ORIGINAL ARTICLE

Percutaneous hallux valgus correction using the Reverdin-Isham osteotomy

T. Bauer*, D. Biau, A. Lortat-Jacob, P. Hardy

Orthopedic and Traumatologic Surgery Department, Ambroise-Paré Hospital, Paris Area West University, 9, avenue Charles-de-Gaulle, 92100 Boulogne, France

Accepted: 25 January 2010

KEYWORDS
Hallux valgus deformity; Percutaneous surgery; Metatarsal osteotomy; Reverdin-Isham osteotomy

Summary
Introduction: The present study assessed 2-year clinical and radiological results of percutaneous correction of hallux valgus by Reverdin-Isham osteotomy and sought to clarify indications for the technique.

Patient and methods: A continuous prospective single-center series of 104 cases of medium-to-moderate hallux valgus was managed by the same percutaneous technique, with a median 2 years’ clinical and radiological follow-up (with no loss to follow-up). Uni- and multivariate analysis determined predictive factors for the mobility and degree of correction obtained.

Results: American Orthopedic Foot and Ankle Society (AOFAS) functional score rose from a preoperative median of 49/100 to 87.5/100 postoperatively (p < 0.05); 89% of patients were satisfied or very satisfied with their result at end of follow-up. Hallux valgus and distal metatarsal articular angle (DMAA) were significantly reduced (30 and 15° to 15 and 7°, respectively; p < 0.05). Associated lateral ray surgery significantly increased the postoperative risk of MTP1 joint incongruence (p = 0.009).

Discussion: Percutaneous correction by Reverdin-Isham osteotomy seemed effective in isolated medium-to-moderate hallux valgus, but involves a learning curve and lacks precision in case of associated lateral metatarsal osteotomy, with a risk of DMAA hypercorrection and increased risk of MTP1 joint incongruence. Indications for percutaneous Reverdin-Isham osteotomy seem to be limited to isolated medium-to-moderate hallux valgus (M1M2 angle <15°, M1P1 angle around 30°) with elevated DMAA and congruent MTP1 joint.

Level of evidence: Level IV. Therapeutic study.

© 2010 Elsevier Masson SAS. All rights reserved.

Introduction
Hallux valgus is a frequent deformity of the first-ray of the forefoot, progressively and to varying degrees associating first-phalanx abduction and pronation, first-metatarsal...
adduction, pronation and elevation and lateral capsuloliga
dimentary retraction of the first-ray metatarsophalangeal
(MTP1) joint [1—3]. Surgical correction is indicated for
pain and difficulty with footwear. Many procedures have
been described and notably a variety of first-metatarsal
osteotomy procedures [3—9].

Distal metatarsal osteotomy is recommended to cor-
rect mild-to-moderate deformity with intermetatarsal angle
not exceeding 15° or to correct the distal metatarsal
articulating angle (DMAA) [10,11]. Minimally invasive or
percutaneous designs have been described for distal first-
metatarsal osteotomy, with or without osteosynthesis
[11—15]. Reverdin’s osteotomy, revised by Isham, is a per-
cutaneous procedure without osteosynthesis, to align the
first-ray by medial rotation of the first-metatarsal head
and DMAA correction [12]. The interest of a percutaneous
 technique lies in the reduced morbidity and surgery time,
theoretically shortening recovery time. Its vagaries concern
the quality of correction and long-term stability.

The present study assessed 2-year clinical and radiolog-
cal results of percutaneous correction of hallux valgus by
Reverdin-Isham osteotomy and analyzed prognostic factors
of failure, so as to clarify indications for the technique.

Patient and methods

Description of study

A continuous prospective single-center, single-surgeon series
of 104 cases of hallux valgus was managed by the same
percutaneous technique, in 82 patients, between Septem-
ber 2004 and June 2006. Surgery was indicated for painful
hallux valgus with functional impact and difficulty with
footwear. A percutaneous design was indicated for mild-to-
moderate deformity: hallux valgus angle (M1P1 angle) up to
40° and intermetatarsal angle (M1M2 angle) up to 15°. Some
patients presenting with M1P1 >40° but M1M2 <15° were also
included, as were others with M1M2 >15° but M1P1 <40°.
Median age was 57 years (range, 23 to 87 years); there were
76 women and six men. There were 33 right feet, 27 left,
and 22 one-step bilateral operations.

