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MIČELOVA I GOLĐENOVA METATARZALNA OSTEOTOMIJA U LEČENJU UMERENIH DEFORMITETA ČUKLJEVA: UPOREDNA ANALIZA

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Mitchell and Golden metatarsal Osteotomies for the Treatment of Moderate Hallux Valgus Deformity: A Comparative Analysis
Mičelova i Goldenova metatarzalna osteotomija u lečenju umerenih deformiteta čucljeva: Uporedna analiza

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Mitchell and Golden metatarsal Osteotomies for the Treatment of Moderate Hallux Valgus Deformity: A Comparative Analysis

SAŽETAK

Uvod/Cilj: Svrha rada je poređenje postoperativnih rezultata postupaka po Mitchellu i Goldenu u lečenju umerenih deformiteta hallux valgusa. Metode: U opservacionoj studiji kontrole slučajeva (Case control) je učestvovalo 49 pacijenata (81 stopalo) operisanih distalnom osteotomijom I metatarzialne kosti po Mitchellu i 49 pacijenata (77 stopala) operisanih proksimalnom osteotomijom I metatarzialne kosti po Goldenu. Za procenu rezultata lečenja korišćene su: Klasifikacija po Boney i McNabu modifikovana po Helalu i Haluks Metatarzofalangealni Interfalangealni Skor - Hallux Metatarsophalangeal Interphalangeal Score (HMIS). Rađena je statistička analiza rezultata, a vrednosti p<0.05 su uzete kao statistički značajne. Rezultati: Oba hirurška postupka su pokazala uspešne statistički visoko značajno bolje postoperativne rezultate u odnosu na preoperativne (p<0.001). Poređenjem rezultata Mitchellovog i Goldenovog postupka prema klasifikaciji po Bonney i McNabu modifikovanoj po Helalu pokazano je da postoji visoko statistički značajna razlika u korist postupka po Mitchellu (p<0.001), a poređenjem na osnovu HMIS-a da ne postoji statistički značajna razlika (p=0.123). Analiza procene rezultata oba postupka na osnovu vrednosti halus-valgus ugla, intermetatarzialnog ugla, pozicije sezamoida, dužine imobilizacije, trajanja lečenja i na osnovu komplikacija je pokazala da postoji visoko statistički značajna razlika u korist postupka po Mitchellu (p<0.001), dok je procena vrednosti skraćenja prve metatarzialne kosti pokazala da je skraćenje izraženije kod postupka po Mitchellu (p<0.001), što ide u prilog Goldenovoj metodi. U pogledu pokreta palca operisanih stopala nije postojala statistički značajna razlika (p=0.723) između dva postupka. Zaključak: Na osnovu obavljenih istraživanja konstatuje se da su oba postupka pokazala dobre postoperativne rezultate. Poređenjem rezultata oba postupka došlo se do zaključka da su rezultati Mitchellovog postupka bolji u odnosu na Goldenov postupak.

Keywords: Hallux valgus, Mitchell osteotomy, Golden osteotomy
ABSTRACT

Background: The purpose of the study is to compare postoperative results of Mitchell versus Golden methods of treating moderate hallux valgus deformity.

Methods: Observational Case control study included 49 patients (81 feet) who had the Mitchell distal metatarsal osteotomy performed, and 49 patients (77 feet) that had the Golden proximal metatarsal osteotomy performed. The results of treatment were evaluated using Hellal’s modification of Bonney and McNab classification and Hallux Metatarsophalangeal Interphalangeal Score (HMIS). Statistical analysis of the results was done, thus the values p<.05 were considered statistically significant.

Results: Both operative procedures showed successful and statistically significant postoperative results compared to preoperative status (p<.001). Comparative analysis of the results from Mitchell and Golden procedures, according to Hellal’s modification of Bonney and McNab classification, has proven that there was highly statistically significant difference in favor of Mitchell method (p<.001); whereas comparison based on HMIS showed no statistically significant difference (p=.123) between the two methods. Estimated results analysis of both procedures, based on the values of hallux valgus angle, intermetatarsal angle, sesamoid position, length of immobilization, treatment duration, and complications demonstrated that there was highly significant difference in favor of Mitchell method (p<.001), whereas the value of the shortening of the first metatarsal bone indicated that the shortening was greater in Mitchell method (p<.001), which goes in favor of Golden method. Regarding the flexion of the thumb of the feet operated on, there was no statistically significant difference (p=.723).

Conclusion: The examinations performed indicated that both methods showed good postoperative results, but in Mitchell method they were better.

