Compare the Initial Result of One Screw or Two Screws Fixation for Proximal Crescentic Metatarsal Osteotomy with Distal Soft Tissue Reconstruction in Severe Hallux Valgus Treatment

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Research Article

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Abstract

Background: Proximal crescentic metatarsal osteotomy and distal soft tissue reconstruction have been introduced to correct severe hallux valgus (HV). The intrinsically unstable proximal first crescentic osteotomy depends on enough force fixation for stability. It is necessary to judge the number of fixation's screw for osteotomy.

Methods: Fifty two feet from 50 adult patients with severe HV were included in this study. The treatment was proximal crescentic metatarsal osteotomy with a single screw and distal soft tissue reconstruction in Group 1. The fixation with two screws with distal soft tissue reconstruction in Group 2. Clinical and radiological follow-ups were assessed after 4 and 12 months of operation.

Methods: In Group 1, hallux valgus angle (HVA) was decreased from 46.4 ±3.28 to 19.9 ±4.70 after 12 months of operation. HVA was decreased from 45.1 ±3.45 to19.1 ±4.70 for group 2. For intermetatarsal angle (IMA) in Group 1, it was changed from 18.5 ±1.98 to 9.25 ±1.11 after 12 months of operation. For group 2, it was decreased from 18.3 ±1.81 to 9.53 ±1.70. Meanwhile, the American Orthopedic Foot and Ankle Society (AOFAS) score was improved from 63.1 to 83.9 after 12 months of operation for group1, and was improved from 64.3 to 82.8 for group2. Furthermore, the visual analogue scale (VAS) score was reduced from 4.5±1.01 to 1.7± 0.43 for group 1, and it was reduced from 4.7±0.92 to 1.7±0.55 for group 2 after 12 months of operation.

Conclusions: The first metatarsal dorsal elevation was occurred in 4 feet in Group1, and no metatarsal dorsal elevation was occurred in Group 2. There were no significant differences identified among Group1 and Group 2 in terms of VAS and AOFAS scores, and HVA and IMA measurements. However, there is less complication in two-screw fixation for crescentic osteotomy compared to a single screw fixation.

Background

Hallux valgus (HV) deformity is a very common disease, characterized by lateral subluxation of the first metatarsophalangeal joint, metatarsus primus varus, and lateral rotation of the sesamoids, affecting about every fourth individuals up to 65 years and about every third individuals later on in life[1]. Hallux valgus angle (HVA) more than 40º and inter-metatarsal angle (IMA) more than 16º are the radiological features which are defined severe hallux valgus deformity. Symptomatic severe hallux valgus deformity should be corrected with soft tissue reconstruction and first metatarsal osteotomy. There is no controversy to do soft tissue reconstruction about correction for deformity. However, there are still some controversies regarding the osteotomy treatment technique for severe HV including the correction of the first metabone deformity by opening the wedge, closing the wedge, crescent and proximal chevron, scarf and Ludloff proximal osteotomy[2–5]. These authors suggested that proximal metatarsal osteotomy as well as distal soft tissue reconstruction wore applied more widely for severe HV deformity because they allow a larger number of corrections compared with distal or midshaft osteotomy procedures.

There was a comparative research about the proximal crescentic and Mau osteotomies (Level III) showed that the results of the two techniques were similar however the crescent osteotomy had a higher complication rate [6]. The complications of this procedure include under-correction, metatarsus primus elevatus, shortening of the first ray, over-correction of hallux varus deformity, and exaltation of the first ray causing the pain migrates to second metatarsal head(transfer metatarsalgia). These complications also have been described in most literatures[4, 7, 8]. Therefore, strong fixation for proximal metatarsal osteotomy will avoid the failure of osteotomy, recurrence of HVA deformity and transfer metatarsalgia. Using a single screw with proximal crescentic osteotomy has been intensively reported in most literatures[7, 9, 10]. Theoretically, two-screw fixation offers a stronger fixation and stable force than single screw and faster healing after osteotomy. To our knowledge, however, it remains unknown that whether the proximal crescentic metatarsal osteotomy using two-screw fixation and distal soft tissue reconstruction for HV can improve radiological and clinical outcomes.

We conjectured that two cannulated screws would offer better stability than a single screw. Thus, we applied two 3.0-mm headless cannulated screws for fixation rather than single screw fixation, both of which are with distal soft tissue reconstruction. The objective of this study is to compare the radiological and clinical outcomes of two-screw fixation and single screw fixation of proximal crescentic metatarsal osteotomy and distal soft tissue reconstruction for HV.

Methods

This study was conducted in accordance with the World Medical Association Declaration of Helsinki approved by the Ethics Committee of the Affiliated Hospital of Medical School of Ningbo University. The first registration of this trial was 05/10/2019 in Chinese Clinical Registry which registration's number is ChiCTR1900026375. Informed consent was obtained from all patients. From January 2013 to January 2017, fifty two feet from 50 adult patients were included in this research. The inclusion criteria of this research include the patients aged from 30 to 75 years old, with HVA more than 40 degrees and IMA more than 16 degrees. The anterior–posterior (AP) weight bearing X-ray was conducted and measured for all patients in this research (Figure1). The exclusion criteria include patients with rheumatoid arthritis, osteoarthritis of the first metatarsophalangeal joints, vascular diseases and pregnancy. All patients had pain at the medial eminence of the first metatarsophalangeal (MTP) joint. No cases had osteoporosis and previous surgery history of forefoot in this research.

