Purpose: The aim of this study was to compare clinical and radiographic outcomes of proximal opening wedge osteotomy using a straight versus oblique osteotomy. Materials and Methods: We retrospectively reviewed 104 consecutive first metatarsal proximal opening wedge osteotomies performed in 95 patients with hallux valgus deformity. Twenty-six feet were treated using straight metatarsal osteotomy (group A), whereas 78 feet were treated using oblique metatarsal osteotomy (group B). The hallux valgus angle (HVA), intermetatarsal angle (IMA), distal metatarsal articular angle, and distance from the first to the second metatarsal (distance) were measured for radiographic evaluation, whereas the American Orthopaedic Foot and Ankle Society (AOFAS) forefoot score was used for clinical evaluation. Results: Significant corrections in the HVA, IMA, and distance from the first to the second metatarsals were obtained in both groups at the last follow-up ($p<0.001$). There was no difference in the mean IMA correction between the 2 groups (6.1±2.7° in group A and 6.0±2.1° in group B). However, a greater correction in the HVA and distance from the first to the second metatarsals were found in group B (HVA, 13.2±8.2°; distance, 25.1±0.2 mm) compared to group A (HVA, 20.9±7.7°; distance, 28.1±0.3 mm; $p<0.001$). AOFAS scores were improved in both groups. However, group B demonstrated a greater improvement relative to group A ($p=0.005$). Conclusion: Compared with a straight first metatarsal osteotomy, an oblique first metatarsal osteotomy yielded better clinical and radiological outcomes.

Key Words: Hallux valgus, proximal opening wedge osteotomy, straight, oblique, low-profile plate
an increased intermetatarsal angle (IMA), compared to a
distal osteotomy.1 Numerous proximal osteotomy operative
techniques have been described, including crescentic, chev-
ron, Mau, Scarf, Ludloff, and biplanar closing wedge oste-
otomies, with varying results,2,7 and the optimal method for
osteotomy remains controversial.8

First metatarsal proximal opening wedge osteotomy is a
proximal corrective osteotomy for hallux valgus deformity
that was first described by Trethowan.9 This original pro-
cedure is seldom used because of its technically demanding
nature, involving the use of a bone graft wedge, and con-
cerns about nonunion and instability.10,11 In spite of these
concerns, a stable, proximal osteotomy that maintains the
relative length of the first metatarsal in relation to the sec-
ond is needed.12 Recently, a proximal opening wedge oste-
otomy using a low-profile wedge plate (Low Profile Plate
and Screw System; Arthrex, Naples, FL, USA) was devel-
oped, and a few studies have evaluated this procedure.12-14
According to the guidelines of this surgical procedure, ei-
ther a straight or oblique first metatarsal osteotomy can be
performed based on the surgeons’ preference.12-14 To our
best knowledge, however, there are no comparative studies
between a straight and oblique first metatarsal osteotomy
for proximal opening wedge osteotomy using a low profile
wedge plate. Even though previous studies, which used a
straight or oblique first metatarsal osteotomy, reported suit-
able clinical and radiological results, various factors can in-
fluence the outcomes of hallux valgus surgery. Park, et al.15
reported that a larger IMA and wider distance from the first
to the second metatarsal contributed to the recurrence of hal-
lux valgus deformity. Therefore, we postulated that two dif-
ferent osteotomy directions could influence the correction of
the IMA and distance from the first to the second metatarsus,
as well as the postoperative clinical results. The aim of this
study was to investigate and compare the clinical and radi-
ographic outcomes of proximal opening wedge osteotomy us-
ing a straight versus oblique osteotomy.

