mm; fixation with a medial L-shaped non-locking plate and 4 × 2.3-mm self-tapping screws; impaction of cancellous bone from medial exostectomy into the open wedge site. **Rehabilitation** Both groups: 1 week of partial weight-bearing, 5 weeks in static walker, gradually allowing full weight-bearing; MTP joint mobility exercises after 3–4 weeks; sutures removed after 14 days; toe alignment splint for 6 weeks. **Any co-interventions**: distal lateral release (through a separate dorsal incision on the first web space); exostectomy of the bony prominence and capsulorrhaphy (through a separate medial longitudinal incision over the metatarsal head); additional Akin procedure if there was a tendency for the first and second toes to collide after the main osteotomy. All co-interventions were performed equally across all groups.
Outcomes	**Length of follow-up**: 12 months Participants were evaluated preoperatively and after 6 weeks, 4 months and 1 year of surgery. **Withdrawals**: 0 **Major outcomes** • VAS • AOFAS

Wester 2016 *(Continued)*

- Adverse events
  - Implant removal: 5 in the crescentic group and 4 in the open wedge group
- Treatment failure:
  - Reoperation due to recurrence: 3 participants in the proximal crescentic group

Secondary outcomes

- Radiographic assessment (HVA; IMA; first metatarsal length compared to the second; radiological healing)

Notes

Composite adverse events: the 3 participants in the proximal crescentic group that needed reoperation also had implant removal.

During the surgical technique session, the authors described a third (dorsal) incision. However, this is not conventional, and the pictures of the article actually show a long medial incision (as if it was an elongation of the second incision).

Surgeries were performed by 4 senior foot and ankle surgeons.

At the 6-week follow-up no scores or x-rays were documented; furthermore, 12 months postoperatively the hallux valgus and IMA increased for both groups, in comparison with the 4-month evaluation. Thus, it is unknown whether the desired angle correction was ever reached or if the loss of correction occurred during the first 4 months and continued further until 12 months.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Participants were randomised to 1 of the 2 groups by drawing of lots.
Allocation concealment (selection bias)	Unclear risk	Allocation was performed double-blind; procedure was not detailed (e.g. type of envelope or opaque box).
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Participants were blinded.
Blinding of outcome assessment (detection bias): self-reported outcomes	Low risk	Participants were blinded.
Blinding of outcome assessment (detection bias): objective outcomes	Unclear risk	Not specified.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No participants were lost to follow-up. Participants were treated as intended.
Selective reporting (reporting bias)	Low risk	Adequate measuring tool was provided with SD.
Other bias	High risk	Baseline demographic information was not given in detail; thus, it is impossible to know if the population was homogeneous.

AOFAS: American Orthopedic Foot and Ankle Scale; DMAA: distal metatarsal articular angle; HVA: hallux valgus angle; IMA: intermetatarsal angle; MCA: metatarsocuneiform angle; MIS: minimally invasive surgery; MIS: mini-invasive surgery; MTP: metatarsophalangeal; MTP-

IP: metatarsophalangeal-interphalangeal; RCT: randomised controlled trial; SD: standard deviation; SF-36: 36-item Short Form; SFEF: Subjective Foot Evaluation Form; TMT: tarsometatarsal; VAS: visual analogue scale.

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Calder 1999	Compared 2 cohorts of participants who received the same treatment (distal, open, simple osteotomy) for hallux valgus deformity.
DiGiorgio 2016	Compared 2 cohorts of participants who received similar treatment (distal, minimally invasive, transverse osteotomies).
Irha 2016	Compares 2 cohorts of participants who received the same treatment (mid-shaft, open, complex osteotomy) for hallux valgus deformity.
Lazaro 2018	Compares participants who received the same treatment for hallux valgus deformity differing only in the type of skin suture.
Martin 2012	Compared participants who received the same treatment for hallux valgus deformity differing only in the type of nerve block adopted.
Matricali 2014	Compared participants who received the same treatment for hallux valgus deformity differing only in the type of capsule suture (capsulorraphy).
Pentikainen 2015	Compared 2 cohorts of participants who received the same treatment (distal, open, complex osteotomy) for hallux valgus deformity.
Plaass 2018	Compared 2 cohorts of participants who received the same treatment (distal, open, complex osteotomy) for hallux valgus deformity.
Resch 1994	Compared 2 cohorts of participants who received the same treatment (distal, open, complex osteotomy) for hallux valgus deformity.
Riva 2012	Compared 2 cohorts of participants who received the same treatment (distal, open, complex osteotomy) for hallux valgus deformity.
Tada 2015	Study only includes participants with rheumatoid arthritis and severe complex deformities of the foot. This would lead to extreme outlier results.
Tonbul 2009	Compares 2 cohorts of participants who received the same treatment (distal, open, crescentic osteotomy) for hallux valgus deformity.
Windhagen 2013	Compared 2 cohorts of participants who received the same treatment (distal, open, complex osteotomy) for hallux valgus deformity.

DATA AND ANALYSES

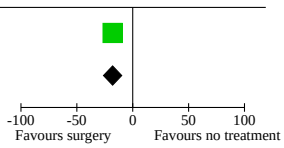
Comparison 1. Surgery versus no treatment

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.1 Pain	1	140	Mean Difference (IV, Random, 95% CI)	-18.00 [-26.14, -9.86]
1.2 Function	1	140	Mean Difference (IV, Fixed, 95% CI)	9.00 [5.16, 12.84]
1.3 Quality of life	1	140	Mean Difference (IV, Fixed, 95% CI)	0.00 [-2.12, 2.12]
1.4 Participant global assessment of treatment success	1	140	Mean Difference (IV, Fixed, 95% CI)	19.00 [8.11, 29.89]
1.5 Reoperation (treatment failure)	1	140	Risk Ratio (M-H, Fixed, 95% CI)	Not estimable
1.6 Adverse events	1	140	Risk Ratio (M-H, Fixed, 95% CI)	8.75 [0.48, 159.53]
1.7 Serious adverse events	1	140	Risk Ratio (M-H, Fixed, 95% CI)	Not estimable

Analysis 1.1. Comparison 1: Surgery versus no treatment, Outcome 1: Pain

	Surgery			No treatment				Mean Difference	Mean Difference
Study or Subgroup	Mean [points]	SD [points]	Total	Mean [points]	SD [points]	Total	Weight	IV, Random, 95% CI [points]	IV, Random, 95% CI [points]
Torkki 2003	21	23	71	39	26	69	100.0%	-18.00 [-26.14 , -9.86]	
Total (95% CI)			**71**			**69**	**100.0%**	**-18.00 [-26.14 , -9.86]**	

