Distal metatarsal osteotomy for hallux varus following surgery for hallux valgus

We reviewed the outcome of distal chevron metatarsal osteotomy without tendon transfer in 19 consecutive patients (19 feet) with a hallux varus deformity following surgery for hallux valgus. All patients underwent distal chevron metatarsal osteotomy with medial displacement and a medial closing wedge osteotomy along with a medial capsular release.

The mean hallux valgus angle improved from -11.6° pre-operatively to 4.7° post-operatively, the mean first-second intermetatarsal angle improved from -0.3° to 3.3° and the distal metatarsal articular angle from 9.5° to 2.3° and the first metatarsophalangeal joints became congruent post-operatively in all 19 feet. The mean relative length ratio of the metatarsus decreased from 1.01 to 0.99 and the mean American Orthopaedic Foot and Ankle Society score improved from 77 to 95 points.

In two patients the hallux varus recurred. One was symptom-free but the other remained symptomatic after a repeat distal chevron osteotomy. There were no other complications.

We consider that distal chevron metatarsal osteotomy with a medial wedge osteotomy and medial capsular release is a useful procedure for the correction of hallux varus after surgery for hallux valgus.

Hallux varus may be congenital or acquired, the latter following trauma, burn contracture or, most frequently, operative overcorrection of hallux valgus.1-5 The incidence of hallux varus after surgery for hallux valgus is reported to range from 2% to 15.4%.1,6-9 The surgical options for the treatment of this deformity are medial capsular release, corrective osteotomy, tendon transfer and arthrodesis.10 However, medial capsular release alone is insufficient and is usually combined with other procedures, such as corrective osteotomy or tendon transfer. Arthrodesis is recommended as palliative treatment when hallux varus is accompanied by arthritis in the first metatarsophalangeal joint (MTPJ).11

The most frequent operation for hallux varus is the transfer of extensor hallucis to the lateral aspect of the proximal phalanx.11 However, the disadvantages include the sacrifice of a tendon with normal function, resulting in weakened extension of the hallux and the technical difficulty of passing the tendon underneath the scarring from earlier resection of the transmetatarsal ligament. Moreover, tendon transfer alone cannot rectify an overcorrected inter-metatarsal angle.

An alternative operation for hallux varus is a distal metatarsal osteotomy and medial capsular release without tendon transfer. We describe our results of this procedure in 19 feet.

Patients and Methods
Between January 2003 and December 2007 1559 patients underwent hallux valgus surgery by a single surgeon (KJC). Of these patients, 23 (23 feet) developed symptomatic hallux varus deformities between December 2004 and January 2009. Of these, four refused re-operation and the remaining 19 underwent distal metatarsal osteotomy and medial capsular release without tendon transfer, after a mean of six months (4 to 24) of conservative treatment. All patients were women and none had systemic disease such as rheumatoid arthritis or diabetes. Their mean age at operation was 45.2 years (20 to 65) and the mean follow-up was 25 months (14 to 42). Their hallux valgus had been treated by scarf osteotomy in 13 cases (68.4%) and proximal chevron osteotomy in six (31.6%); all patients had also undergone an Akin osteotomy.11 None had radiological arthritis of the first MTPJ pre-operatively but nine had a decreased range of movement (ROM) in this joint.

All procedures were performed under ankle block anaesthesia by a single surgeon. A medial longitudinal incision was made...
through the previous scar, followed by a T-shaped capsular incision (the transverse arm of the T was along the MTPJ line, and the vertical was along the shaft of the first metatarsal) to expose the head of the first metatarsal. A distal metatarsal chevron osteotomy was performed at an angle of 60° to the apex of the distal portion (Fig 1). The distal fragment was translated medially, followed by a 1 mm to 3 mm sized medial biplanar closing wedge between 8 mm and 10 mm proximal from the first MTPJ line. The amount of medial displacement, which was about 4 mm to 5 mm, was determined according to the first to second inter-metatarsal angle (IMA). The degree of medial closing wedge was based on the distal metatarsal articular angle (DMAA). A minimal (1 mm to 2 mm) medial closing wedge osteotomy was performed in six patients whose DMAA was < 7°. The osteotomy was fixed with one or two 1.58 mm Kirschner (K-) wires (Fig. 2). The medial capsules were not repaired in order to allow the medial release. If severe varus instability remained, a 2 mm to 3 mm transverse capsular excision was made by an approach through the previous scar over the dorsum of the first web and the lateral capsule was tightened. The patients were encouraged to start immediate weight-bearing wearing in a wooden-soled rocker-bottom shoe which was worn for six to eight weeks post-operatively. Passive exercises of the MTPJ were begun at two weeks post-operatively. Radiographs were taken at two, six and 12 weeks post-operatively and at final follow-up.