Surgical technique

All patients were operated on under locoregional anesthe-
sia (permetatarsal conduction block), and 77 in ambulatory
surgery. All underwent the same first-ray procedure per-
formed by the same surgeon, following Isham [12] and
De Prado et al. [16]. The patient was installed in supine
position, with a tourniquet above the malleoli, inflated to
250 mmHg. A 3—5 mm incision in the medial and plantar
edge of the first-metatarsal head was followed by cap-
sule detachment to obtain a work-space. First, the medial
and dorsal protrusion of the first-metatarsal head was
resected by conical burr on a drill with torque multipli-
cation, operating at low speed (max.: 5000 rpm) to avoid
burning and bone and skin necrosis (Fig. 1). Bone resec-
tion was pursued under fluoroscopy up to the functional
joint surface of the first-metatarsal head, outside the medial
sagittal groove. Bone fragments were evacuated under man-
ual pressure, with saline lavage and cleansing by rasps

Figure 1 Bone resection by motorized burr, with medial
approach.

in the work-space. In the second stage, first-metatarsal
Reverdin-Isham osteotomy was performed using a straight
burr with the same medial approach. The medial closed
wedge osteotomy of the first-metatarsal distal metaphysis,
parallel to the joint surface, was carried out from distal
dorsal, just behind the joint space, to proximal plantar,
behind the sesamoids, with a slope of 45° (Fig. 2). The lat-
eral cortex was conserved. The hallux was then put in forced
adduction, enabling compression by osteoclasis, medial clo-
cure of the Reverdin-Isham osteotomy and DMAA correction
(Fig. 3). In the third step, lateral capsuloligamentary release
of the metatarsophalangeal joint was associated with trans-
verse abductor tenotomy by Beaver® blade with a second
dorsolateral approach facing the metatarsophalangeal joint-
line. The final step comprised varization osteotomy of the
first-phalanx, with a third, dorsomedial, approach of 3 mm
medially to the extensor hallucis longus tendon. A short
straight burr was used for proximal metaphyseal osteotomy
of the phalanx, under fluoroscopy, conserving the lateral
cortex. Correction was obtained by medial closure of the
osteotomy with the hallux in forced varus (Fig. 4). No
osteosynthesis was performed. Postoperative dressing in
slight hypercorrection for 10 days maintained the correc-
tion and kept the osteotomies closed, and was then changed
for a dressing with a cohesive bandage with an ortho-
plasty maintaining first-ray alignment for 1 month (Fig. 5).
Complete weight-bearing was resumed immediately, with a

Figure 2 Reverdin-Isham osteotomy (AP view).
rigid flat-soled orthopedic shoe for the first month. Preventive anticoagulants were not prescribed except in case of history of deep venous thrombosis or risk factors (coagulation disorder, thrombopathy). Metatarsophalangeal joint mobilization was authorized after the first dressing was put on.

In 39% of cases \( (n=41) \), osteotomy of the lateral metatarsals was performed in the same surgical step. These were all patients presenting with lateral ray metatarsalgia associated with the first-ray deformity. In all cases, percutaneous first-, third- and fourth-ray distal metatarsal osteotomy was performed. In case of associated claw-toe, percutaneous surgery was performed in the same step, associating dorsal metatarsophalangeal arthrolysis, extensor and flexor tenotomy, P1 osteotomy and arthroplastic resection of the proximal interphalangeal joint, depending on the severity and reducibility of the deformity.

Assessment

Clinical
Pre- and postoperative functional American Orthopedic Foot and Ankle Society (AOFAS) scores (the AOFAS hallux-metatarso-phalangeal-interphalangeal scale) was calculated in all cases \[17\]. Passive MTP1 joint mobility (sum of dorsi- and plantar flexion) was measured by manual goniometry with the patient in dorsal decubitus, ankle in neutral position and knee in extension. Other parameters were also noted: forefoot digital formula (Greek, square or Egyptian), time to resumption of normal footwear, and presence of postoperative edema. Patient satisfaction (very satisfied, satisfied, dissatisfied or disappointed) was also rated at end of follow-up.