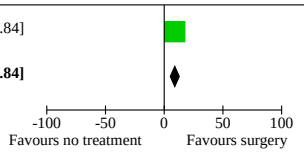
Heterogeneity: Not applicable
Test for overall effect: Z = 4.33 (P < 0.0001)
Test for subgroup differences: Not applicable



Analysis 1.2. Comparison 1: Surgery versus no treatment, Outcome 2: Function

	Surgery			No treatment				Mean Difference	Mean Difference
Study or Subgroup	Mean [points]	SD [points]	Total	Mean [points]	SD [points]	Total	Weight	IV, Fixed, 95% CI [points]	IV, Fixed, 95% CI [points]
Torkki 2003	75	13	71	66	10	69	100.0%	9.00 [5.16 , 12.84]	
Total (95% CI)			**71**			**69**	**100.0%**	**9.00 [5.16 , 12.84]**	

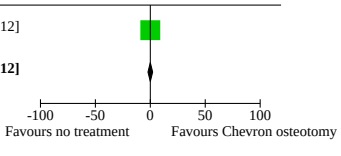
Heterogeneity: Not applicable
Test for overall effect: Z = 4.60 (P < 0.00001)
Test for subgroup differences: Not applicable



Analysis 1.3. Comparison 1: Surgery versus no treatment, Outcome 3: Quality of life

	Chevron osteotomy			No treatment				Mean Difference	Mean Difference
Study or Subgroup	Mean [points]	SD [points]	Total	Mean [points]	SD [points]	Total	Weight	IV, Fixed, 95% CI [points]	IV, Fixed, 95% CI [points]
Torkki 2003	93	6.2	71	93	6.6	69	100.0%	0.00 [-2.12 , 2.12]	
Total (95% CI)			**71**			**69**	**100.0%**	**0.00 [-2.12 , 2.12]**	

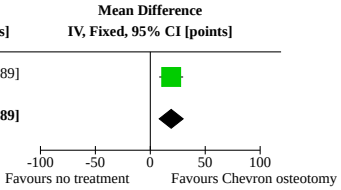
Heterogeneity: Not applicable
Test for overall effect: Z = 0.00 (P = 1.00)
Test for subgroup differences: Not applicable



Analysis 1.4. Comparison 1: Surgery versus no treatment, Outcome 4: Participant global assessment of treatment success

Study or Subgroup	Chevron osteotomy Mean [points]	SD [points]	Total	No treatment Mean [points]	SD [points]	Total	Weight	Mean Difference IV, Fixed, 95% CI [points]
Torkki 2003	80	28	71	61	37	69	100.0%	19.00 [8.11 , 29.89]
Total (95% CI)			**71**			**69**	**100.0%**	**19.00 [8.11 , 29.89]**

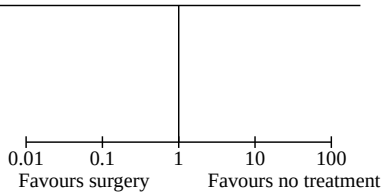
Heterogeneity: Not applicable
Test for overall effect: Z = 3.42 (P = 0.0006)
Test for subgroup differences: Not applicable



Analysis 1.5. Comparison 1: Surgery versus no treatment, Outcome 5: Reoperation (treatment failure)

Study or Subgroup	Surgery Events	Total	No treatment Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Torkki 2003	0	71	0	69		Not estimable
Total (95% CI)		**71**		**69**		**Not estimable**
Total events:	0		0			

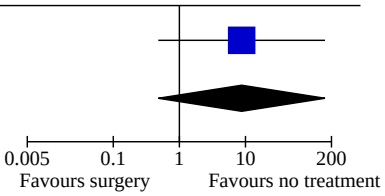
Heterogeneity: Not applicable
Test for overall effect: Not applicable
Test for subgroup differences: Not applicable



Analysis 1.6. Comparison 1: Surgery versus no treatment, Outcome 6: Adverse events

Study or Subgroup	Surgery Events	Total	No treatment Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Torkki 2003	4	71	0	69	100.0%	8.75 [0.48 , 159.53]
Total (95% CI)		**71**		**69**	**100.0%**	**8.75 [0.48 , 159.53]**
Total events:	4		0			

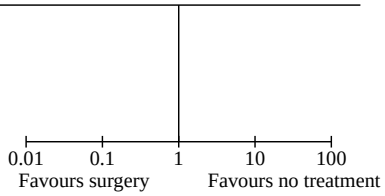
Heterogeneity: Not applicable
Test for overall effect: Z = 1.46 (P = 0.14)
Test for subgroup differences: Not applicable



Analysis 1.7. Comparison 1: Surgery versus no treatment, Outcome 7: Serious adverse events

Study or Subgroup	Surgery Events	Total	No treatment Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Torkki 2003	0	71	0	69		Not estimable
Total (95% CI)		**71**		**69**		**Not estimable**
Total events:	0		0			

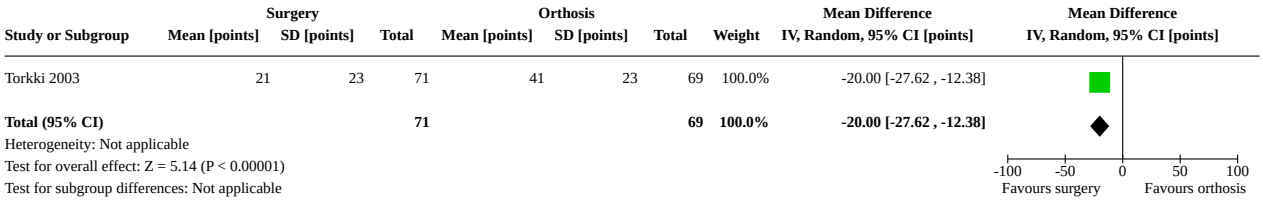
Heterogeneity: Not applicable
Test for overall effect: Not applicable
Test for subgroup differences: Not applicable



