Outcome of Hallux Valgus Deformity Correction Using Mitchell Osteotomy with Screw fixation

Abstract
Background: Mitchell osteotomy is one of first metatarsal distal corrective osteotomies for hallux valgus deformity. The purpose of this study was to evaluate the outcome of Mitchell osteotomy.

Methods: Eighteen patients underwent Mitchell corrective osteotomy using screw fixation for hallux valgus deformities from 2011 to 2015 were included. Clinical outcome was assessed using American Orthopedic Foot and Ankle Score, Hallux metatarsophalangeal-interphalangeal scale, (AOFAS Hallux), visual analogue score, and changes in hallux valgus and intermetatarsal angles based on standard weight-bearing radiographs, at least one year after surgery.

Results: About 95% of patients were completely satisfied. Mean of AOFAS score was 86.7 at final follow-up. The mean of changes in intermetatarsal and hallux valgus angles were 5.6 ± 3.1 and 17.0 ± 5.2 respectively. Pain of the cases based on visual analogue score decreased from 5.8 ± 0.8 preoperatively to 1.3 ± 1.2 postoperatively. There were no deep infections, nonunion or osteonecrosis of first metatarsal head.

Conclusion: Mitchell corrective osteotomy with screw fixation could be a simple and effective procedure to correct hallux valgus deformity with high levels of patient satisfaction.

Keywords: Hallux Valgus, Big Toe, Mitchell Osteotomy

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Introduction

Recognized as the most common deformity of forefoot, hallux valgus is more observed in female adults, compared to male individuals (1). Some of the factors involved in the incidence of this condition are genetic factors, improper shoes, feet deformities (e.g., hindfoot pronation in the flatness of feet), short Achilles tendon, hypermobility, and neuromuscular diseases (2,3).

Treatment for this deformity is initially non-surgical using a special thumb pad. In this regard, lack of use of high heels and tight shoes can reduce the pain created. There is no evidence for deformity correction with non-surgical treatment in these patients (1). More than 140 types of surgery exist for correction of hallux valgus deformity, none of which is the best method for all patients. These treatments include soft tissue correction, osteotomy of the first metatarsal or first phalange of the big toe, arthrodesis, and resection arthroplasty (4,5). In most of the past 50 years, the Mitchell osteotomy has been exploited as the osteotomy of the first distal metatarsal articular ankle (DMAA) (6). Considering the low number of studies on results of this type of osteotomy, especially in moderate-severe hallux valgus deformities, the present study aimed to evaluate the efficiency of this technique in correction of hallux valgus deformity in two groups with moderate-severe deformities with hallux valgus angle below 30 degrees and moderate-severe deformity with an angle above 35 degrees.
All patients undergoing Mitchell osteotomy (performed by the senior surgeon of the article) in Chamran and Ordibehesht Hospitals of Shiraz, Mashhad during 2011-2015 due to hallux valgus with no deformity of the second finger were enrolled in the study. It should be noted that the article was approved with the code of ethics of IR.SUMS.RES.1396.S85. Inclusion criteria were passing of a minimum of one year from the surgery and visit for re-examination. Exclusion criteria were unwillingness to cooperate with the research and lack of referral for re-examination. The objectives of the research were explained to the patients via phone calls. In addition, consent was obtained from all subjects prior to the research, and the researcher asked for an in-person meeting for clinical examination and taking new pictures.

The hallux valgus angle (HVA) and intermetatarsal angle (IMA) were measured preoperatively and postoperatively. In addition, the pain was assessed based on a visual analogue scale (VAS). The researcher asked that if the pain before the surgery was 10, what score would they give to their current pain level. The American Orthopedic Foot and Ankle Score (hallux metatarsophalangeal-interphalangeal scale) was applied to evaluate the final function of the first metatarsophalangeal joint of the big toe. This criteria includes three parts of pain, function and foot alignment and has a total score of 100. Qualitatively, the scores within the range of 90-100 are excellent, whereas the scores in the ranges of 80-89, 70-79, and below 70 are good, moderate, and weak, respectively[7]. In the end, patients were compared to each other in two groups: patients with a hallux valgus angle below 35 degrees before the surgery and patients with a hallux valgus angle above 35 degrees. The aim of this classification was comparing the results related to weak-moderate and moderate-severe cases.

Statistical Analysis
Data analysis was performed in SPSS version 21 using descriptive statistics, such as mean and standard deviation, for quantitative observations, and frequency and percentage methods for qualitative observations. In addition, t-test and paired sample t-test were exploited to evaluate the level of change in the hallux valgus and intermetatarsal angles. In case of abnormality of the observations, Mann-Whitney U was used. In addition, P-value of less than 0.05 was considered statistically significant.

Results
Over five years, 18 patients (2 males and 16 females) were evaluated. In the present study, the mean age of the patients was 38.5 years with a standard deviation of 16 years. In addition, the lowest and highest ages were 17 and 60 years, respectively. Moreover, the minimum and maximum follow-up duration were one and five years, respectively with a mean of 23 months. In addition, the mean and standard deviation of AOFAS was 86.7±6.2 (highest and lowest scores were 92 and 62, respectively). From 18 patients, seven (39%) were within the excellent range, 10 (55.5%) were within the good range, and one (5.5%) was in the weak range. However, two patients underwent surgical removal of hardware for internal fixation of fractured bones due to feeling the discomfort caused by the screw when wearing shoes. There was no report of deep infection, osteonecrosis of the first metatarsal head, transfer metatarsalgia, and nonunion. In the end, 94.5% of the patients were satisfied with the surgical outcomes. The level of changes in IMA and HAV and pain VAS before and after the surgery are presented in Table 1.