All patients were Asians, ages ranged from 35 to72 years, with the average age of 55 years. Thirty-eight feet were from 36 female patients and fourteen feet were from 14 male patients. After informed consent gained from all patients, the patients were divided into two groups by tossing a coin. Thirty feet from 29 patients were included in Group 1 (distal soft tissue reconstruction and proximal crescentic osteotomy with a single screw) and twenty-two feet from 21 patients were included in Group 2 (distal soft tissue reconstruction and proximal crescentic osteotomy with two screws). No difference was found between the two groups in terms of mean age and sex ratio. All patients were operated by two surgeon of author list. The outcomes of pre and post-operative clinical data were collected according to guidelines recommended by the American Orthopedic Foot and Ankle Society (AOFAS) score [11],and the VAS scores (10 points) which were obtained preoperatively and at the end of 4 and 12 months postoperatively. The AP and lateral weight-bearing X-ray were collected from the patient's medical records at the end of 4 and 12 months postoperatively.

All patients were evaluated clinically and radiologically before surgery and at the 4 and 12 months after surgery. The AP and lateral weight-bearing X-ray were taken preoperatively and during the time of follow-up. The HVA and IMA were measured on the AP weight-bearing X-ray.

Operation procedures

First, the distal soft tissue reconstruction was performed with two incisions under continuous spinal or general anesthesia. Dorsal incision was performed in the first inter-metatarsal space of the forefoot, where the adductor hallucis tendon, the deep transverse inter-metatarsal ligament and the lateral capsule of the first MTP joint were released intensively (Figure2). The second incision was conducted over the first MTP joint from midshaft of the proximal phalanx to approximate head of the metatarsal. An inverted "L" medial capsulotomy was used to expose the medial eminence, which was removed with a sharp saw blade (Figure3). After shaving of the medial eminence, the medial capsule was closed and plicated tightly. Attention was then turned to the dorsal aspect of the base of the first metatarsal. An incision was made from the midportion of the first metatarsal shaft to the plane of the tarsometatarsal (TMT) joint. The extensor hallucis longus tendon and dorsomedial sensory nerve were avoided to injury in this incision. The crescentic osteotomy was performed 1 cm distal to the first TMT joint, and one or two screws used for fixation was/were positioned 1 cm away from the osteotomy position. The crescentic blade was positioned neither perpendicular to the plantar foot nor metatarsal, but ideally approximately halfway between these two positions (Figure4). One cannulated screw placed 1 cm away from the osteotomy position with an angle of approximate 50° relative to the metatarsal shaft .The other cannulated screw placed 1 cm away from the osteotomy position parallelly with the metatarsal shaft.

Group 1

After distal soft tissue reconstruction, a proximal crescentic osteotomy was performed 1cm away from the TMT joint. The osteotomy was used with crescentic blade saw between the angle of perpendicular to the plantar foot and metatarsal shaft .The deformity correction was confirmed with an intraoperative fluoroscopy until the HVA and IMA angle were reduced for the desired alignment, then fixation was carried out using one 3 mm cannulated AO titanium (Synthes Inc, Shanghai) screw for stabilization, with an approximate angle of 50° relative to the metatarsal shaft(Figure5). The HVA and IMA corrections were verified by fluoroscopy intraoperatively before the skin was sutured.

Group 2

After distal soft tissue reconstruction, a proximal crescentic osteotomy about 1cm away from the first TMT joint. The distal part of the osteotomy was translated and rotated laterally under fluoroscopic to reduce the HVA and IMA angle, and the proximal part was translated medially until the desired alignment was achieved{Şahin, 2018 #209}[12]. Provisional fixation was carried out with two guide pins. Routine fluoroscopic observation was performed to confirm the IMA and HVA correction with guide pin position. One 3 mm cannulated AO titanium (Synthes Inc, Shanghai) screw was used for fixation from the distal osteotomy part to proximal part with an approximate angle of 50° relative to the metatarsal shaft. The other one 3 mm cannulated AO titanium screw was fixed percutaneous from distal medial osteotomy part to proximal lateral metatarsal shaft (Figure6).

After the osteotomy and fixations were completed, the congruence of metatarsophalangeal joint and reduction of the sesamoids were evaluated. If there was a tendency to collision or overlap between the first and second toe after the osteotomy procedure and fixation , the Akin procedure at the proximal phalanx was performed in both Groups[13]. In combination with a lateral release, the medial capsular was performed to close and plicate tightly.

Postoperative treatment

All patients were casted with below keen splint for six weeks in both groups with the same postoperative procedure. The patients were requested to do partial weight bearing within the first 2 weeks and allowed full weight bearing after 4 weeks of operation. Sutures were removed 14 days postoperatively. Clinical and radiographic evaluation were performed for all patients after 4 months (Figure 7) and 12 months (Figure 8). Active and passive extension and flexion exercises of the first MTP joint were then encouraged. No physical rehabilitation therapy was initiated for any of the groups.