**MATERIALS AND METHODS**

A total of 104 consecutive cases in 95 patients with hallux
valgus deformity between May 2010 and November 2011
were retrospectively reviewed for this study. All cases re-
ceived proximal opening wedge osteotomies using a low-
profile plate. Twenty-six feet were treated using a straight
osteotomy (group A), whereas 78 feet were treated using an
oblique osteotomy (group B). Inclusion criteria were symp-
tomatic, moderate-to-severe hallux valgus deformity with a
hallux valgus angle (HVA) greater than 20° and an IMA
greater than 12°. Fourteen feet in group A and 44 feet in
group B had the moderate deformity (HVA of 20° to 40° or
IMA of 12° to 15°), and 44 feet in group A and 34 feet in
group B had the severe deformity (HVA of greater than 40°
or IMA of greater than 15°). All patients had undergone pre-
viously failed non-operative treatment consisting of shoe
modification and non-steroidal anti-inflammatory medica-
tion. Patients with rheumatoid arthritis, failed hallux valgus
surgery, symptomatic or radiographic evidence of hallux
rigidus, or instability of the first metatarsocuneiform joint
were excluded from this study.

The study included 86 women and 9 men with an aver-
age age of 45.3 years (range, 21–67 years) at the time of
surgery. Among the 104 hallux valgus deformities, 42 oc-
curred in the right foot, 44 in the left foot, and 9 in both
feet. The average follow-up period was 24.5 months (range,
19–42 months) in group A and 23.6 months (range, 18–32
months) in group B. There were no significant differences
in the patient gender, age, and follow-up period between
the groups (Table 1). The study protocols were approved by
our ethics committee.

**Surgical procedure**

Patients were placed in the supine position, and surgery
was performed under spinal or general anesthesia. The op-
ervative technique consisted of distal soft tissue procedures,
excision of the medial eminence, proximal opening wedge
osteotomy, and plication of the medial joint capsule. Through
a dorsal first web space incision, the transverse metatarsal
ligament, adductor hallucis tendon, and lateral capsule were
sharply released. A medial longitudinal incision was made
over the medial eminence and extended proximally along
the first metatarsal shaft to the first metatarsocuneiform
joint. A T-shaped medial capsulotomy was performed, and
a strip of capsule was excised. The medial eminence of the
first metatarsal head was removed 1 mm medial to the sag-
ittal sulcus. Subsequently, metatarsal osteotomy was per-
formed using a small oscillating saw.

In the straight osteotomy group, a straight cut was made
into the proximal medial metatarsal base, approximately 1.0
cm from the first metatarsocuneiform joint where the osteo-
tomy was performed, midway between the dorsal and planter
surfaces, leaving the lateral cortex and periosteum intact
(Fig. 1). In the oblique osteotomy group, an oblique cut was
teotome, and a mini lamina spreader was inserted to hold
the desired correction of the IMA under fluoroscopic visu-
alization. The appropriate opening wedge plate (Low Pro-
file Plate and Screw System; Arthrex) was selected based
on fluoroscopic visualization of first metatarsal correction
(i.e., it was parallel to the second metatarsal). The plate was
first secured by screw fixation in the most proximal of the
distal screw holes. The two distal screws were always placed
made into the proximal medial metatarsal base, beginning
approximately 1.5 cm distal to the first metatarsocuneiform
joint, then angled so that the lateral apex was positioned ap-
proximately 5 mm distal to the first metatarsocuneiform
joint (Fig. 2). Care was taken to avoid breaking the lateral
cortex, by performing the osteotomy under direct vision un-
til the sawblade just touched the lateral cortex. The osteoto-
y was carefully opened to the desired width using an os-
teotome, and a mini lamina spreader was inserted to hold
the desired correction of the IMA under fluoroscopic visual-
alization. The appropriate opening wedge plate (Low Pro-
file Plate and Screw System; Arthrex) was selected based
on fluoroscopic visualization of first metatarsal correction
(i.e., it was parallel to the second metatarsal). The plate was
first secured by screw fixation in the most proximal of the
distal screw holes. The two distal screws were always placed

### Table 1. Demographic Data

| Parameters                   | Group A     | Group B     | Total      | \( p \) value |
|------------------------------|-------------|-------------|------------|---------------|
| Number of patients/feet      | 24/26       | 71/78       | 95/104     |               |
| Sex                          |             |             |            | 0.061         |
| Male                         | 2           | 7           | 9          |               |
| Female                       | 22          | 64          | 86         |               |
| Mean age, yrs                | 41.9±12.7   | 46.4±11.7   | 45.3±12.0  | 0.051         |
| Follow-up period, months     | 24.5±4.7    | 23.6±3.1    | 23.8±3.6   | 0.109         |

Data are presented as means±standard deviations unless otherwise indicated.