Radiological
Anteroposterior (AP) weight-bearing views were taken preoperatively and at end of follow-up, in all cases. Several manual measurements were made on each image, by a single observer: hallux valgus angle (M1P1 angle), metatarsus varus angle (M1M2 angle), first-metatarsal distal joint surface orientation angle (DMAA), first-ray shortening (metatarsus and phalanx), and metatarsal index (index plus, index minus, index minus). MTP1 joint congruency was assessed on Pigott’s criteria (centered congruent joint, deviated or subluxated non-congruent joint) \[2\]. MTP1 joint arthritis was assessed on Coughlin and Shurnas’s criteria (Table 1) \[18\].
### Statistical analysis

Quantitative variables were expressed as median and interquartile range (IQR), unless stated otherwise. Qualitative variables were expressed as numbers and percentages. Stepwise descending multiple regression models, based on Akaike’s Information Criterion (AIC) [19] were used to predict: M1P1 angle, M1M2 angle, DMAA, and postoperative dorsiflexion and joint congruence. The following dependent variables showing sufficient influence ($p < 0.2$) on univariate analysis were included in the multivariate model: preoperative M1P1 angle, preoperative M1M2 angle, preoperative DMAA, percutaneous lateral metatarsal osteotomy, and MTO1 arthritis (as seen from MTP1 joint-line pinching on preoperative AP X-ray). Analysis used R software [20]. All tests were bilateral; the significance threshold was set at 0.05.

### Results

All patients were followed up for at least 12 months, with a mean follow-up (FU) of 24 months (range: 12 – 40 months). None were lost to follow-up (Table 2, Fig. 6a and b).

**Figure 6**  
a: isolated hallux valgus: preoperative clinical and radiologic aspect; b: clinical and radiologic control at 18 months.
Complications

Complications included four M1 and five P1 lateral cortex fractures, not requiring revision. There were six cases of DMAA hypercorrection (DMAA > 0°). Two patients showed severe painful MTP1 joint stiffness (global mobility < 30°), and two others showed complex regional pain syndrome. Three patients (3%) showed recurrence of deformity (M1P1 angle > 20°); there were no cases of hallux varus. Two patients showed transfer metatarsalgia 18 months after percutaneous correction of isolated hallux valgus.

Subjective and functional results

AOFAS functional score improved significantly, from a preoperative median of 49/100 (IQR: 44–52) to 87.5/100 postoperatively (IQR: 67–93.5) (p < 0.05). All items in the global AOFAS score (pain, function, alignment) showed significant improvement. Eighty-nine percent of patients were satisfied or very satisfied with their result at end of follow-up. Normal footwear was resumed at a mean 5 weeks (range: 10 days to 3 months) after percutaneous correction of isolated hallux valgus, and a mean 8 weeks (range: 3 weeks to 6 months) in case of associated lateral metatarsal osteotomy.

Clinical results

At 1 month postoperatively, edema was observed in 10% of patients in case of correction of isolated hallux valgus and in 82% in case of associated lateral metatarsal osteotomy (p < 0.01). Median MTP1 joint mobility was 95° (IQR: 60–100) preoperatively (median = 80° [IQR: 70–90] in dorsiflexion and 15° [IQR: 10–20] in plantar flexion) and 80° (IQR: 55–100) postoperatively (median = 70° [IQR: 60–80] in dorsiflexion and 10° [IQR: 10–20] in plantar flexion) (NS).

Radiographic results

Radiographic analysis found a significant reduction in hallux valgus, with a median MTP1 angle of 30° (IQR: 25–32) preoperatively and of 15° (IQR: 11–18) postoperatively (p < 0.05). The median intermetatarsal M1M2 angle decreased from 14° (IQR: 12–15) preoperatively to 11° (IQR: 9–13) postoperatively (NS). The DMAA decreased from 15° (IQR: 12–18) preoperatively to 7° (IQR: 4–10) postoperatively (p < 0.05). DMAA values (on weight-bearing AP view) showed great variation, with a preoperative range from 8° to 25° (i.e., 17°) and a postoperative range from −5 to 15° (i.e., 20°). The MTP1 joint was non-congruent in 31 cases (30%) preoperatively and in 34 (33%) postoperatively (NS). Mean first-metatarsal shortening was 4 mm (range: 0–9 mm) and mean first-phalanx shortening was 3 mm (range: 0–6 mm). No failures of metatarsal or phalangeal osteotomy consolidation were observed. No radiologic progression of arthritis was observed at end of follow-up.