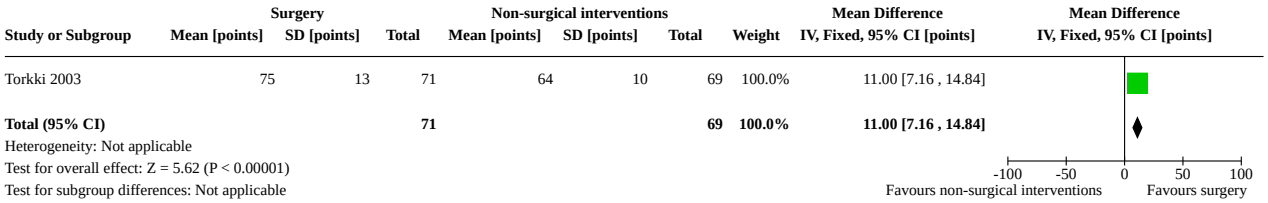
Comparison 2. Surgery versus non-surgical interventions

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.1 Pain	1	140	Mean Difference (IV, Random, 95% CI)	-20.00 [-27.62, -12.38]
2.2 Function	1	140	Mean Difference (IV, Fixed, 95% CI)	11.00 [7.16, 14.84]
2.3 Quality of life	1	140	Mean Difference (IV, Fixed, 95% CI)	0.00 [-2.04, 2.04]
2.4 Participant global assessment of treatment success	1	140	Mean Difference (IV, Fixed, 95% CI)	10.00 [1.05, 18.95]
2.5 Reoperation (treatment failure)	1	140	Risk Ratio (M-H, Fixed, 95% CI)	Not estimable
2.6 Adverse events	1	140	Risk Ratio (M-H, Fixed, 95% CI)	8.75 [0.48, 159.53]
2.7 Serious adverse events	1	140	Risk Ratio (M-H, Fixed, 95% CI)	Not estimable

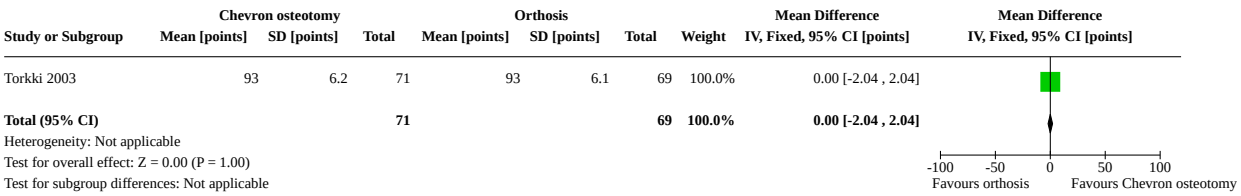
Analysis 2.1. Comparison 2: Surgery versus non-surgical interventions, Outcome 1: Pain



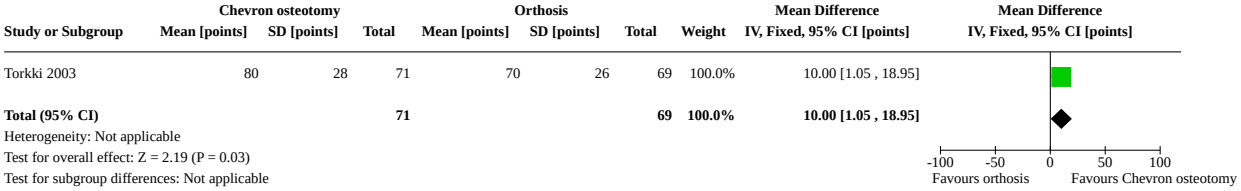
Analysis 2.2. Comparison 2: Surgery versus non-surgical interventions, Outcome 2: Function



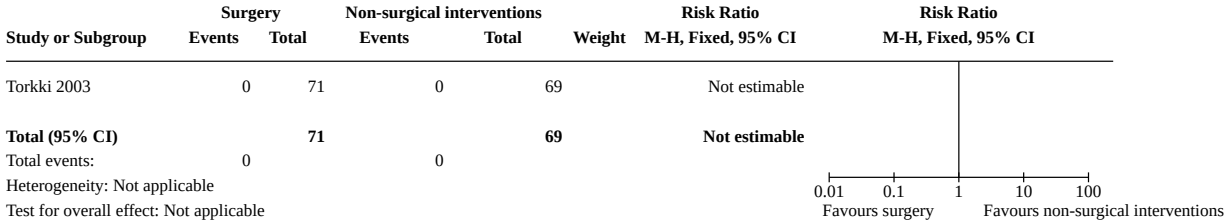
Analysis 2.3. Comparison 2: Surgery versus non-surgical interventions, Outcome 3: Quality of life



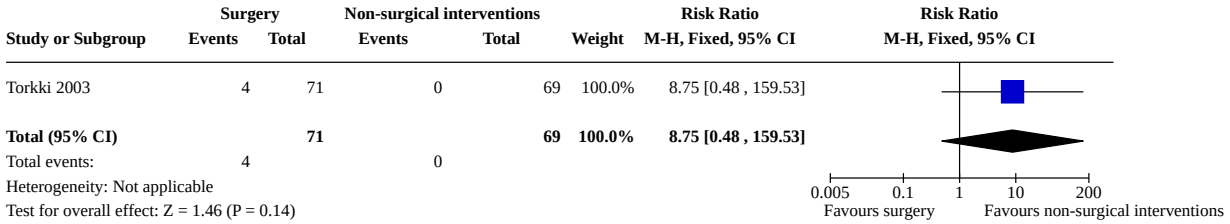
Analysis 2.4. Comparison 2: Surgery versus non-surgical interventions, Outcome 4: Participant global assessment of treatment success



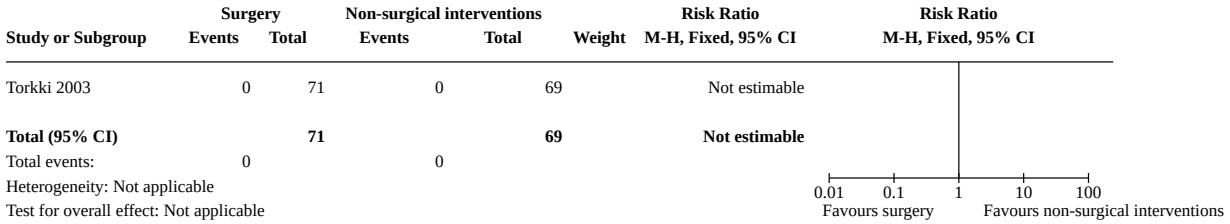
Analysis 2.5. Comparison 2: Surgery versus non-surgical interventions, Outcome 5: Reoperation (treatment failure)



Analysis 2.6. Comparison 2: Surgery versus non-surgical interventions, Outcome 6: Adverse events



Analysis 2.7. Comparison 2: Surgery versus non-surgical interventions, Outcome 7: Serious adverse events