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**Fig. 1.** Preoperative (left) and 3-month postoperative (right) weight-bearing anteroposterior radiographs (A) and schematic drawings (B) of a proximal opening wedge osteotomy utilizing a straight osteotomy. Although the intermetatarsal angle was corrected after surgery, the distance from the first to the second metatarsal was not significantly decreased, and the hallux valgus angle was not corrected.

**Fig. 2.** Preoperative (left) and 12-month postoperative (right) weight-bearing anteroposterior radiographs (A) and schematic drawings (B) of a proximal opening wedge osteotomy utilizing an oblique osteotomy. After surgery, the intermetatarsal angle and hallux valgus angle were corrected, and the distance from the first to the second metatarsal was decreased.
perpendicular to the long axis of the first metatarsal. Both proximal screws were placed parallel to the osteotomy in an oblique fashion. Then, the final distal screw was placed. A similar surgical technique has been previously reported. Cancellous bone, obtained from the excised medial eminence or a demineralized bone matrix product (DBM, CG Bio Inc., Seoul, Korea), was packed into the osteotomy site. Then, the medial capsule was repaired using absorbable sutures. An Akin osteotomy was performed at the base of the proximal phalanx when a hallux valgus interphalangeal deformity and/or pronation of the hallux were present. After surgery, a coban strap dressing was applied for the first 2 weeks, and patients were allowed to bear weight as tolerated on their heel and lateral forefoot in an open, hard-soled surgical shoe. Upon radiographic evidence of healing at the osteotomy site, usually 6 weeks later, transfer of weight to the forefoot in a regular shoe was permitted.

Radiographic evaluation
To measure the HVA, IMA, distal metatarsal articular angle (DMAA), the degree of lateral translation of the first metatarsal head, and the congruency of the first metatarsophalangeal joint, standing weight-bearing anteroposterior and lateral radiographs were obtained before surgery, 1 day, 6 weeks, 3 and 6 months after surgery, and at the final follow-up. To avoid potential bias, an independent observer, who was a musculoskeletal-trained radiologist not involved in the care of the patients and blinded to the intention of this study, evaluated the radiographs. The HVA was measured as the angle between a line from the center of the metatarsal base to the center of the first metatarsal head and a line connecting the midpoints of the proximal and distal articular surfaces of the proximal phalanx. The IMA was measured as the angle between a line of the first metatarsal and a line bisecting the diaphyseal portions of the second metatarsal bone. The DMAA was measured on anteroposterior radiograph. To measure the DMAA, a line was drawn from the most medial extent of the metatarsal articular surface to its most lateral extent. A perpendicular line was then drawn to this articular line. The angle between this perpendicular line and the long axis of the metatarsal was determined as the DMAA. To determine the degree of lateral translation of the first metatarsal head, the distance from the first to the second metatarsal was measured on anteroposterior radiographs as the shortest distance between the center of the first metatarsal head and the longitudinal axis of the second metatarsal, as described by Park, et al.

Clinical evaluation
For clinical evaluation, the American Orthopaedic Foot and Ankle Society (AOFAS) forefoot score for the hallux was used. All patients were evaluated before surgery and as part of the follow-up. Furthermore, patients rated their overall satisfaction with the operation as excellent, good, fair, or poor, and were asked whether they would undergo the procedure again under similar circumstances.

Statistical analysis
To evaluate changes between preoperative and final follow-up values, a Wilcoxon signed-rank test was used for group A and the paired t test was used for group B. The Mann-Whitney U test was performed to compare the outcomes between groups A and B. All continuous data were expressed as mean±standard deviation. The Spearman rank-order correlation test was used to analyze the correlation between the congruency of the first metatarsophalangeal joint and performance of the Akin osteotomy in both groups. To analyze the association between clinical and radiographic outcomes at the final follow-up in each group, we used stepwise multivariate linear regression to assess the correlation between the AOFAS score and radiographic outcomes, including HVA, IMA, DMAA, and the distance from the first to the second metatarsal. We used SPSS version 15.0 (IBM Corporation, Armonk, NY, USA) for all analyses, and statistical significance was accepted for p values less than 0.05.