Statistical analysis

Multivariate analysis identified preoperative MTP1 joint mobility (p < 10⁻⁴; estimate = 0.64; 95% confidence interval [CI], 0.48–0.81) and radiographic signs of MTP1 arthritis (p = 0.02) as independent predictors of postoperative MTP1 joint mobility. Preoperative MTP1 arthritis was associated with a significant loss of dorsiflexion of 10% compared to arthritis-free patients (p = 0.02). Preoperative M1P1 angle was the sole predictor of postoperative M1P1 angle (estimate = 0.29; 95% CI: 0.18–0.41; p < 10⁻⁴). Mean metatarsophalangeal valgus correction was 4° less than in case of isolated first-ray surgery (p < 0.001). Multivariate analysis identified lateral metatarsal surgery as a predictor of postoperative DMAA: in case of lateral ray distal metatarsal osteotomies, resolution of metatarsalgia. Recurrence of deformity, distal metatarsal articular angle (DMAA) hypercorrection, non-congruent first-ray metatarsophalangeal (MTP1) joint.

Discussion

In the present series, percutaneous correction of mild-to-moderate hallux valgus by Reverdin-Isham osteotomy provided significant functional improvement, comparable to results from other percutaneous first-ray distal metatarsal osteotomy procedures, with or without osteosynthesis [6,11,12,14,21–23]. Clinical results for percutaneous correction of hallux valgus are comparable to those of the main
conventional open surgery procedures, such as chevron, Scarf or proximal metatarsal osteotomy, where postoperative AOFAS scores range from 82 to 93.5, depending on the reports (Table 3) [24—34]. Patient expectations focus on pain, footwear tolerance and walking [35—40]. Percutaneous Reverdin-Isham osteotomy would thus seem to be as effective as the main conventional procedures, providing both significant functional improvement on all criteria (pain, function, alignment) and a high-level of patient satisfaction [10—13,21,25,26,33—35,41—48].

Unlike Kadakia et al., who reported unacceptable rates of early complication following percutaneous distal metatarsal osteotomy, the present series showed no non-union, osteonecrosis or early recurrence [15]. It should nevertheless be stressed that the percutaneous technique involves a non-negligible learning curve to achieve reproducibility, avoiding soft-tissue trauma, and that the postoperative dressing protocol and rigorous follow-up over the first months are mandatory.

MTP1 joint stiffness

MTP1 joint stiffness is one of the most feared complications of hallux valgus correction surgery. Mild stiffness with about 10—20% loss of mobility is generally reported for open hallux valgus surgery [10,31,33,41,49]. Medial MTP1 capsule plasty induces immediate joint amplitude loss, first impairing dorsiflexion [50]. Severe MTP1 joint stiffening with significant functional impact is relatively rare, and often the result of complications such as infection, delayed consolidation or complex regional pain syndrome [11,33,35,47]. Fibrosis and MTP1 joint capsuloligamentary retraction following extensive resection are considered to be the main causes of stiffness secondary to open correction. Percutaneous techniques theoretically reduce the risk of stiffness, due to the limited approach, and in case of extra-articular metatarsal osteotomy [6,11,48]. Percutaneous Reverdin-Isham osteotomy may, however, induce stiffness, due to the extensive medial resection of the metatarsal head, the release of bone debris in the joint space and capsule and the intracapsular osteotomy involved [12,13]. With a median 15° loss of MTP1 joint mobility, stiffness secondary to percutaneous Reverdin-Isham osteotomy is comparable to that induced by other percutaneous or open surgery techniques [31,33,49]. The need for abundant lavage of the work-space, however, should be stressed, to clear bone debris liable to cause an inflammatory reaction, with fibrosis and stiffening.