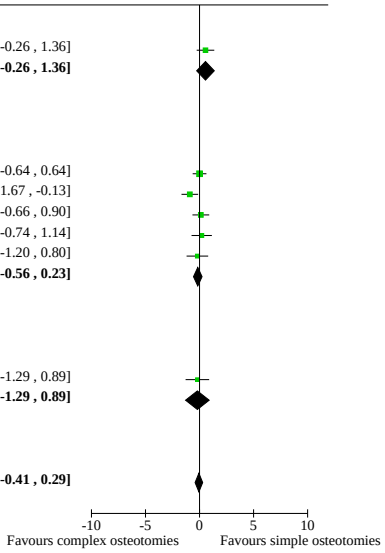
Comparison 3. Complex versus simple osteotomies

Outcome or subgroup title	No. of studies	No. of partici-pants	Statistical method	Effect size
3.1 Pain	7	414	Mean Difference (IV, Random, 95% CI)	-0.06 [-0.41, 0.29]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.1.1 Mild to moderate (intermetatarsal angle < 16 degrees)	1	60	Mean Difference (IV, Random, 95% CI)	0.55 [-0.26, 1.36]
3.1.2 Moderate to severe (intermetatarsal angle > 12 degrees)	5	318	Mean Difference (IV, Random, 95% CI)	-0.16 [-0.56, 0.23]
3.1.3 Mild to severe (any preoperative intermetatarsal angle)	1	36	Mean Difference (IV, Random, 95% CI)	-0.20 [-1.29, 0.89]
3.2 Function	10	616	Mean Difference (IV, Random, 95% CI)	1.60 [-2.33, 5.54]
3.2.1 Mild to moderate (intermetatarsal angle < 16 degrees)	1	60	Mean Difference (IV, Random, 95% CI)	-2.53 [-6.17, 1.11]
3.2.2 Moderate to severe (intermetatarsal angle > 12 degrees)	7	400	Mean Difference (IV, Random, 95% CI)	-0.82 [-3.16, 1.52]
3.2.3 Mild to severe (any preoperative intermetatarsal angle)	2	156	Mean Difference (IV, Random, 95% CI)	9.93 [-0.26, 20.11]
3.3 Quality of life	0	0	Mean Difference (IV, Random, 95% CI)	Not estimable
3.4 Participant global assessment of treatment success	8	462	Risk Ratio (M-H, Fixed, 95% CI)	1.66 [0.99, 2.80]
3.5 Reoperation (treatment failure)	7	461	Risk Ratio (M-H, Fixed, 95% CI)	2.04 [1.01, 4.11]
3.5.1 Mild to moderate (intermetatarsal angle < 16 degrees)	0	0	Risk Ratio (M-H, Fixed, 95% CI)	Not estimable
3.5.2 Moderate to severe (hallux valgus angle > 20 degrees)	5	345	Risk Ratio (M-H, Fixed, 95% CI)	2.72 [1.14, 6.49]
3.5.3 Mild to severe (any preoperative intermetatarsal angle)	2	116	Risk Ratio (M-H, Fixed, 95% CI)	0.96 [0.27, 3.42]
3.6 Adverse events	12	787	Risk Ratio (M-H, Fixed, 95% CI)	0.66 [0.51, 0.84]
3.7 Serious adverse events	12	787	Risk Ratio (M-H, Fixed, 95% CI)	Not estimable
3.8 Radiological measurement of the hallux valgus angle	12	767	Mean Difference (IV, Random, 95% CI)	1.29 [0.08, 2.51]

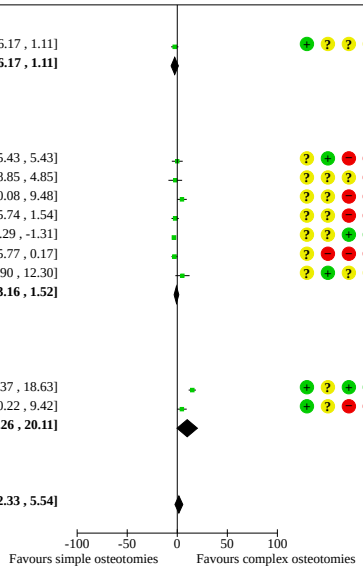
Analysis 3.1. Comparison 3: Complex versus simple osteotomies, Outcome 1: Pain

Study or Subgroup	Complex osteotomies Mean [points]	SD [points]	Total	Simple osteotomies Mean [points]	SD [points]	Total	Weight	Mean Difference IV, Random, 95% CI [points]
3.1.1 Mild to moderate (intermetatarsal angle < 16 degrees)								
Radwan 2012	1.67	1.8	31	1.12	1.4	29	14.9%	0.55 [-0.26 , 1.36]
Subtotal (95% CI)			**31**			**29**	**14.9%**	**0.55 [-0.26 , 1.36]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 1.33 (P = 0.18)								
3.1.2 Moderate to severe (intermetatarsal angle > 12 degrees)								
Saro 2007	1.5	1.8	49	1.5	1.4	50	21.6%	0.00 [-0.64 , 0.64]
Glazebrook 2014	2.94	1.8	33	3.84	1.4	35	16.2%	-0.90 [-1.67 , -0.13]
Uygur 2016	0.5	1.8	34	0.38	1.4	32	16.0%	0.12 [-0.66 , 0.90]
Wester 2016	1.7	1.8	23	1.5	1.4	22	11.7%	0.20 [-0.74 , 1.14]
Avcu 2018	2.6	1.8	20	2.8	1.4	20	10.5%	-0.20 [-1.20 , 0.80]
Subtotal (95% CI)			**159**			**159**	**76.1%**	**-0.16 [-0.56 , 0.23]**
Heterogeneity: Tau² = 0.04; Chi² = 4.87, df = 4 (P = 0.30); I² = 18%								
Test for overall effect: Z = 0.81 (P = 0.42)								
3.1.3 Mild to severe (any preoperative intermetatarsal angle)								
Palmanovich 2020	0.8	1.8	15	1	1.4	21	9.1%	-0.20 [-1.29 , 0.89]
Subtotal (95% CI)			**15**			**21**	**9.1%**	**-0.20 [-1.29 , 0.89]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 0.36 (P = 0.72)								
Total (95% CI)			**205**			**209**	**100.0%**	**-0.06 [-0.41 , 0.29]**
Heterogeneity: Tau² = 0.04; Chi² = 7.41, df = 6 (P = 0.28); I² = 19%								
Test for overall effect: Z = 0.34 (P = 0.73)								
Test for subgroup differences: Chi² = 2.48, df = 2 (P = 0.29), I² = 19.4%								