RESULTS
Radiographic outcomes
Radiographic outcomes are summarized in Table 2. There were no significant differences between the groups in the preoperative HVA, IMA, DMAA, and distance from the first to the second metatarsal. Significant corrections in the HVA, IMA, and distance from the first to the second metatarsal were obtained in both groups at the final follow-up (p<0.001). The HVA decreased from 34.6±6.4° to 20.9±7.7° in group A and from 33.7±8.4° to 13.2±8.2° in group B. Mean HVA correction was 13.6±6.9° in group A and 20.6±8.1° in group B, with a significant difference between the 2 groups at the final follow-up (p<0.001). The IMA improved from 17.5±3.0° to 6.1±2.7° in group A and from 16.7±1.5° to 6.0±2.1° in group B. The mean IMA correction was 11.4±4.0° in group A and 10.7±2.4° in group B. No difference was detected in the mean IMA correction between the
to the Spearman rank-order correlation test, there was no significant correlation between the first metatarsophalangeal joint congruency and performance of the Akin osteotomy in both groups (Table 3).

Clinical outcomes

The AOFAS score showed a significant improvement in both groups, from 51.5±6.1 to 79.0±6.8 in group A and from 50.3±6.0 to 83.5±7.0 in group B (p<0.001). There was a significant difference in the mean AOFAS score at the final follow-up between groups (p=0.005) (Table 2). As for the overall patient satisfaction with the operation, 9 patients (38%) reported their satisfaction as excellent, 6 (25%) as good, 5 (20%) as fair, and 4 (17%) as poor in group A, and 24 (34%) as good, 2 (3%) as fair, and 1 (1%) as poor in group B. The satisfaction rate of group B was higher than group A (p<0.001).

The 4 patients in group A and 1 in group B who graded their satisfaction as poor stated that they would not be willing to undergo the same operation again. The remaining 20 patients (83%) in group A and 70 (99%) in group B stated that they would be willing to undergo the same foot operation again.

Table 2. Comparison of Clinical and Radiographic Outcomes between the Groups

| Parameter                              | Group A     | Group B     | p value*  |
|----------------------------------------|-------------|-------------|-----------|
| AOFAS score                            |             |             |           |
| Preoperative                           | 51.5±6.1    | 50.3±6.0    | 0.326     |
| Last follow-up                         | 79.0±6.8    | 83.5±7.0    | 0.005     |
| p value†                               | <0.001      | <0.001      |           |
| Hallux valgus angle, °                 |             |             |           |
| Preoperative                           | 34.6±6.4    | 33.7±8.4    | 0.724     |
| Last follow-up                         | 20.9±7.7    | 13.2±8.2    | <0.001    |
| p value†                               | <0.001      | <0.001      |           |
| Intermetatarsal angle, °               |             |             |           |
| Preoperative                           | 17.5±3.0    | 16.7±1.5    | 0.112     |
| Last follow-up                         | 6.1±2.7     | 6.0±2.1     | 0.883     |
| p value†                               | <0.001      | <0.001      |           |
| Distal metatarsal articular angle, °   |             |             |           |
| Preoperative                           | 3.2±1.4     | 2.9±1.3     | 0.365     |
| Last follow-up                         | 7.8±2.9     | 7.4±3.5     | 0.509     |
| p value†                               | <0.001      | <0.001      |           |
| Distance from the first to second metatarsal, mm |   |             |           |
| Preoperative                           | 29.9±0.3    | 30.2±0.3    | 0.751     |
| Last follow-up                         | 28.1±0.3    | 25.1±0.2    | <0.001    |
| p value†                               | 0.036       | <0.001      |           |

AOFAS, American Orthopaedic Foot and Ankle Society.