Statistical analysis

The results were exported into Excel file format. All statistical calculations were done using Microsoft Excel 2003 (Microsoft Headquarters, Redmond, WA, United States). All experimental data (continuous variables) was presented as the mean and standard deviation or median and range. Statistical analysis was performed using the Statistical Package for Social sciences (SPSS, IBM) version 20.0. The Kolmogorov-Smirnov test was used in the distribution of cases. As data showing a normal distribution, the groups were compared by gender using independent samples

t -test. An independent *t*-test was used to compare the results of a single screw fixation, two screws fixation for osteotomy site and gender difference. Significance was reached with a *p*-value less than 0.05 ($p < 0.05$). The difference between of three time periods for clinical and radiographic results was compared using One-Way ANOVA test and using the Bonferroni multiple comparison test.

Results

Fixation of proximal crescentic metatarsal osteotomy and distal soft tissue reconstruction of fifty-two feet from 50 adult patients were performed and followed up in this study. For clinical assessment, significant improvements were observed for the AOFAS and VAS scores at 4 months and 12 months postoperatively in both groups. The AOFAS scores were improved from 64.3 to 83.6 at 4 months after operation, and to 82.8 at12 months after operation in Group1. For Group 2, the improvements were found to be from 63.1 to 84. 1 and 83.9 and, respectively (Table 1). The VAS scores decreased from 4.5 preoperatively to 2.0 and 1.7 after 4 and 12 months respectively in Group 1, and from 4.7 to 2.1 and 1.7 in Group 2 respectively (Table 2). There is no significant difference for AOFAS scores and VAS scores between the two groups after 4 months and 12 months ($p > 0.05$) (Table 1,2). A significant difference ($p < 0.05$) was found for AOFAS and VAS scores as expected between preoperatively and postoperatively in the two groups (Table3.4). But there was no significant difference for AOFAS score and VAS score after 4 months and 12 months postoperatively in Group 1 and Group 2 (Table3.4).

For the radiological evaluation, improvements were observed in the HVA and IMA values in both groups at the time of 4 months and 12 months postoperatively in comparison with the preoperative period. The HVA values decreased from 45.1 to 17.5 and 19.1 after 4 months and 12 months postoperatively in the Group1, and from 46.4 ±5 to 18.9 and 19.9 in the Group2(Table 5). The IMA values also decreased from 18.3 to 8.34 and 9.53 after 4 months and 12 months postoperatively in the Group1, and from 18.5 to 8.89 and 9.25 in the Group2 (Table 6). For the metatarsal length, an average 2.6±3.8 mm shortening was observed in the two groups at the 12 months postoperatively. There was no significant difference between the two groups. A significant difference ($p < 0.05$) in HVA and IMA was found as expected between preoperatively and postoperatively in the two groups (Table3.4). But there was no significant difference in HVA and IMA after 4 months and 12 months postoperatively in Group 1 and Group 2 (Table3.4).

For change in angles, the changing percentage of HVA value was similar among these two groups, however, the changing percent of IMA value of group 2 was significantly bigger than that of group 1. There was no significant difference in the degree of shortening in the metatarsal length between these two groups. Mean operation time for a single screw fixation in Group 1 was 88.9 min and 92.8 min for the two screws fixation in Group 2. No statistical difference was found in the mean operating time. Of note, there was no significant difference for all measuring data between male and female in Group1 and Group2 (Table1.2.5.6).

Postoperative Complications

Hallux varus deformity (HVA < 0 degree) did not occur in both Groups at the last follow-up. The first metatarsal dorsal elevation was occurred in 4 feet in Group1, and no metatarsal dorsal elevation was occurred in Group 2. Two feet recurrence of HV underwent painful transfer metatarsalgia with plantar keratosis under the head of second metatarsal in Group1, which were refixed with the first metatarsal open wedge osteotomy to lower the head of the first metatarsal head. The medial digital nerve of the hallux was injured in two patients in Group1, and one patient in Group 2. No infection was occurred in both groups. No patients complained of stiffness of the first MTP joint and difficulty in wearing shoes. (Table 7)

Discussion

Severe hallux valgus (1-2 IMA more than 16º) can be corrected using proximal metatarsal osteotomies with distal soft tissue procedures. The most advantage of proximal osteotomy is that it could significantly correct the 1-2 IMA. The proximal metatarsal osteotomies have many techniques such as proximal Chevron, crescentic, opening, and closing wedge osteotomy[14–17]. The first tarsometatarsal joint arthrodesis (Lapidus) is also another option in severe painful hallux valgus or combine with flat foot[18, 19]. But the series studies of these proximal osteotomies have shown various complications such as recurrence of hallux valgus, the first metatarsal head elevation, the first metatarsal shortening and transfer metatarsalgia due to changes in forefoot plantar pressure. The hallux varus deformity did not occur in our study at the last follow-up. But the rate of first metatarsal head elevation in Group1 was more higher compare with Group 2. Another refixation surgery was performed in Group1. There is less complication in two-screw fixation for crescentic osteotomy compared to a single screw fixation.