Analysis 3.2. Comparison 3: Complex versus simple osteotomies, Outcome 2: Function

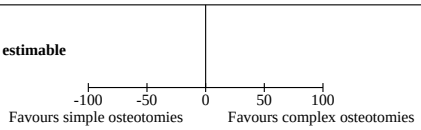
Study or Subgroup	Complex osteotomies Mean [points]	SD [points]	Total	Simple osteotomies Mean [points]	SD [points]	Total	Weight	Mean Difference IV, Random, 95% CI [points]	Risk of Bias A B C D E F G H
3.2.1 Mild to moderate (intermetatarsal angle < 16 degrees)									
Radwan 2012	87.71	7.6	31	90.24	6.8	29	10.5%	-2.53 [-6.17 , 1.11]	? + ? ? ? + − ?
Subtotal (95% CI)			**31**			**29**	**10.5%**	**-2.53 [-6.17 , 1.11]**	
Heterogeneity: Not applicable									
Test for overall effect: Z = 1.36 (P = 0.17)									
3.2.2 Moderate to severe (intermetatarsal angle > 12 degrees)									
Saro 2007	85	12.9	50	85	14.6	49	9.5%	0.00 [-5.43 , 5.43]	? + − − + + + +
Giannini 2013	87	10	20	89	12	20	8.6%	-2.00 [-8.85 , 4.85]	? ? ? − − + + +
Glazebrook 2014	78.5	9.5	34	73.8	10.75	35	9.9%	4.70 [-0.08 , 9.48]	? ? − − − + + +
Uygur 2016	89.74	8.4	34	91.84	6.64	32	10.5%	-2.10 [-5.74 , 1.54]	? ? − − + + + ?
Wester 2016	81.5	3.5	23	84.8	3.3	22	11.3%	-3.30 [-5.29 , -1.31]	? ? + + ? + + −
Othman 2017	86.8	5.5	17	89.6	3.5	24	10.9%	-2.80 [-5.77 , 0.17]	? − − − − + + −
Avcu 2018	77	13.4	20	71.8	9.1	20	8.4%	5.20 [-1.90 , 12.30]	? + ? ? − + − −
Subtotal (95% CI)			**198**			**202**	**69.0%**	**-0.82 [-3.16 , 1.52]**	
Heterogeneity: Tau² = 5.05; Chi² = 13.90, df = 6 (P = 0.03); I² = 57%									
Test for overall effect: Z = 0.69 (P = 0.49)									
3.2.3 Mild to severe (any preoperative intermetatarsal angle)									
Buciuto 2014	89	9.5	60	74	10.75	60	10.5%	15.00 [11.37 , 18.63]	+ ? + + − + − ?
Palmanovich 2020	88.6	7.6	15	84	6.8	21	9.9%	4.60 [-0.22 , 9.42]	+ ? − − − ? − ?
Subtotal (95% CI)			**75**			**81**	**20.4%**	**9.93 [-0.26 , 20.11]**	
Heterogeneity: Tau² = 49.34; Chi² = 11.41, df = 1 (P = 0.0007); I² = 91%									
Test for overall effect: Z = 1.91 (P = 0.06)									
Total (95% CI)			**304**			**312**	**100.0%**	**1.60 [-2.33 , 5.54]**	
Heterogeneity: Tau² = 34.80; Chi² = 92.29, df = 9 (P < 0.00001); I² = 90%									
Test for overall effect: Z = 0.80 (P = 0.42)									
Test for subgroup differences: Chi² = 5.11, df = 2 (P = 0.08), I² = 60.9%									



Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias): self-reported outcomes
(E) Blinding of outcome assessment (detection bias): objective outcomes
(F) Incomplete outcome data (attrition bias)
(G) Selective reporting (reporting bias)
(H) Other bias

Analysis 3.3. Comparison 3: Complex versus simple osteotomies, Outcome 3: Quality of life

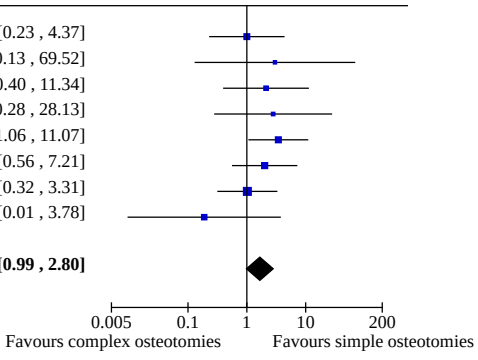
Study or Subgroup	Complex osteotomies Mean	SD	Total	Simple osteotomies Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI	Risk of Bias A B C D E F G H
Total (95% CI)			**0**			**0**		**Not estimable**		
Heterogeneity: Not applicable										
Test for overall effect: Not applicable										
Test for subgroup differences: Not applicable										



Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias): self-reported outcomes
(E) Blinding of outcome assessment (detection bias): objective outcomes
(F) Incomplete outcome data (attrition bias)
(G) Selective reporting (reporting bias)
(H) Other bias

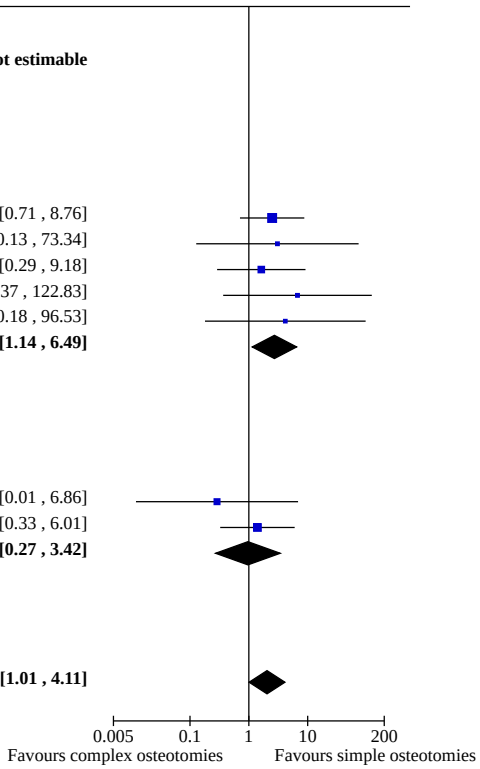
Analysis 3.4. Comparison 3: Complex versus simple osteotomies, Outcome 4: Participant global assessment of treatment success