Clinical assessment. The flexion and extension of the first MTPJ was measured with a goniometer by the surgeon (KJC). A joint with a ROM < 30° was defined as having limited motion. The American Orthopaedic Foot and Ankle Society (AOFAS) hallux score was recorded pre-operatively and at final follow-up. The patients were asked to give their opinion on their operation, using the terms ‘very satisfied’, ‘satisfied’, ‘unsatisfied’, or ‘very unsatisfied’.

Any complications, such as recurrence of hallux varus, infection, nonunion, avascular necrosis of the first metatarsal head, and transfer metatarsalgia, were recorded.

Radiological assessment. Standardised weight-bearing radiographs were taken pre-operatively and at final follow-up. The hallux valgus angle (HVA), IMA, DMAA, joint congruity, and relative-length ratio of the metatarsus were measured (Fig 3). The HVA was determined using the mid-longitudinal axis of the first metatarsal and proximal phalanx as references whereas the IMA was measured with respect to the mid-longitudinal axis of the first and second metatarsals. Post-operatively, the line between the centre of the displaced distal fragment and the base of the first metatarsal was considered to represent its long axis. The angle between the mid-longitudinal axis of the first metatarsal and the line perpendicular to its distal articular surface were used to measure the DMAA. The relative-length ratio of the first and second metatarsals were measured using the Hardy and Clapham method (Fig. 4). In this, a line is drawn between the most lateral portion of the calcaneocuboid joint and most medial portion of the talonavicular joint and the point where this line crosses the mid-longitudinal axis of the second metatarsal is determined. The distances in centimetres from this intersection to the distal ends of the first and second metatarsal heads were defined as the lengths of these metatarsals and the relative length ratio of the metatarsus was calculated by dividing the lengths of the first metatarsal by the second.
Howeve three (2° follow-up, to -5°) pre-operatively to 4.7° wit
(37% (patient
f alliance os pl, abnormality (DMA)
the green li
be the ratio of
red line is 0.99. Figure 3b – post-operative radiograph taken at 28 months showing hallux varus deformity correc
tion. The angle between the yellow and black line is the HVA (6°). The DMA of the green line is -2°. The re
relative MT ratio, which is the ratio of the purple line divided by the red line, is 0.97.

The average measurements by two orthopedic surgeons (YRC, YSY) were used. Statistical analysis. The Wilcoxon signed-rank test was used to compare pre- and post-operative data. A p-value < 0.05 was considered statistically significant.

Results
Of the 19 patients, 11 (58%) were very satisfied, seven (37%) were satisfied, and one (5%) was very dissatisfied with their operation (Table I). Nine feet with limited ROM improved to values > 60°. The mean AOFAS score rose si
significantly from 77 points (62 to 82) pre-operatively to 95 points (53 to 100) at last follow-up.

The mean HVA improved significantly from -11.6° (-26° to -5°) pre-operatively to 4.7° (-2° to 10°, p < 0.01) at last follow-up, as did the mean DMA from -0.3° (-6° to 4°) to 3.3° (0° to 7°, p < 0.01) and the mean DMMA, from 9.5° (2° to 19°) to 2.3° (-5° to 10°, p < 0.01) (Table I). Also, the mean relative length ratio of the metatarsus decreased si
significantly, from 1.01 (0.96 to 1.05) pre-operatively to 0.99 (0.92 to 1.05, p < 0.01) post-operatively.

All incongruities of the MTPJ were corrected by the operation.