Benefits of the proximal crescentic osteotomy combined with a distal soft-tissue procedure have been described for the correction of severe hallux valgus in many literatures[12, 20]. This technique was popular for correction of hallux valgus associated with metatarsus primus varus in a report [20]. A majority (93%) of the patients were satisfied with this technique in Mann's literature[20]. The average AOFAS hallux score was 92 points in Successful cases. Ninety five percent cases have shown excellent to good correction of clinical and radiological AOFAS with an average hallux score of 92 points[21]. Yasuda et al [22] described a distal soft tissue surgery on 83 feet combined with a proximal crescent osteotomy. The average AOFAS score increased significantly from 58.0 to 93.8. Pauli et al[23] described a new fixation method that uses a head-locking X-Plate to stabilize the proximal metatarsal crescentic osteotomy to correct moderate to severe hallux valgus. This technique showed excellent patient satisfaction with stability, bone healing, clinical outcome because of the plate provided powerful stable support for the osteotomy. Screw versus plates were designed on nine pairs of fresh/frozen cadaver feet to stabilize the proximal crescentic osteotomy to correct hallux valgus. This study describes that the dorsal plate is more biomechanically stable than a single cancellous screw [24]. The proximal crescentic osteotomy with distal soft tissue reconstruction and rigid dorsal plate fixation was a reliable and safe method to correcting severe hallux valgus. As a complement, Akin osteotomy was also played an role important in many cases to correct in angle, pronation, and overall appearance of the foot deformity [8].

Moon et al [25] have reported that proximal chevron osteotomy also could provide an effective correction for severe hallux valgus deformity. Scarf osteotomy is suggested for the treatment of severe hallux valgus deformity with good clinical and radiological results[26]. The open wedge osteotomy procedure could correct the severe hallux valgus very well. The open-wedge osteotomy resulted in a slight lengthening of the first metatarsal (1–2 mm)[27].But only very few prospective randomized researches have been reported to compare two different kinds of techniques of correction for hallux valgus.

Sahin et al[12] made a report about the comparison of rotational scarf osteotomy and proximal crescentic osteotomy in correction of the hallux valgus. The proximal crescentic osteotomy and scarf osteotomy combined with the distal soft tissue procedures provided similar satisfactory correction, clinical and radiological results. Those patients, who has high preoperative distal metatarsal articular angle(DMAA), may increase IMA and the HVA values in the first postoperative year compared with six weeks of post-operation. There was a prospective comparative study described about crescentic osteotomy and open wedge metatarsal osteotomy to correct severe hallux valgus deformity[13]. Open wedge osteotomy and crescentic osteotomy can improved AOFAS and VAS score in correction severe hallux valgus. There was no significant difference in the two groups at 4 and 12 months postoperatively. And no significant difference was found in the postoperative AOFAS score and VAS score for the two groups. Compared with the crescentic osteotomy, the complication of using the open wedge osteotomy to extend the first metatarsal was not observed.

All above, proximal metatarsal crescentic osteotomy is an effective means of correction for severe hallux valgus deformity. The technique provides a powerful space to correct wide IMA with minimal shortening. Regardless of different fixation of the first metatarsal proximal osteotomy screw, Kirschner wire or plate, dorsiflexion malunion and elevation malunion of the first ray has been reported to occur frequently. Therefore, significant pressure would occur underneath the second, third, fourth or fifth metatarsal heads, and patients might complain of transfer metatarsalgia with or without plantar callosity beneath the metatarsal head.

Recurrence of hallux valgus is a major complication in different techniques for correction. A cross-pinning technique with two or three 1.5-mm Kirschner wires for fix crescentic osteotomy site combined distal soft tissue reconstruction was also an effective and reliable method for moderate and severe hallux valgus. But the prevalence of recurrent hallux valgus in severe hallux valgus was significantly higher than that in moderate valgus[28].The proximal metatarsal crescentic osteotomy have been reported from 4–25% with a rate of recurrence in different literatures[7, 29, 30]. In the present study, the recurrence rate of hallux valgus was observed in2 feet (2/32, 6.25%) in Group1 at the last 12 months follow-up. But there was no recurrence case in Group2. The recurrence was relatively lower than that in previous report in spite of a small number of cases in this research because the time of follow-up was more short than other literature’s. The high rate of complication was observed in long time follow-up more than 24 months in most reports[4, 7, 20, 31]. The recurrence rate of complications in Group2 was obviously lower than that of Group1. Adequate internal fixation implant was necessary for the first metatarsal proximal crescentic osteotomy because dorsal angulation has been reported to occur in the range of 28 - 82% undergoing this procedure[12, 21]. The rate of first metatarsal dorsal angulation was occurred in 4 feet (13%) in Group1, and no feet was occurred in Group 2. This study has shown that there is statistical significance between a single screw-fixed proximal metatarsal crescentic osteotomy and double screw-fixed proximal metatarsal crescentic osteotomy in terms of complication. The complication occurred was associated with the number of screws, but not with the clinical healing time and radiological image.