Patients with Hallux Valgus Angle below 35 Degrees
Upon admission, 11 patients had a hallux valgus angle below 35 degrees. Mean and
standard deviation of preoperative and postoperative angles are shown in Table 2. In this study, all results were significant considering P<0.001 in all cases. The mean AOFAS scores in these patients after surgery was 87.8 with a standard deviation of 2.6.

<table>
<thead>
<tr>
<th>Table 1. Mean Radiographic and Pain Changes in Patients before and after the Surgery</th>
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<tbody>
<tr>
<td>Before Surgery</td>
</tr>
<tr>
<td>IMA</td>
</tr>
<tr>
<td>15.9±3.7</td>
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<td>10.3±1.0</td>
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</tbody>
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HVA: Hallux valgus angle, IMA: Intermetatarsal angle, VAS: Visual analogue score

Patients with Hallux Valgus Angle above 35 Degrees
In total, seven patients had hallux valgus angle above 35 degrees before surgery. In addition, mean AOFAS scoring criterion in these patients after surgery was 85.0±3.6. Considering P<0.001 for all cases, the results were reported to be significant. Other results are presented in Table 3.

<table>
<thead>
<tr>
<th>Table 2. Mean Radiographic and Pain Changes in Patients with Hallux Valgus Angle below 35 Degrees upon Admission</th>
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<tbody>
<tr>
<td>Before surgery</td>
</tr>
<tr>
<td>IMA</td>
</tr>
<tr>
<td>15.9±3.8</td>
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<tr>
<td>10.1±1.0</td>
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</tbody>
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HVA: Hallux valgus angle, IMA: Intermetatarsal angle, VAS: Visual analogue score

<table>
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<tr>
<th>Table 3. Mean Radiographic and Pain Changes in Patients with Hallux Valgus Angle above 35 Degrees upon Admission</th>
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<tbody>
<tr>
<td>After surgery</td>
</tr>
<tr>
<td>IMA</td>
</tr>
<tr>
<td>16.0±0.39</td>
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<td>10.5±1.1</td>
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HVA: Hallux valgus angle, IMA: Intermetatarsal angle, VAS: Visual analogue score

Discussion
In the present research, the results of Mitchell osteotomy were acceptable both in patients with mild deformity and individuals with moderate-severe deformities, which is in line with previous studies (8,9). In the current research, 94.5% of the patients were completely satisfied with the results, which was more efficient, compared to the results obtained by Dennis et al (10). This lack of consistency between the results might be due to internal fixation of the distal part with screws, which improved the stability of the osteotomy site and thus prevented the loss of postoperative deformity correction.

In the present study, while the number of patients with severe deformity was lower, compared to the group with hallux valgus angle below 35 degrees, similar results were obtained for both groups, which is a sign of the effectiveness of Mitchell osteotomy in severe cases of hallux valgus.

There is a wide range of discussions regarding the transfer metatarsalgia following Mitchell osteotomy (8,11,12), which might be due to an excessively short first metatarsal and dorsiﬁexion of the distal segment. The chance of metatarsalgia and transition of pressure to the head of the lateral metatarsal of the leg during walking decreased when the first author of the article made a 10-degree plantar ﬁxation of the distal segment before ﬁxation with screws during the surgery. In addition, the shortness of the first metatarsal was approximately three mm during the surgery, which reduced the chance of metatarsalgia and patient dissatisfaction. In addition, it was claimed in a research that the osteotomy of other metatarsals along with Mitchell osteotomy of the first metatarsal had no impact on the transfer level of metatarsalgia (12).

In the current research, a thumb spica splint was applied immediately after plaster cast, which increased the chance of union by preventing the displacement of the distal
segment. Therefore, there was no patient with nonunion of the distal segment. Blood supply to the first metatarsal head is carried out intramedullary and extramedullary. In this respect, over-manipulation of the soft tissue and release of the lateral capsule cause damage to the extramedullary arteries. Therefore, Mitchell osteotomy is prone to osteonecrosis of the metatarsal head. In the present study, there was no report of osteonecrosis of the first metatarsal head, which is consistent with the results obtained by Dennis et al\textsuperscript{(10)}. However, 3% of the patients in the mentioned research had superficial pin site infections due to fixation with a pin and bending it on the skin. In a research by Dermon et al\textsuperscript{(13)}, in 2009, one patient suffered from osteonecrosis of the first metatarsal head, and 2.5% of patients required re-operation, which might be due to lateral soft-tissue along release with Mitchell osteotomy in cases with a hallux valgus angle above 35 degrees and probably pin fixation and improper correction during the surgery. One of the causes of lack of osteonecrosis in our patients was lack of lateral soft-tissue release. Prolonged duration of surgery and over- manipulation of the soft tissue (e.g., using plates for fixation at osteotomy site) can lead to complications in the would union. Kalender et al\textsuperscript{(14)} evaluated the Mitchell osteotomy and fixation by mini-plates. According to these researchers, one patient experienced wound dehiscence and infection. However, no such complications were observed in the current research due to shorter duration of surgery and less manipulation.

According to Huang et al\textsuperscript{(15)}, deformity recurrence is considered when the HVA after Mitchell osteotomy is above 20 degrees along with a correction level below 10 degrees. While no recurrence was reported in the present study, one patient experienced deformity recurrence in the research by Huang. Recurrence following surgical correction of hallux valgus can have various causes, including insufficient displacement to the lateral distal segment, technical problems, and incompetence of the surgeon. One of the major drawbacks of the present study was lack of referral of some patients for evaluation and participation in the research.

**Conclusion**

Mitchell osteotomy with screw fixation is a simple and beneficial method for correcting the deformity of hallux valgus, which can increase satisfaction not only in patients with mild deformity but also in those with severe deformity.

**Conflicts of Interest**

None.

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**References**