Radiographic results

This percutaneous procedure proved effective in correcting mild-to-moderate deformity, achieving a median postoperative MTP1 angle of 15°. Such a 50% angular correction is comparable to that reported with other per-
Table 4  Comparison of techniques: radiologic results.

<table>
<thead>
<tr>
<th>Author (ref)</th>
<th>Year</th>
<th>Technique</th>
<th>Preoperative M1P1 angle</th>
<th>Postoperative M1P1 angle</th>
<th>Preoperative M1M2 angle</th>
<th>Postoperative M1M2 angle</th>
<th>Preoperative DMAA</th>
<th>Postoperative DMAA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veri et al. [34]</td>
<td>2001</td>
<td>Proximal</td>
<td>37</td>
<td>13</td>
<td>16</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plaweski et al. [46]</td>
<td>1998</td>
<td>Scarf</td>
<td>28</td>
<td>18</td>
<td>14</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bonnel et al. [54]</td>
<td>1999</td>
<td>Scarf</td>
<td>31.3</td>
<td>9</td>
<td>11.4</td>
<td>6.2</td>
<td>14.6</td>
<td>12.6</td>
</tr>
<tr>
<td>Jardé et al. [43]</td>
<td>1999</td>
<td>Scarf</td>
<td>39.8</td>
<td>22.7</td>
<td>15</td>
<td>10.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crevoisier et al. [42]</td>
<td>2001</td>
<td>Scarf</td>
<td>32</td>
<td>17</td>
<td>16</td>
<td>10</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Salmeron et al. [52]</td>
<td>2001</td>
<td>Scarf</td>
<td>28</td>
<td>17</td>
<td>11.5</td>
<td>8.2</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>Kristen et al. [28]</td>
<td>2002</td>
<td>Scarf</td>
<td>19.1</td>
<td></td>
<td>6.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freslon et al. [35]</td>
<td>2005</td>
<td>Scarf</td>
<td>31.2</td>
<td>17.5</td>
<td>12.1</td>
<td>7.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aminian et al. [24]</td>
<td>2006</td>
<td>Scarf</td>
<td>34.5</td>
<td>16.9</td>
<td>15.4</td>
<td>10.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skotak and Behounek [49]</td>
<td>2006</td>
<td>Scarf</td>
<td>37</td>
<td>18</td>
<td>16</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chou et al. [25]</td>
<td>1998</td>
<td>Chevron</td>
<td>22</td>
<td>18</td>
<td>11</td>
<td>9</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>Trnka et al. [33]</td>
<td>2000</td>
<td>Chevron</td>
<td>29</td>
<td>18</td>
<td>13</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teli et al. [52]</td>
<td>2001</td>
<td>Chevron</td>
<td>31.7</td>
<td>16.9</td>
<td>15.4</td>
<td>8.6</td>
<td>11.3</td>
<td>7.1</td>
</tr>
<tr>
<td>Strienstra et al. [32]</td>
<td>2002</td>
<td>Chevron</td>
<td>29.4</td>
<td>11.4</td>
<td>15</td>
<td>4.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schneider et al. [31]</td>
<td>2004</td>
<td>Chevron</td>
<td>27.6</td>
<td>14</td>
<td>13.8</td>
<td>8.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weinberger et al. [48]</td>
<td>1991</td>
<td>Distal</td>
<td>26</td>
<td>7.5</td>
<td></td>
<td></td>
<td>12.6</td>
<td>6.6</td>
</tr>
<tr>
<td>Bauer et al. [23]</td>
<td>2009</td>
<td>Distal</td>
<td>28</td>
<td>14</td>
<td>13</td>
<td>10</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>Present series</td>
<td>2009</td>
<td>Distal</td>
<td>30</td>
<td>15</td>
<td>14</td>
<td>11</td>
<td>15</td>
<td>7</td>
</tr>
</tbody>
</table>
cutaneous or open distal metatarsal osteotomy techniques [6,11,13,23,31–33,51,52] or with Scarf osteotomy (Table 4) [24,27,28,30,35,42,49,53–55]. Weinberger et al. reported better angular correction with a different percutaneous metatarsal osteotomy, with M1P1 angle reduced from 26 to 7.5° [48]. With a mean 50% M1P1 angle correction and slight impact on the M1M2 angle, percutaneous Reverdin-Isham osteotomy is adapted and effective for the correction of mild-to-moderate deformities (M1M2 angle ≤15°, and M1P1 angle about 30°).