The association with the number of screws for radiological recurrence of HV may be significant since two screws provide better fixation with more forces to stabilize the first proximal metatarsal osteotomy. In other words, one screw may be not strong enough to hold the osteotomy position on the first metatarsal crescentic osteotomy. This study revealed the association between the number of screws with radiological recurrence of HV and transfer metatarsalgia. There is no evidence of association between the number of screws with clinical outcome as there was no significant difference in AOFAS score in two groups. There were some advantages of single-screw fixation over double-screw fixation, such as faster operation, low cost and lesser tissue irritation. In this study, we provided new perspective of potential association between the number of screws and radiological and clinical outcomes. Meanwhile, this study also provided some meaningful information of correction for severe HV deformity preoperative planning for other surgeon.

Limitations

There are several limitations in our study. First, the results may be deviation due to the limited number of cases. Another limitation is that the follow-up time was short, especially for complications such as MTP joint osteoarthritis, which needs longer time to occur. Evaluation of healing of the osteotomy was limited to using plane radiographs. Another limitation is the AOFAS score evaluation system including validity and reliability have never been examined.

Conclusions

The proximal first metatarsal crescentic osteotomy and distal soft tissue reconstruction improved AOFAS score and VAS score of patients operated with severe hallux valgus. No significant difference was found in the two groups regarding improvement of HVA and IMA evaluated at 4 and 12 months after operation. Within the scope of this study, double-screw fixation for proximal first metatarsal crescentic osteotomy appears superior to single scew fixation due of less complications. Therefore, double-screw fixation is a reasonable option for severe hallux valgus osteotomy treatment. The postoperative VAS score and AOFAS score were comparable with no significant difference for the two groups. In addition, double-screw fixation shows significant less complication than single screw fixation. A clinical study utilizing the dorsal plate could determine if double-screw fixation is truly superior to single screw fixation. Additional surgical procedures for HV may be considered if patients could not tolerate metatarsalgia transfer. The authors believe that stable fixation should be focus on the osteotomy site to avoid recurrent deformity and dorsiflexion angle.

Abbreviations

HV
Hallux valgus
HVA
Halluxvalgus angle

IMA
Intermetatarsal angle
AOFAS
American Orthopedic Foot and Ankle Society scores
VAS
Visual analogue scale
MTP
Metatarsophalangeal
AP
Anterior–posterior
SPSS
Statistical Package for Social sciences

Declarations

Additional Information

Competing financial interests: The authors declare no competing financial interests.

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Availability of data and materials

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Author’s contribution

Linger Wang wrote the main manuscript text. Haijiao Mao reviewed and revised the manuscript. Liwei Yao and Wenwei Dong have done with these surgery.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable.

Ethics approval and consent to participate

Ethical clearance was obtained through the Ethics Review Committee, Ethics Committee of the Affiliated Hospital of Medical School of Ningbo University and the informed consent was obtained from all participants. Data collected from participants were kept confidential and were accessible only to the researchers.

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Tables

Table 1 Comparison AOFAS scores (Group1=32，Group2=20; female=36, male=14)

AOFAS scores	Group1	Group2	*p*	male	female	*p*
Preoperative	64.3±2.54	63.1±2.31	*0.196*	64.3±2.75	63.7±2.43	*0.892*
4 months postoperatively	83.6 ±2.18	84. 1 ±1.84	*0.411*	83.1 ±2.09	84.0±2.01	*0.532*
12 months postoperatively	82.8±3.25	83.9±1.57	*0.209*	82.7±3.36	83.4±2.55	*0.103*

The *p*-values were determined using independent sample *t*-test. Significance levels are one symbol: $p < 0.05$.

Non-significant difference between preoperative AOFAS scores in group 1 and group 2.

Non-significant difference of AOFAS scores group 1 and group 2 after 4 months.

Non-significant difference of AOFAS scores in group 1 and group 2 after 12 months.

Non-significant difference of gender group 1 and group 2.

Table 2 Comparison VAS scores (Group1=32，Group2=20; female=36, male=14)

VAS scores	Group1	Group2	*p*	male	female	*p*
Preoperative	4.5±1.01	4.7±0.92	*0.606*	4.9±0.73	4.4±1.03	0.133
4 months postoperatively	2.0 ±0.73	2.1 ±0.67	*0.872*	1.9±0.62	2.2 ±0.72	0.517
12 months postoperatively	1.7± 0.43	1.7±0.55	*0.303*	1.6± 0.49	1.8± 0.47	0.291

The p-values were determined using independent sample t-test. Significance levels are one symbol: $p < 0.05$.

Non-significant difference between preoperative VAS scores e in group 1 and group 2.

Non-significant difference of VAS scores in group 1 and group 2 after 4 months.

Non-significant difference of VAS scores in group 1 and group 2 after 12 months.

Non-significant difference of gender group 1 and group 2.

Table 3 Comparison different time (Group1)(n=32)

	AOFAS	VAS	HVA	IMA
Preoperative	63.1±2.31	4.7±0.92	46.4 ±3.28	18.5 ±1.98
4 months postoperatively	84. 1 ±1.84	2.1 ±0.67	18.9 ±3.06	8.89±1.39
12 months postoperatively	83.9±1.57	1.7±0.55	19.9 ±4.70	9.25 ±1.11
F	519.23	119.27	535.68	340.20
p	<0.05	<0.05	<0.05	<0.05
p^a	0.000	0.000	0.000	0.000
p^b	0.000	0.000	0.000	0.000
p^c	0.694	0.229	0.286	0.016

p^a compare the results between preoperative with 4 months postoperatively .

p^b compare the results between preoperative with 12 months postoperatively.

p^c compare the results between 4 months with 12 months postoperatively.