Data are presented as means±standard deviations.

*Mann-Whitney U test.

†Wilcoxon signed-rank test for group A and paired t-test for group B.
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Three patients in group A and 10 in group B had symptoms of plate irritation; the plates were removed after radiographic confirmation of union at the osteotomy site. There were no other complications such as sensory loss of the great toe, nonunion at the osteotomy site, recurrence of deformity, or development of hallux varus during the follow-up period.

DISCUSSION

A few retrospective studies have assessed the effectiveness of proximal opening wedge osteotomy using a low-profile plate.\textsuperscript{12-14} In these studies, only a single osteotomy, either straight or oblique osteotomies, was utilized, based on the surgeons’ preference. In the present study, we performed a proximal opening wedge osteotomy using both osteotomies. To our knowledge, this is the first study to compare the outcomes of hallux valgus correction utilizing a straight versus an oblique osteotomy.
operative HVA in this study was relatively larger than that in previous studies. Thus, correction of the HVA was not sufficient, especially in group A.

We also measured the distance from the first to the second metatarsal preoperatively and at the final follow-up. This distance was improved significantly in both groups ($p=0.036$ for group A and $p<0.001$ for group B), but there was also a significant difference in the mean change in distance between groups ($p<0.001$) (Table 2). Park, et al.\textsuperscript{15} compared the results of hallux valgus surgery between feet fixed with Kirschner wires and those fixed with a plate, and reported that, although the immediate postoperative HVA was not different between the 2 groups, the plate group had a larger IMA and wider distance from the first to the second metatarsal. They concluded that a larger IMA and wider distance from the first to the second metatarsal attributed to the recurrence of hallux valgus. In the current study, the IMA was decreased similarly at the final follow-up in both groups, but the distance from the first to the second metatarsal was improved more in group B. We believe that the significant difference in the distance from the first to the second metatarsal between the groups at the final follow-up was due to a difference in the center of rotation of angulation (CORA) at the osteotomy site. When performing an oblique osteotomy, the CORA is located more proximally and closer to the second metatarsal base than in a straight osteotomy. Thus, the distance from the first to the second metatarsal decreases to a greater extent in an oblique osteotomy than in a straight osteotomy (Fig. 5). Moreover, by linear regression analysis, we found a good correlation between the last follow-up HVA and distance from the first to the second metatarsal in group A ($r=0.844$, $p<0.001$). This correlation was not observed in group B. Furthermore, we investigated if performance of an Akin osteotomy influ-

![Fig. 4. Associations between the American Orthopaedic Foot and Ankle Society (AOFAS) score and final follow-up radiographic outcomes, including the hallux valgus angle (HVA), intermetatarsal angle (IMA), and distance from the first to the second metatarsal (distance), in group B.](image)

![Fig. 5. In an oblique osteotomy (right), the center of rotation of angulation (CORA) is located more proximally and closer to the second metatarsal base than in a straight osteotomy (left). Thus, the distance from the first to the second metatarsal decreases more in an oblique osteotomy than in a straight osteotomy. In a straight osteotomy, correction of the hallux valgus angle (dotted line) is decreased because of the wide distance from the first to the second metatarsal.](image)
enced congruency of the first metatarsophalangeal joint at the final follow-up. According to a Spearman rank-order correlation test revealed no significant correlation between congruency of the first metatarsophalangeal joint and performance of an Akin osteotomy in both groups (Table 3). In addition, incongruences of the first metatarsophalangeal joint were observed in 7 cases despite the performance of 18 Akin osteotomies in group A. Therefore, we believe that a decreased distance from the first to the second metatarsal has more influence on HVA correction than an Akin osteotomy. Interestingly, the radiographic outcomes, which demonstrated significant improvements in the HVA and distance from the first to the second metatarsal between groups, support the significant differences in clinical outcomes between groups. In multivariate analyses, the HVA and distance from the first to the second metatarsal significantly influenced the AOFAS score at the final follow-up ($p<0.001$), whereas the IMA did not influence the AOFAS score at the final follow-up ($p=0.834$) in group A (Fig. 3). However, no radiographic outcome influenced the AOFAS score at the final follow-up in group B ($p>0.05$) (Fig. 4). These findings indicate that, in proximal opening wedge osteotomy using a low-profile plate, an oblique osteotomy is a more useful method than a straight osteotomy to obtain better clinical and radiographic outcomes.