Study or Subgroup	Complex osteotomies Events	Total	Simple osteotomies Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Avcu 2018	3	20	3	20	15.1%	1.00 [0.23 , 4.37]
Giannini 2013	1	20	0	20	2.5%	3.00 [0.13 , 69.52]
Othman 2017	3	17	2	24	8.4%	2.12 [0.40 , 11.34]
Palmanovich 2020	2	15	1	21	4.2%	2.80 [0.28 , 28.13]
Radwan 2012	11	31	3	29	15.6%	3.43 [1.06 , 11.07]
Resch 1993	7	43	3	37	16.3%	2.01 [0.56 , 7.21]
Saro 2007	5	49	5	50	24.9%	1.02 [0.32 , 3.31]
Uygur 2016	0	34	2	32	13.0%	0.19 [0.01 , 3.78]
Total (95% CI)		**229**		**233**	**100.0%**	**1.66 [0.99 , 2.80]**
Total events:	32		19			
Heterogeneity: Chi² = 5.10, df = 7 (P = 0.65); I² = 0%						
Test for overall effect: Z = 1.91 (P = 0.06)						
Test for subgroup differences: Not applicable						



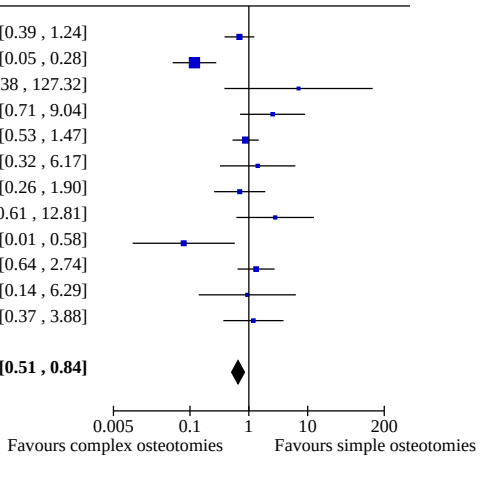
Analysis 3.5. Comparison 3: Complex versus simple osteotomies, Outcome 5: Reoperation (treatment failure)

Study or Subgroup	Complex osteotomies Events	Total	Simple osteotomies Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
3.5.1 Mild to moderate (intermetatarsal angle < 16 degrees)						
Subtotal (95% CI)		**0**		**0**		**Not estimable**
Total events:	0		0			
Heterogeneity: Not applicable						
Test for overall effect: Not applicable						
3.5.2 Moderate to severe (hallux valgus angle > 20 degrees)						
Klosok 1993	8	45	3	42	29.4%	2.49 [0.71 , 8.76]
Saro 2007	1	49	0	50	4.7%	3.06 [0.13 , 73.34]
Glazebrook 2014	3	35	2	38	18.2%	1.63 [0.29 , 9.18]
Wester 2016	3	23	0	22	4.8%	6.71 [0.37 , 122.83]
Othman 2017	1	17	0	24	4.0%	4.17 [0.18 , 96.53]
Subtotal (95% CI)		**169**		**176**	**61.1%**	**2.72 [1.14 , 6.49]**
Total events:	16		5			
Heterogeneity: Chi² = 0.80, df = 4 (P = 0.94); I² = 0%						
Test for overall effect: Z = 2.26 (P = 0.02)						
3.5.3 Mild to severe (any preoperative intermetatarsal angle)						
Resch 1993	0	43	1	37	15.3%	0.29 [0.01 , 6.86]
Palmanovich 2020	3	15	3	21	23.7%	1.40 [0.33 , 6.01]
Subtotal (95% CI)		**58**		**58**	**38.9%**	**0.96 [0.27 , 3.42]**
Total events:	3		4			
Heterogeneity: Chi² = 0.81, df = 1 (P = 0.37); I² = 0%						
Test for overall effect: Z = 0.06 (P = 0.96)						
Total (95% CI)		**227**		**234**	**100.0%**	**2.04 [1.01 , 4.11]**
Total events:	19		9			
Heterogeneity: Chi² = 2.79, df = 6 (P = 0.84); I² = 0%						
Test for overall effect: Z = 1.99 (P = 0.05)						
Test for subgroup differences: Chi² = 1.75, df = 1 (P = 0.19), I² = 42.9%						



Analysis 3.6. Comparison 3: Complex versus simple osteotomies, Outcome 6: Adverse events

Study or Subgroup	Complex osteotomies Events	Total	Simple osteotomies Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Avcu 2018	9	20	13	20	11.2%	0.69 [0.39 , 1.24]
Buciuto 2014 (1)	5	60	42	60	36.2%	0.12 [0.05 , 0.28]
Giannini 2013	3	20	0	20	0.4%	7.00 [0.38 , 127.32]
Glazebrook 2014	7	35	3	38	2.5%	2.53 [0.71 , 9.04]
Klosok 1993	17	45	18	42	16.0%	0.88 [0.53 , 1.47]
Othman 2017	3	17	3	24	2.1%	1.41 [0.32 , 6.17]
Palmanovich 2020	4	15	8	21	5.7%	0.70 [0.26 , 1.90]
Radwan 2012	6	31	2	29	1.8%	2.81 [0.61 , 12.81]
Resch 1993	1	43	11	37	10.2%	0.08 [0.01 , 0.58]
Saro 2007	13	49	10	50	8.5%	1.33 [0.64 , 2.74]
Uygur 2016	2	34	2	32	1.8%	0.94 [0.14 , 6.29]
Wester 2016	5	23	4	22	3.5%	1.20 [0.37 , 3.88]
Total (95% CI)		**392**		**395**	**100.0%**	**0.66 [0.51 , 0.84]**
Total events:	75		116			
Heterogeneity: Chi² = 37.21, df = 11 (P = 0.0001); I² = 70%						
Test for overall effect: Z = 3.31 (P = 0.0009)						
Test for subgroup differences: Not applicable						



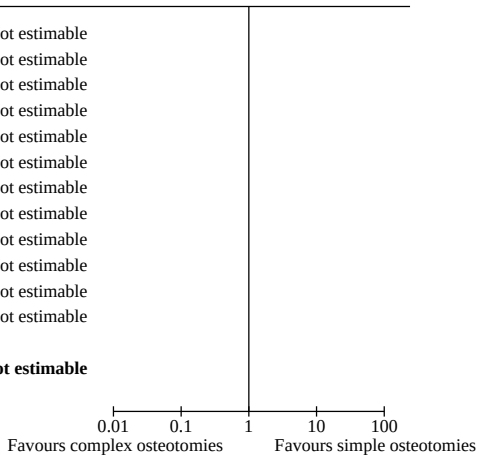
Footnotes

(1) Buciuto 2014 found a very high incidence of transfer metatarsalgia in the Mitchell osteotomy group.