Table 4 Comparison different time (Group2) (n=20)

	AOFAS	VAS	HVA	IMA
Preoperative	64.3±2.54	4.5±1.01	45.1 ±3.45	18.3 ±1.81
4 months postoperatively	83.6 ±2.18	2.0 ±0.73	17.5 ±2.97	8.34 ±1.45
12 months postoperatively	82.8±3.25	1.7± 0.43	19.1 ±4.70	9.53 ±1.70
F	776.7	95.7	343.3	247.6
p	<0.05	<0.05	<0.05	<0.05
p^a	0.000	0.000	0.000	0.000
p^b	0.000	0.000	0.000	0.000
p^c	1.000	0.268	1.000	1.000

p^a compare the results between preoperative with 4 months postoperatively .

p^b compare the results between preoperative with 12 months postoperatively.

p^c compare the results between 4 months with 12 months postoperatively.

Table 5 Comparison HVA (Group1=32, Group2=20; female=36, male=14)

HVA	Group1	Group2	p	male	female	p
Preoperative	45.1 ±3.45	46.4 ±3.28	0.749	45.9±3.60	45.4±3.39	0.762
4 months postoperatively	17.5 ±2.97	18.9 ±3.06	0.984	17.9±3.39	18.2 ±2.97	0.632
12 months postoperatively	19.1 ±4.70	19.9 ±4.70	0.647	18.6± 3.81	19.7± 4.96	0.886

The p-values were determined using independent sample t-test. Significance levels are one symbol: $p < 0.05$.

Non-significant difference between preoperative HVA in group 1 and group 2.

Non-significant difference of HVA in group 1 and group 2 after 4 months.

Non-significant difference of HVA in group 1 and group 2 after 12 months.

Non-significant difference of gender group 1 and group 2.

Table 6 Comparison IMA (Group1=32，Group2=20; female=36, male=14)

IMA	Group1	Group2	*p*	male	female	*p*
Preoperative	18.3 ±1.81	18.5 ±1.98	0.338	19.7±2.22	18.8±1.45	0.102
4 months postoperatively	8.34 ±1.45	8.89±1.39	0.913	8.1±1.70	8.7 ±1.32	0.854
12 months postoperatively	9.53 ±1.70	9.25 ±1.11	0.308	8.9± 1.07	9.6± 1.60	0.228

The p-values were determined using independent sample t-test. Significance levels are one symbol: $p < 0.05$.

Non-significant difference between preoperative IMA n group 1 and group 2.

Non-significant difference of IMA in group 1 and group 2 after 4 months.

Non-significant difference of IMA in group 1 and group 2 after 12 months.

Non-significant difference of gender group 1 and group 2.