Recent studies have reported suitable overall clinical outcomes of proximal opening wedge osteotomy using a low-profile plate. Saragas\textsuperscript{13} retrospectively evaluated 46 patients (64 feet) with hallux valgus deformity who underwent proximal opening wedge osteotomy using a low-profile plate, and reported significant improvement in the AOFAS score (from 51.3 to 86.8; $p=0.0001$). Similarly, Shurnas, et al.\textsuperscript{12} retrospectively evaluated 78 patients (84 feet) and reported that 70 patients (89.7%) noted good to excellent subjective satisfaction after the surgery. In our study, similar postoperative clinical results were found in group B. However, the mean AOFAS score was significantly increased from 51.5 to 79.0 in group A and from 50.3 to 83.5 in group B ($p=0.005$) (Table 2). As for the overall patient satisfaction, 15 patients (63%) in group A and 68 (96%) in group B reported their satisfaction as good to excellent. We believe that the differences in patient satisfaction between the 2 groups were due to cosmetic demands of patients. As mentioned above, significant improvements in the HVA and distance from the first to the second metatarsal were achieved in group B, and these improvements might have contributed to a better appearance of the patient’s feet, and consequently, better patient satisfaction. According to the linear regression analyses, good correlations of the HVA and distance from the first to second metatarsal with the patient satisfaction were found ($r=0.724$, $p<0.001$ for HVA and $r=0.811$, $p<0.001$ for distance, respectively).

The disadvantages of proximal opening wedge osteotomy using a low-profile plate include nonunion at the osteotomy site and lengthening of the first metatarsal by the opening wedge, which can result in tightening of the soft tissue and a higher rate of recurrence.\textsuperscript{11,13,19} Shurnas, et al.\textsuperscript{12} reported 1 case of nonunion in 78 patients (84 feet); revision with a Lapidus procedure was performed in that patient. They reported that even with nonunion, the plate and screws did not break, but the wedge became dissociated from the bone and recurrence of a widened IMA was evident. Fortunately, we found no nonunion. With regards to lengthening of the first metatarsal, Saragas\textsuperscript{13} reported that despite a mean increase in the first metatarsal length of 2.3 mm, no complications were found due to this lengthening, and Shurnas, et al.\textsuperscript{12} also reported a mean increase in the first metatarsal length of 1.9 mm, and found that the effect of lengthening was minimal and not statistically significant. In the current study, a mean increase in the first metatarsal length of 1.4 mm was observed, but no complications were found. Although we did not statistically compare the correlation between the lengthening of the first metatarsal and width of the open wedge, we believe that the amount of lengthening in the current study was relatively minimal compared to that in previous studies because of the narrow opening wedges used.

The present study had some limitations. First, the number of patients was small, especially in group A, and the relatively short follow-up period. In addition, the data were retrospectively collected. For more accurate evaluation of the outcomes of hallux valgus correction using straight versus oblique osteotomy, a prospective randomized study and a larger series of cases with a longer follow-up period are required. Second, we found that the distance from the first to the second metatarsal decreased to a greater extent in an oblique osteotomy than in a straight osteotomy because the CORA is located more proximally and closer to the second metatarsal base in an oblique osteotomy than in a straight osteotomy. However, we cannot quantify the exact association between the amount of the decreases of the distance from the first to the second metatarsal achieved by two different osteotomies and location of CORA. Cadaveric study with precise measurements is required to compare the difference in magnitude of correction between the two osteot-
omies. Lastly, it is important to note potential long term effects of ‘jamming’ in the first metatarsophalangeal joint from the lengthening of the first metatarsal. Therefore, a prospective study with a longer follow-up period is required to specifically look into this potential problem, and it is prudent for the authors to consider a distal shortening osteotomy of the first metatarsal.