Analysis 3.7. Comparison 3: Complex versus simple osteotomies, Outcome 7: Serious adverse events

Study or Subgroup	Complex osteotomies Events	Total	Simple osteotomies Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Avcu 2018	0	20	0	20		Not estimable
Buciuto 2014 (1)	0	60	0	60		Not estimable
Giannini 2013	0	20	0	20		Not estimable
Glazebrook 2014	0	35	0	38		Not estimable
Klosok 1993	0	45	0	42		Not estimable
Othman 2017	0	17	0	24		Not estimable
Palmanovich 2020	0	15	0	21		Not estimable
Radwan 2012	0	31	0	29		Not estimable
Resch 1993	0	43	0	37		Not estimable
Saro 2007	0	49	0	50		Not estimable
Uygur 2016	0	34	0	32		Not estimable
Wester 2016	0	23	0	22		Not estimable
Total (95% CI)		**392**		**395**		**Not estimable**
Total events:	0		0			

Heterogeneity: Not applicable
Test for overall effect: Not applicable
Test for subgroup differences: Not applicable



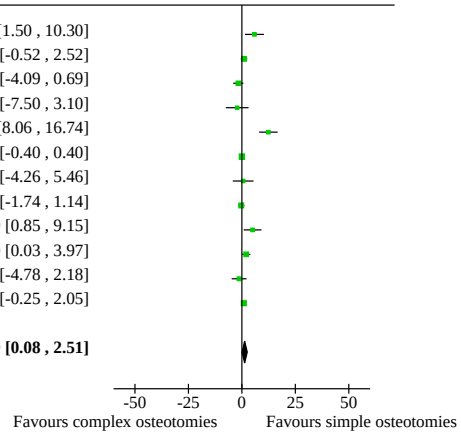
Footnotes

(1) Buciuto 2014 found a very high incidence of transfer metatarsalgia in the Mitchell osteotomy group.

Analysis 3.8. Comparison 3: Complex versus simple osteotomies, Outcome 8: Radiological measurement of the hallux valgus angle

Study or Subgroup	Complex osteotomies Mean	SD	Total	Simple osteotomies Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Avcu 2018	23	8.6	20	17.1	5.2	20	5.0%	5.90 [1.50 , 10.30]
Buciuto 2014	16	4.5	60	15	4	60	11.7%	1.00 [-0.52 , 2.52]
Giannini 2013	20.1	3.6	20	21.8	4.1	20	9.2%	-1.70 [-4.09 , 0.69]
Glazebrook 2014	17.7	12.1	35	19.9	10.9	38	3.8%	-2.20 [-7.50 , 3.10]
Klosok 1993	25.7	10	36	13.3	8.1	31	5.1%	12.40 [8.06 , 16.74]
Othman 2017	6.5	0.5	17	6.5	0.8	24	14.0%	0.00 [-0.40 , 0.40]
Palmanovich 2020	20.7	6.9	15	20.1	7.9	21	4.4%	0.60 [-4.26 , 5.46]
Radwan 2012	12.8	2.9	31	13.1	2.8	29	11.9%	-0.30 [-1.74 , 1.14]
Resch 1993	25	8.6	43	20	10.1	37	5.4%	5.00 [0.85 , 9.15]
Saro 2007	17	5	49	15	5	50	10.4%	2.00 [0.03 , 3.97]
Uygur 2016	13.9	7.2	34	15.2	7.2	32	6.6%	-1.30 [-4.78 , 2.18]
Wester 2016	27.9	1.4	23	27	2.4	22	12.6%	0.90 [-0.25 , 2.05]
Total (95% CI)			**383**			**384**	**100.0%**	**1.29 [0.08 , 2.51]**

Heterogeneity: Tau² = 2.70; Chi² = 52.93, df = 11 (P < 0.00001); I² = 79%
Test for overall effect: Z = 2.08 (P = 0.04)
Test for subgroup differences: Not applicable



APPENDICES

Appendix 1. CENTRAL (Ovid) search strategy

EBM Reviews - Cochrane Central Register of Controlled Trials <March 2023>

1 exp Hallux Valgus/ 244

2 exp METATARSOPHALANGEAL JOINT/ 95

3 exp bunion/ 29

4 bunion*.ti,ab. 248

5 hv.ti,ab. 874

6 hallux/ 48

7 (great adj2 toe*).ti,ab. 175

8 (big adj2 toe*).ti,ab. 142

9 6 or 7 or 8 340

10 exp foot diseases/ 1619

11 (deform* or valgus or deviat* or abduct*).ti,ab. 32185

12 10 or 11 33750

13 9 and 12 76

14 12 and 13 76

15 1 or 2 or 3 or 4 or 5 1367

16 14 or 15 1418

17 su.fs. 77856

18 (surger$ or surgical$ or operat$).ti,ab. 285975

19 exp Orthopedic Procedures/ 16822

20 osteotomy/ 780

21 osteotom*.ti,ab. 2193

22 arhtroplast*.ti,ab. 3

23 exp arthrodesis/ 1457

24 arthrodes*.ti,ab. 487

25 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 314823

26 16 and 25 463

Appendix 2. MEDLINE (Ovid) search strategy

Ovid MEDLINE(R) ALL <1946 to April 20, 2023>

1 exp Hallux Valgus/ 3890

2 exp METATARSOPHALANGEAL JOINT/ 3016

3 exp bunion/ 233

4 bunion*.ti,ab. 897

5 hv.ti,ab. 6805

6 hallux/ 2156

7 (great adj2 toe*).ti,ab. 2313

8 (big adj2 toe*).ti,ab. 1226

9 6 or 7 or 8 5130

10 exp foot diseases/ 22676

11 (deform* or valgus or deviat* or abduct*).ti,ab. 457759

12 10 or 11 479373

13 9 and 12 1491

14 12 and 13 1491

15 1 or 2 or 3 or 4 or 5 12958

16 14 or 15 13743

17 su.fs. 2238021

18 (surger$ or surgical$ or operat$).ti,ab. 3025475

19 exp Orthopedic Procedures/ 356491

20 osteotomy/ 33069

21 osteotom*.ti,ab. 38939

22 arhtroplast*.ti,ab. 8

23 exp arthrodesis/ 41109

24 arthrodes*.ti,ab. 13772

25 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 4164037

26 16 and 25 6173

27 randomized controlled trial.pt. 591208

28 controlled clinical trial.pt. 95277

29 randomized.ab. 600452

30 placebo.ab. 237552

31 drug therapy.fs. 2583537

32 randomly.ab. 406592

33 trial.ab. 644777

34 groups.ab. 2506173

35 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 5636596

36 (animals not (humans and animals)).sh. 5081103

37 35 not 36 4917543

38 26 and 37 924

Appendix 3. Embase (Ovid) search strategy

Embase Classic+Embase <1947 to 2023 April 20>

1 exp Hallux Valgus/ 6039

2 Metatarsophalangeal Joint/ 5825

3 bunion*.ti,ab. 1116

4 hv.ti,ab. 11729

5 exp "American Orthopedic Foot and Ankle Society hallux metatarsophalangeal interphalangeal score"/ 37