Figures

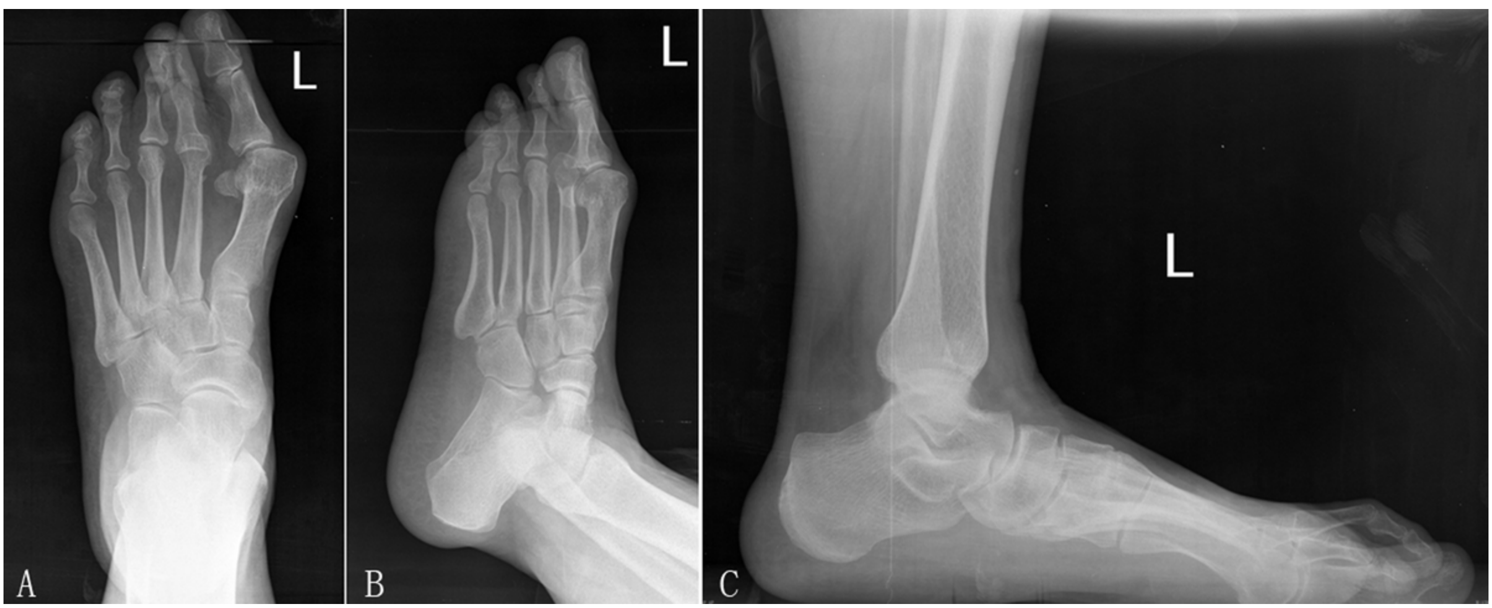

Figure 1

A preoperative radiograph showing severe hallux valgus.

The weight bearing anteroposterior (A), oblique (B)and lateral X-ray (C) of a 65-year-old woman shown with a severe hallux valgus deformity.

Figure 2

The lateral soft tissue releasing

Release the adductor hallucis tendon, the deep transverse inter-metatarsal ligament, tendon from the base of the proximal phalanx and the fibular sesamoid, the transverse inter-metatarsal ligament and the lateral capsule of the first MTP joint.

Figure 3

The medial eminence removing

An inverted “L” medial capsulotomy was used to expose the medial eminence which was removed with a sharp saw blade.

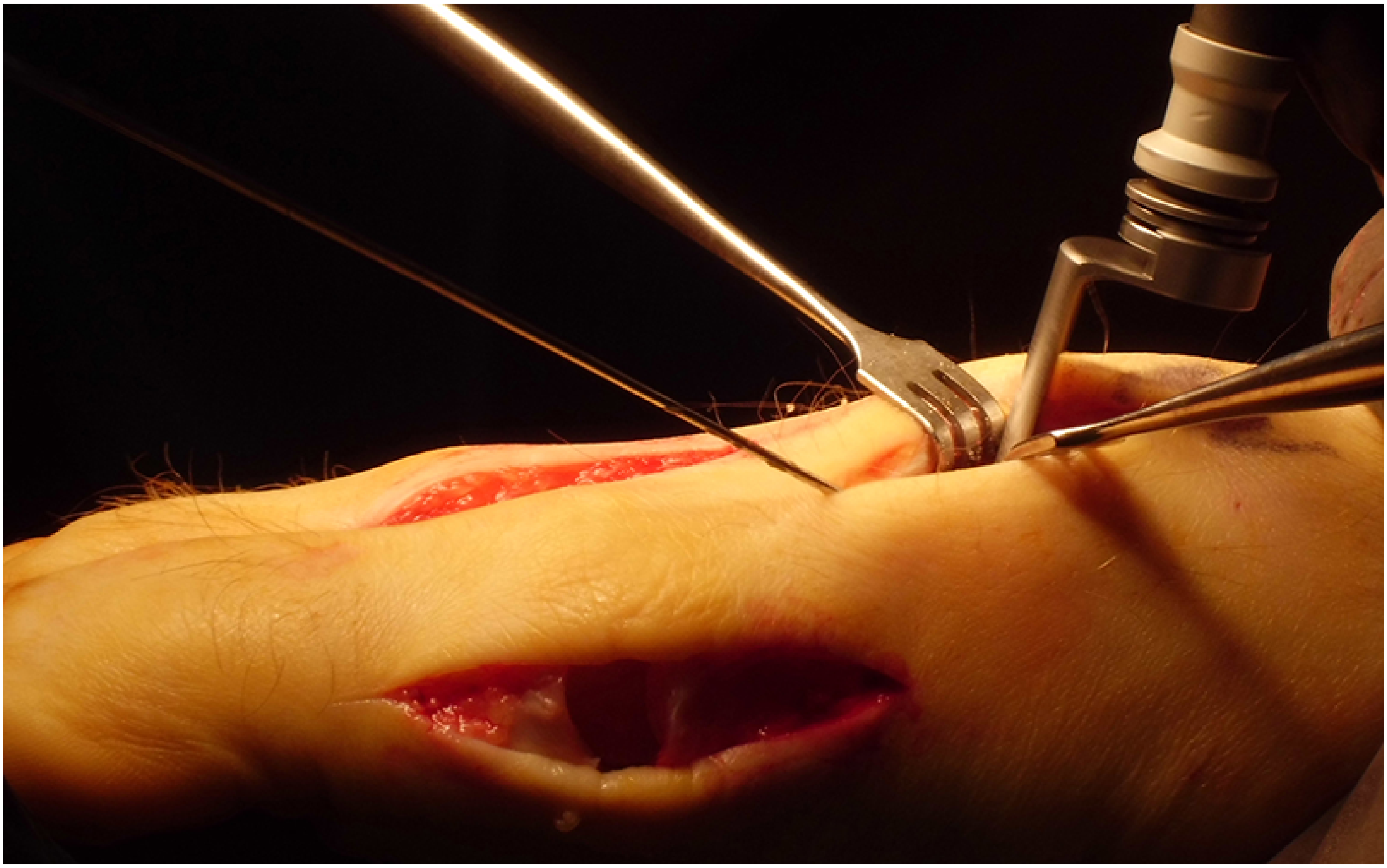

Figure 4

The crescentic osteotomy.