Two patients had recurrence of hallux varus deformity. One (patient 1) showed radiological recurrence, from 4° at three months post-operatively to -2° at final follow-up. However, she required no further operation as she had no symptoms and was improved compared with her pre-
operative HVA of -7°. In the case of the other patient (patient 8), who was very dissatisfied; her pre-operative HVA of -5° improved only to -3°. She had subjective insta
bility and, after ten months of follow-up, underwent a repeat distal metatarsal osteotomy. This improved her HVA to 3° but, she continued to complain of instability and decreased power of toe flexion.

We encountered no other complication, such as wound infection, nonunion, avascular necrosis or transfer metatarsalgia.

Discussion
The causes of hallux varus deformity following surgery for hallux valgus include excessive lateral release, excision of the lateral sesamoid or lateral head of the tendon of flexor hallucis brevis, overcorrection of the IMA, excessive medial capsulorrhaphy, or excessive resection of the medial emi
nence. These causes are usually combined rather than isolated in most cases.

Although the causes were usually combined, we deduced the main cause of hallux varus following bunion surgery from the radiographs of the 19 feet. This was overcorrection of the IMA in 13 patients, excessive excision of the medial eminence with overcorrection of the IMA in one patient (Fig. 5) and soft-tissue imbalance in the five patients with an IMA greater than 0°.

As part of the earlier surgery for hallux valgus in our institution, an open lateral release was performed by the modified McBride procedure, whereby the adductor hallucis is transferred to the first metatarsal, along with release of the lateral capsule and transverse metatarsal ligament lateral release by a medial incision or transarticular approach, which was a novel procedure used by us after 2007.15-17

Patients with hallux varus should initially have conserva
tive treatment which has been reported to be successful in 22% of patients.18 Of our 23 patients, four had mild deformities and did not want an operation. Although soft-tissue release can be successful, release of the contracted medial capsule alone is rarely adequate and requires additional procedures, such as extensor hallucis longus transfer and interphalangeal arthrodesis,19 split extensor hallucis longus transfer without interphalangeal arthrodesis, and split extensor brevis transfer.20 MTPJ stiffness after tendon transfer is reported in more than 40% of patients, along with a decrease in push-off power in some.18-20 Until 2004, we tried to correct a varus deformity by medial capsule release and split tendon transfer of extensor hallucis. However, three of four such cases were failures and we consid
ered that a soft-tissue procedure with metatarsal osteotomy would be more effective.

Soft-tissue procedures may restore soft-tissue balance previously disturbed by excessive medial capsulorrhaphy and lateral release. However, if poor tissue balance is due to bony causes, such as excessive resection of the medial eminence or overcorrection of the IMA, metatarsal osteotom
omy is more appropriate.
Soft-tissue procedures alone have been recommended only for flexible joints without bony abnormality. Of our 19 patients, nine had limited ROM without radiological arthritis. Overcorrection of the IMA during surgery for hallux valgus may increase the DMAA, resulting in joint incongruity. Indeed, all nine patients with limited ROM had a large DMAA. Most hallux varus deformities are accompanied by joint incongruity, which can cause joint stiffness and arthritic changes. It results from an increase of the DMAA because of lateral rotation of the distal fragment during the osteotomy. We did not appreciate the significance of the DMMA in our earlier operations for hallux

<table>
<thead>
<tr>
<th>Patient</th>
<th>HVA* (°)</th>
<th>IMA† (°)</th>
<th>DMAA‡ (°)</th>
<th>Relative MT§ ratio</th>
<th>AOFAS¶ score</th>
<th>Subjective satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-</td>
<td>Post-</td>
<td>Pre-</td>
<td>Post-</td>
<td>Pre-</td>
<td>Post-</td>
</tr>
<tr>
<td>1</td>
<td>-7</td>
<td>-2</td>
<td>0</td>
<td>2</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>-5</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>-21</td>
<td>6</td>
<td>-3</td>
<td>3</td>
<td>2</td>
<td>-2</td>
</tr>
<tr>
<td>4</td>
<td>-20</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>-6</td>
<td>4</td>
<td>0</td>
<td>3</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>-8</td>
<td>10</td>
<td>-4</td>
<td>3</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>-5</td>
<td>8</td>
<td>-2</td>
<td>0</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>-5</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>-10</td>
<td>10</td>
<td>-4</td>
<td>2</td>
<td>8</td>
<td>-2</td>
</tr>
<tr>
<td>10</td>
<td>-5</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>-5</td>
<td>8</td>
<td>0</td>
<td>3</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>-26</td>
<td>7</td>
<td>-6</td>
<td>3</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>13</td>
<td>-9</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>14</td>
<td>-14</td>
<td>0</td>
<td>-2</td>
<td>2</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>-25</td>
<td>6</td>
<td>0</td>
<td>3</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>16</td>
<td>-11</td>
<td>8</td>
<td>4</td>
<td>7</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>17</td>
<td>-17</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>-5</td>
</tr>
<tr>
<td>18</td>
<td>-9</td>
<td>7</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>19</td>
<td>-13</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Mean</td>
<td>-1.6</td>
<td>4.7</td>
<td>-0.3</td>
<td>3.4</td>
<td>9.6</td>
<td>2.3</td>
</tr>
</tbody>
</table>