One of the aims of Reverdin-Isham osteotomy is to reduce the DMAA by medial rotation of the first-metatarsal head. In the present series, the mean reduction in DMAA was 50% (median DMAAA = 15° preoperatively vs. 7° postoperatively). Comparable DMAA correction was reported by Magnan et al. for the same type of percutaneous procedure [23], with percutaneous distal metatarsal osteotomy [11,14] and by Chou et al. [25] for chevron osteotomy. Coughlin and Carlson reported better DMAA correction (from 23 to 9°) with double metatarsal osteotomy [26]. With Scarf osteotomy, medial rotation of the plantar metatarsal fragment seems more limited, but still possible using certain tricks to obtain several degrees of DMAA correction [28,35,42,53,54]. The present series featured wide variation in DMAA, with a range of 17° preoperatively and a range of 20° postoperatively. This confirms that DMAA measurements lack precision and reproducibility, due both to the X-ray views (X-ray orientation) and to first-metatarsal rotation in case of severe metatarsus varus [41,56—60]. In moderate first-ray deformity, there is less first-metatarsal rotation, making DMAA measurement theoretically more reliable. The wide variation in postoperative DMAA values, however, shows that this percutaneous correction technique fails to ensure reliably precise and foreseeable DMAA reduction [48]. This imprecise adjustment of first-metatarsal head medial rotation, which may be due to technical error or to bone quality (excessive impaction in case of osteoporosis), can induce hypocorrection of the DMAA, with a risk of recurrence of valgus deformity, or hypercorrection, with a risk of postoperative MTP1 joint non-congruency. The main limit of Reverdin-Isham osteotomy emerging from the present series was lack of stability in case of associated lateral ray surgery, with a significant 4° hypercorrection of the DMAA and significantly elevated risk of postoperative MTP1 joint non-congruency (17% for isolated first-ray surgery, and 47% in case of associated lateral ray surgery). It is as though the displacement induced by the lateral ray osteotomies (shortening and elevation of the metatarsal heads) increased stress on the Reverdin-Isham osteotomy, jeopardizing stability (with risk of DMAA hypercorrection du DMAA and MTP1 joint non-congruency). The present study indicates that Reverdin-Isham osteotomy is a reliable technique for the correction of isolated medium-to-moderate hallux valgus without significant metatarsus varus (M1M2 angle ≤15°), with elevated DMAA and congruent MTP1 joint.

Study limitations

The present study involves certain limitations, and notably a mean follow-up of no more than 2 years. Longer-term assessment will be required to confirm the present findings, both clinically and in terms of angular correction. Bias may also have been induced by the fact that the clinical and radiological measurements were not made by an independent assessor.

Conclusion

Percutaneous correction of mild-to-moderate hallux valgus by Reverdin-Isham osteotomy provided clinical results that were comparable to those of most minimally invasive or conventional procedures, with 89% of patients satisfied or very satisfied at 2 years’ follow-up. The technique does, however, involve a steep and long learning curve, and lacks precision in case of associated lateral metatarsal osteotomies, with a risk of DMAA hypercorrection and an elevated risk of MTP1 joint non-congruency. The optimal indications for correction of hallux valgus by percutaneous Reverdin-Isham osteotomy seem to be restricted to isolated (without lateral metatarsal procedure) mild-to-moderate hallux valgus (M1M2 angle ≤15°, and M1P1 angle about 30°), with elevated DMAA and good MTP1 congruency. In case of associated lateral metatarsal procedure (percutaneous distal osteotomy), another first-ray technique should be used: conventional (Scarf, chevron), or minimally invasive or percutaneous chevron osteotomy, with or without fixation. Further studies of percutaneous hallux valgus correction techniques are needed, to refine indications and assess long-term stability and patient benefit in terms of resumption of footwear and activity.

Conflict of interest

None.

References