Keywords: Hallux valgus, Mitchell osteotomy, Golden osteotomy
INTRODUCTION

Hallux valgus deformity shows high prevalence among general population. Depending on the age, the incidence rate of the deformity goes from 7.8% among youth under the age of 18, to 35.7% among those over 65 years old. As for the population between the ages of 18 and 65, the deformity incidence rate is 27%. Hallux valgus deformity progression can lead to gradual loss of function of the forefoot, resulting in decreased quality of patient’s life. The treatment of hallux valgus deformity can be carried out by nonoperative and operative procedures. For lack of effectiveness of nonoperative procedures, in the majority of cases the treating of deformity concludes with operative procedure. The objective of the operative treatment of the deformity is to get a pain-free, functioning and aesthetically pleasing foot. Surgical correction of the deformity can relieve the pain, prevent further progression of the condition and restore the function of the foot. There is a vast number of operative procedures for treating bunions, which clearly supports the observation that there is no single method that could resolve all clinical varieties of this deformity. The osteotomy that is commonly used is made in the distal first metatarsal bone. Distal metatarsal osteotomy is recommended, primarily, to correct mild to moderate deformities when there are no arthritic malformations of the first metatarsophalangeal joint. This osteotomy manages to correct most of the components of the deformity: Hallux valgus angle (HVA), Intermetatarsal angle (IMA), sesamoid position and the length of the first metatarsal bone. Proximal metatarsal osteotomy is used in the operative treatment of moderate and severe hallux valgus deformity.

In medical literature there is no a definite opinion on whether it is better to perform distal or proximal metatarsal osteotomy with distal soft tissue procedure for treating moderate deformities (HVA of 25° to 40° and IMA of 13° to 20°).

The objective of the study was to estimate the effects of Mitchell and Golden procedures respectively, also by comparing the two methods, in order to determine which procedure should be given the advantage, in correcting moderate hallux valgus deformities. The hypothesis or the main premise of the study is that Mitchell method gives better results than Golden method of operative treating of moderate hallux valgus deformity.
MATERIALS AND METHODS

Observational case control study was conducted in patients with moderate hallux valgus deformity who underwent the procedure at the Department of Orthopaedics of Clinical Hospital Center, KBC "Zvezdara" during the period from January, 2007, to February, 2013. Two directions were applied: corrective distal metatarsal osteotomy by Mitchell and corrective proximal metatarsal osteotomy by Golden. (Fig. 1 and 2)

Fig. 1. Fig. 2.

Mitchell method
Distal metatarsal osteotomy was performed according to Mitchell procedure which includes subcapital osteotomy of the first metatarsal bone with medial translation of the distal fragment with thread fixation in the corrected position. In the postoperative period the operated foot is immobilized with a short walking cast shoe, with an opening in the wound region for postoperative wound care and check-ups. Decision on removing the cast immobilization is made after the X-ray scan and clinical assessment, in about 5 weeks. After the cast immobilization is removed, the physical therapy may begin.

Golden Method
Golden osteotomy includes wedge osteotomy of the base of the first metatarsal bone using wedge base laterally and on the plantar side, where the fragment fixation is enabled by a single Kirschner wire. In addition, thumb adductor tenotomy of the foot was performed through another approach using a different cut (Fig. 3). Postoperatively, a walking cast shoe is placed onto the operated foot and after 5 to 7 weeks it is removed and physical therapy begins (Fig. 4).

Fig. 3. Fig. 4.

The number of patients who were operated on was 110, but 12 of them were not part of the study. Furthermore, 5 of those 12 patients didn’t get regular check-ups, 4 did not wish to join the study, and 3 patients were excluded from the study due to the presence of comorbidity (2 patients with rheumatoid arthritis and 1 patient with neuromuscular disorder).
The research involved two study groups. One study group included 49 patients (81 feet) who had Mitchell procedure. The other study group included 49 patients (77 feet) that had Golden procedure.

In forty-nine patients who were operated on by Mitchell method, 43 patients (87.8%) were female and 6 (12.2%) were male. Mean age was 52 years (range, 26-67). In 32 patients (65.3%) both feet were operated on. Surgery was performed on the left foot in 43 cases (53.1%), and on the right foot in 38 (46.9%).

In forty-nine patients who had Golden procedure performed, 46 (93.9%) were female, and 3 (6.1%) were male. Mean age was 51 years (range, 23-77). In 28 patients (57.1%) both feet were operated on. Surgery was performed on the left foot in 33 cases (42.9%), and on the right foot in 44 (57.1%). (Table 1.)

Table 1.

The mean follow-up for all patients was 3 years and 4 months (1.5 – 6.2 years).

The study was approved by the Ethics Committee of KBC “Zvezdara” in Belgrade. The ethical principles of The Declaration of Helsinki were respected in the conduct of this research. Each foot was treated as an independent case. Data were obtained before, during and after the treatment by recommendations of the American Orthopaedic Foot and Ankle Society (AOFAS).25

Inclusion criteria that qualified patients to be part of the study were determined: patients with moderate hallux valgus deformity: the presence of hallux valgus deformity which had been previously nonoperatively treated: patients with no degenerative changes in the first metatarsophalangeal joint. Exclusion criteria were: patients who had prior hallux valgus deformity procedure; patients with neuromuscular disorders and rheumatoid arthritis; patients under the age of 18.

The assessment of results was performed according to Hellal’s modification of the Bonney and McNab classification criteria13 and Hallux Metatarsophalangeal Interphalangeal Score (HMIS).14

The analysis of results was based on preoperative and postoperative assessment of HVA, IMA, sesamoid position and the first metatarsal bone length, using the lateral and dorsoplantar weightbearing foot radiograph projection. Furthermore, these factors were
taken into account: movements in the first metatarsophalangeal joint, length of postoperative immobilization, treatment duration and complications (infections, relapses, pain i.e.-metatarsalgia).