The crescentic blade was positioned neither perpendicular to the plantar foot nor metatarsal, but ideally approximately halfway between these two positions

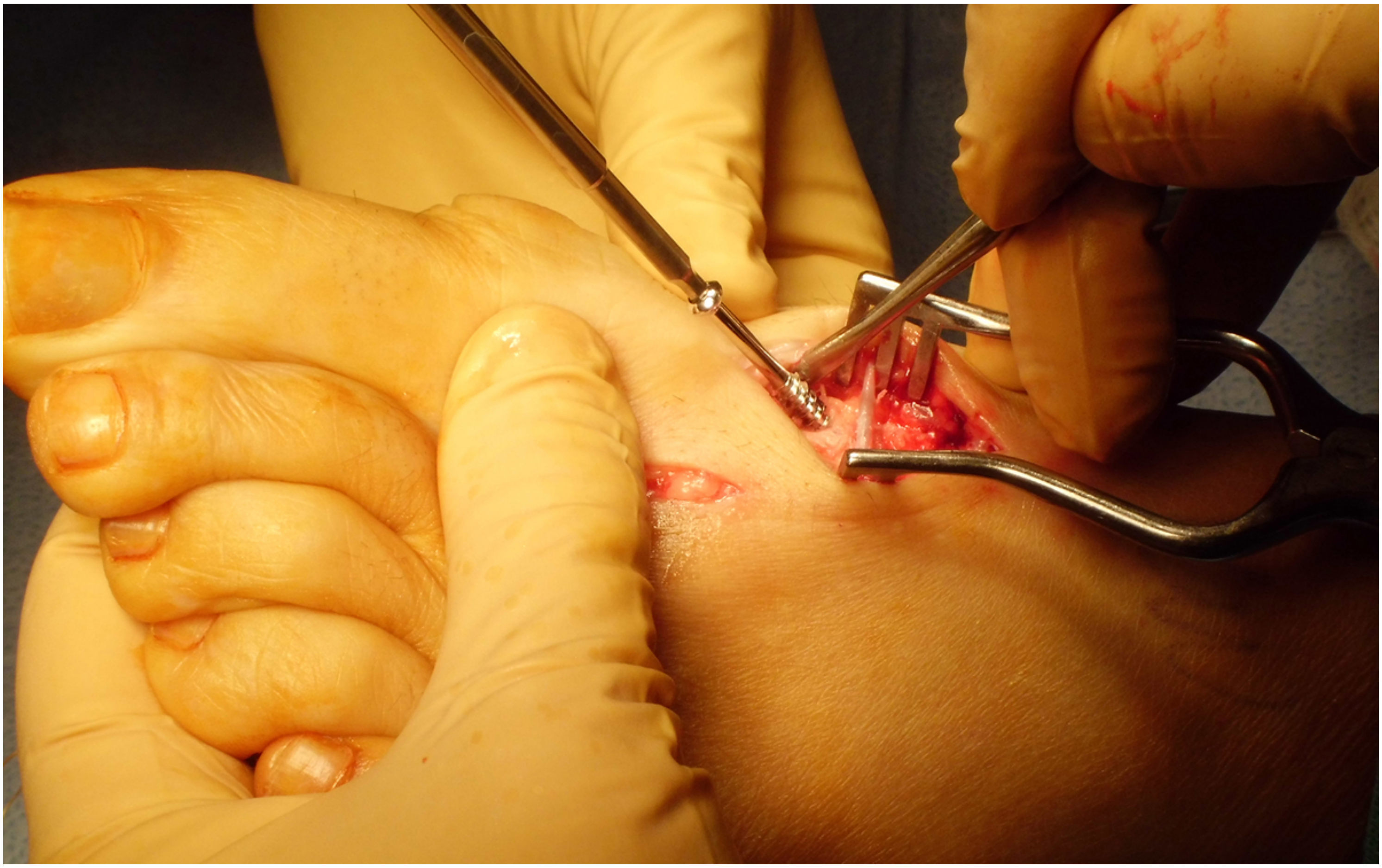

Figure 5

The first screw fixation

Using one 3 mm cannulated AO titanium (Synthes Inc, Shanghai) screw was used for stabilization, approximately 50° relative to the metatarsal shaft.

Figure 6

The second screw fixation

The other one 3 mm cannulated AO titanium screw was fixed percutaneous from distal medial to proximal lateral metatarsal shaft.

Figure 7

One patient's radiograph showing one screw for correction deformity of hallux valgus.

A: The AP radiograph of pre-operation. B: The AP radiograph of fixation with a single screw at the time of 4-month follow-up.

C: The AP radiograph of fixation with a single screw at the time of 12 -month follow-up.

Figure 8

One patient's radiograph showing two screws for correction deformity of hallux valgus.

A: The AP radiograph of pre-operation. B: The AP radiograph of fixation with two screws at the time of 4-month follow-up.

C: The AP radiograph of fixation with two screws at the time of 12 -month follow-up.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- CONSORT2010Checklist.doc
- CONSORT2010FlowDiagram.doc