* HVA, hallux valgus angle
† IMA, first to second intermetatarsal angle
‡ DMAA, distal metatarsal articular angle
§ MT, metatarsus
¶ AOFAS, American Orthopaedic Foot and Ankle Society

---

Fig. 4
Radiograph showing the relative length ratio of the first and second metatarsals.

Fig. 5a
Radiographs demonstrating a) hallux varus deformity arising after excessive excision of medial eminence (overcorrection) and b) at 28 months showing a good correction.
valgus, otherwise the combination of a worsening DMMA and overcorrection of the IMA would have been avoided. Distal chevron osteotomy with a medial closing wedge is a reliable operation for recovery of the DMMA, whereby joint congruity can be restored and the IMA improved.

In hallux varus, overcorrection of the IMA has been defined as a pre-operative angle < 0° \(^{3,5}\) or <2°. \(^{10}\) In our study the hallux valgus had been treated by scarf osteotomy in 13 patients (68.4%) and proximal chevron osteotomy in six (31.6%) but we could not determine which osteotomy was more likely to lead to hallux varus.

Early recognition of hallux varus is important, because conservative treatment (neighbour strapping to between 10° and 15° valgus) should begin within four weeks and continue for eight to 12 weeks. \(^{21}\) Delayed surgery can cause pain, problems with footwear and cosmetic dissatisfaction but, more importantly, lead to progressive stiffness and arthritic changes. We operated on patients who did not respond to conservative treatment after a mean of six months (4 to 24).

The mean pre-operative HVA in patients with hallux valgus has been variously reported as -14° (-30° to -7°), \(^{22}\) -18° (-45° to -6°), \(^{19}\) and -23° (-45° to 10°). \(^{18}\) It has been suggested that surgery should be performed on patients with an HVA less than -15°,\(^{23}\) although others consider that surgery should be performed on flexible joints with an HVA < -25° and on rigid joints with an HVA < -10°. \(^{24}\) The mean pre-operative HVA in our series was -11.6° (-26° to -5°). Although the deformities were not severe, every patient was dissatisfied after conservative management because of dorsolateral prominence of the head of the first metatarsal, joint stiffness, pain on walking and cosmesis. Furthermore, as hallux varus is a complication of bunion surgery, patient dissatisfaction may be an important factor when considering operative correction.

We found that the mean relative length ratio of the first metatarsal decreased from 1.01 pre-operatively to 0.99 post-operatively, indicating that distal chevron osteotomy with medial closing wedge osteotomy can shorten the first metatarsal, which may relax the first MTPJ, and improve ROM. Despite the shortening none of our patients showed transfer metatarsalgia because the shortening was not severe.

Another advantage of distal chevron osteotomy is its stability. In this study, there was no failure of fixation, even with immediate weight-bearing. In a report by Austin and Leventen,\(^{25}\) fixation of the distal chevron osteotomy site was not undertaken. We decided that one or two K-wires would be sufficient.

When considering operative correction of hallux varus, an IMA < 0° and a large DMAA are good indications for our procedure. However, the addition of a metatarsal osteotomy remains debatable in patients with a flexible hallux varus and an IMA > 2°. Distal chevron metatarsal osetotomy and medial capsular release is a useful procedure for the treatment of hallux varus following surgery for hallux valgus.

References