In conclusion, this study shows satisfactory clinical and radiographic outcomes of proximal opening wedge osteotomy using a low-profile plate for correction of hallux valgus deformity. According to radiographic outcomes (including the HVA and distance from the first to the second metatarsal) and the associated clinical outcomes, the oblique osteotomy group had better results than the straight osteotomy group. Therefore, we recommend oblique osteotomy, rather than straight osteotomy, when performing proximal wedge osteotomy using a low-profile plate.

REFERENCES

1. Kummer FJ. Mathematical analysis of first metatarsal osteotomies. Foot Ankle 1989;9:281-9.
2. Easley ME, Kiebzak GM, Davis WH, Anderson RB. Prospective, randomized comparison of proximal crescentic and proximal chevron osteotomies for correction of hallux valgus deformity. Foot Ankle Int 1996;17:307-16.
3. Schwartz N, Groves ER. Long-term follow-up of internal threaded Kirschner-wire fixation of the scarf bunionectomy. J Foot Surg 1987;26:313-6.
4. Saxena A, McCammon D. The Ludloff osteotomy: a critical analysis. J Foot Ankle Surg 1997;36:100-5.
5. Campbell JT, Schon LC, Parks BG, Wang Y, Berger BI. Mechanical comparison of biplanar proximal closing wedge osteotomy with plantar plate fixation versus crescentic osteotomy with screw fixation for the correction of metatarsus primus varus. Foot Ankle Int 1998;19:293-9.
6. Neese DJ, Zelichowski JE, Patton GW. Mau osteotomy: an alternative procedure to the closing abductory base wedge osteotomy. J Foot Surg 1989;28:352-62.
7. Thordarson DB, Leventen EO. Hallux valgus correction with proximal metatarsal osteotomy: two-year follow-up. Foot Ankle 1992;13:321-6.
8. Choi WJ, Yoon HK, Yoon HS, Kim BS, Lee JW. Comparison of the proximal chevron and Ludloff osteotomies for the correction of hallux valgus. Foot Ankle Int 2009;30:1154-60.
9. Trehowan J. Hallux Valgus. In: Choyce CC, editor. A system of surgery. New York: PB Hoeber; 1923. p.1046-9.
10. Coughlin MJ. Hallux valgus. J Bone Joint Surg Am 1996;78:932-66.
11. Cooper MT, Berlet GC, Shurnas PS, Lee TH. Proximal opening-wedge osteotomy of the first metatarsal for correction of hallux valgus. Surg Technol Int 2007;16:215-9.
12. Shurnas PS, Watson TS, Crislip TW. Proximal first metatarsal opening wedge osteotomy with a low profile plate. Foot Ankle Int 2009;30:865-72.
13. Saragas NP. Proximal opening-wedge osteotomy of the first metatarsal for hallux valgus using a low profile plate. Foot Ankle Int 2009;30:976-80.
14. Randhawa S, Pepper D. Radiographic evaluation of hallux valgus treated with opening wedge osteotomy. Foot Ankle Int 2009;30:427-31.
15. Park CH, Ahn JY, Kim YM, Lee WC. Plate fixation for proximal chevron osteotomy has greater risk for hallux valgus recurrence than Kirschner wire fixation. Int Orthop 2013;37:1085-92.
16. Schneider W, Csepan R, Knahr K. Reproducibility of the radiographic metatarsophalangeal angle in hallux surgery. J Bone Joint Surg Am 2003;85-A:494-9.
17. Smith BW, Coughlin MJ. Treatment of hallux valgus with increased distal metatarsal articular angle: use of double and triple osteotomies. Foot Ankle Clin 2009;14:369-82.
18. Kitaoka HB, Alexander JJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. Foot Ankle Int 1994;15:349-53.
19. Watson TS, Shurnas PS. The proximal opening wedge osteotomy for the correction of hallux valgus deformity. Tech Foot Ankle Surg 2012;11:168-74.