6 exp hallux/ 5099

7 (great adj2 toe*).ti,ab. 3275

8 (big adj2 toe*).ti,ab. 1972

9 or/6-8 7914

10 exp foot disease/ 111240

11 (deform* or valgus or deviat* or abduct*).ti,ab. 610101

12 10 or 11 703793

13 9 and 12 2899

14 12 and 13 2899

15 or/1-5 22490

16 14 or 15 24401

17 exp Surgery/ 6200648

18 su.fs. 2451839

19 (surgery$ or surgeries or surgical or operat$).ti,ab. 4283039

20 exp orthopedic surgery/ 630279

21 exp metatarsal osteotomy/ or osteotomy guide/ or osteotomy/ 44755

22 osteotom*.ti,ab. 48574

23 arhtroplast*.ti,ab. 17

24 arthrodesis/ 17829

25 arthrodes*.ti,ab. 18551

26 or/17-25 8114967

27 16 and 26 10794

28 Randomized controlled trial/ 783106

29 Controlled clinical study/ 469371

30 random$.ti,ab. 1967588

31 randomization/ 99144

32 intermethod comparison/ 296325

33 placebo.ti,ab. 369419

34 (compare or compared or comparison).ti. 632323

35 ((evaluated or evaluate or evaluating or assessed or assess) and (compare or compared or comparing or comparison)).ab. 2755044

36 (open adj label).ti,ab. 108260

37 ((double or single or doubly or singly) adj (blind or blinded or blindly)).ti,ab. 278855

38 double blind procedure/ 212051

39 parallel group$1.ti,ab. 32071

40 (crossover or cross over).ti,ab. 125375

41 ((assign$ or match or matched or allocation) adj5 (alternate or group$1 or intervention$1 or patient$1 or subject$1 or participant $1)).ti,ab. 414746

42 (assigned or allocated).ti,ab. 488741

43 (controlled adj7 (study or design or trial)).ti,ab. 451726

44 (volunteer or volunteers).ti,ab. 287599

45 human experiment/ 646861

46 trial.ti. 408332

47 or/28-46 6350897

48 (random$ adj sampl$ adj7 (cross section$ or questionnaire$1 or survey$ or database$1)).ti,ab. not (comparative study/ or controlled study/ or randomi?ed controlled.ti,ab. or randomly assigned.ti,ab.) 9532

49 Cross-sectional study/ not (randomized controlled trial/ or controlled clinical study/ or controlled study/ or randomi?ed controlled.ti,ab. or control group$1.ti,ab.) 344578

50 (((case adj control$) and random$) not randomi?ed controlled).ti,ab. 21454

51 (Systematic review not (trial or study)).ti. 256876

52 (nonrandom$ not random$).ti,ab. 18975

53 Random field$.ti,ab. 2938

54 (random cluster adj3 sampl$).ti,ab. 1530

55 (review.ab. and review.pt.) not trial.ti. 1107386

56 we searched.ab. and (review.ti. or review.pt.) 49252

57 update review.ab. 138

58 (databases adj4 searched).ab. 61507

59 (rat or rats or mouse or mice or swine or porcine or murine or sheep or lambs or pigs or piglets or rabbit or rabbits or cat or cats or dog or dogs or cattle or bovine or monkey or monkeys or trout or marmoset$1).ti. and animal experiment/ 1222191

60 Animal experiment/ not (human experiment/ or human/) 2570338

61 or/48-60 4309543

62 47 not 61 5616067

63 27 and 62 2217

64 63 not 4 1342

HISTORY

Protocol first published: Issue 9, 2020

CONTRIBUTIONS OF AUTHORS

CGD, AG, JF, MF and ML wrote and published the review protocol (Dias 2020).

CGD and AG screened and identified studies for the review; and assessed the risk of bias for each study.

CGD extracted study characteristics and outcome data; and transferred data into the Review Manager.

AG spot-checked study characteristics and outcome data for accuracy.

JF arbitrated in disagreements.

All review authors provided comments and approved the final version of the review.

DECLARATIONS OF INTEREST

CGD and AG are Brazilian board-certified foot and ankle specialists; no financial interests declared.

CGD: none.

AG is a consultant physician for Merck Sharp & Dohme, Sanofi-Aventis, Kinetic Concepts Inc., LifeCell Corporation, Systagenix Wound Management Ltd., Smith & Nephew, Delphos Implants European Company, GMReis Implants and DermaSciences. Smith & Nephew, Delphos Implants (Portugal) and GMReis Implants produce implants for ankle and foot surgery. None of these industries granted any research funding or compensation of any aspect related to this review; the consultancy of the review author did not affect the review process or its results. AG has received payments for lectures and preparation of educational materials from Convatec, Merck Sharp Dohme, Smith & Nephew, Pfizer and GMReis.

JF: none.

MF: none.

ML: none.

SOURCES OF SUPPORT

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  No internal sources of support were received in any forms.

External sources

- New Source of support, Other

  No external sources of support were received in any forms.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

We made the following change from the protocol (Dias 2020).

Radiological measurement of the hallux valgus angle, an objective outcome, was not included in the list of major outcomes in the published protocol because of the lack of a direct relationship with the participant-focused analysis. This outcome was ultimately added as a minor outcome since it may be considered relevant to the foot-surgeon reader.

INDEX TERMS

Medical Subject Headings (MeSH)

*Bias; Bunion [surgery]; *Hallux Valgus [surgery]; *Osteotomy [adverse effects] [methods]; Quality of Life; *Randomized Controlled Trials as Topic; Reoperation [statistics & numerical data]

MeSH check words

Adult; Humans