The sesamoid position was determined by the position of the medial sesamoid in relation to a line drawn through the mid-longitudinal axis of the first metatarsal bone on the dorsoplantar radiography (0 normal position, 1 less than 50% overlap, 2 more than 50% overlap, lateral luxation).29

Dorsoplantar movement in the first metatarsophalangeal joint was measured using a goniometer before and after the operative treatment.

The assessment of the subjective well-being of patients in the postoperative period was conducted by 3 orthopaedic surgeons with more than 6 years of specialist experience in practice, who were not involved in the operative treatment. The aforesaid physicians were not acquainted with the strategy and the results of the study.

Data are presented as count (%) or mean (+/-sd), depending on data type. Chi-square test, t-test and Mann-Whitney U test were used to compare nominal and numerical variables between the groups. Changes in (HVA, IMA, sesamoid position, shortening of the first metatarsal bone, movements of the metatarsophalangeal joint) were calculated as the difference between the first and the last measurement and then compared to t-test and Mann-Whitney U test between the groups, depending on data distribution. All values of p<0.05 were considered significant. Statistical analysis was performed in SPSS 20.0 (IBM corp.).

RESULTS

All of the preoperative values classified according to Hellal’s modification of Bonney and McNab criteria, showed poor results in patients from both groups. Poor results were indicated as well in the preoperative values classified using HMIS.

The analysis of results based on the two mentioned scoring systems, showed that improvement has been made with both applied procedures compared to preoperative state/condition. There was a statistically highly significant difference in scores before and after the procedure in favor of the postoperative findings for both operative procedures (p<0.001).

According to Hellal’s modification of Bonney and McNab classification, in patients who underwent Mitchell procedure, 78 (96%) feet showed improvement postoperatively. Twenty-nine (36%) of that number of feet revealed excellent results, 49 (60%) showed
good, and in 3 (4%) feet poor results were seen. Patients who had Golden procedure demonstrated improvement in 71 (92%) feet. Twenty-three (30%) feet revealed excellent, 48 (62%) good, and 6 (8%) poor results. Statistical analysis of the significant difference classified by Hellal’s modification of Bonney and McNab criteria before and after operation, indicated that when the two surgical procedures were compared, there was statistically highly significant difference in favor of Mitchell compared to Golden procedure (p<0.001).

Preoperative score according to AOFAS scale was 48.46±4.91 points in Mitchell group, and 48.47±5.08 points in Golden group (p=0.989). Postoperative results according to HMIS were improved to 95.85±8.08 in Mitchell group, whereas in Golden group they increased to 93.44±11.48 points (p=0.123). The results in Mitchell group were excellent in 59 (72.8%) feet, good in 16 (19.8%), satisfactory in 4 (4.9%) and poor in 2 (2.5%). Good and excellent results were revealed in 75 (92.6%) of the operated feet. The results observed in Golden group were excellent in 53 (68.8%) feet, good in 15 (19.5%), satisfactory in 3 (3.9%), and poor in 6 (7.8%).

Statistical analysis of the significant difference classified by HMIS score scale before and after operation, indicated that when the two directions of the procedure were compared, there was no statistically significant difference in the results of both procedures (p=0.123).

(Table 2).

Table 2.
The assessment of significance of the differences in HVA, IMA, sesamoid position, shortening of the first metatarsal bone before and after operationes demonstrated statistically highly significant difference in favor of the obtained postoperative values in both operative procedures (p<0.001)

The analysis of dorsoplantar flexion of the thumb has proven to have highly statistically significant better results in both methods postoperatively (p<0.001).

A greater correction in the HVA was found in Mitchell group (21.85±2.15) compared to Golden group (19.66±3.31) (p<0.001). IMA was more reduced in Mitchell group (7.83±1.07) relative to Golden group (6.86±1.690p<0.001). Sesamoid position correction was more improved by Mitchell method (1.30±0.06) versus Golden method (1.20±0.11) (p<0.001). Shortening of the first metatarsal bone was greater in Mitchell group (4.87±0.729) compared to Golden group (2.97±0.77) (p<0.001).
Using Mitchell method, dorsoplantar flexion of the thumb was increased from 40.41±6.13° to 76.56±9.64°, and by using Golden method it was increased from 39.01±4.64° to 74.71±6.12°. Dorsoplantar flexion of the thumb was more improved by Mitchell method (36.15±9.32°) compared to Golden (35.70±6.06°) and the difference in results was not statistically significant. (p=0.723) (Table 1).

Cast removal and physical therapy in Mitchell group followed 37.1±1.3 days after the procedure, and in Golden group it was 44.1±1.3 days after the procedure (p<0.001). Patients returned to regular life activities (end of treatment) in Mitchell group within the period of 57.1±1.3 days after the beginning of a treatment, and in Golden group it was within 68.1±1.3 days (p<0.001)(Table 2).

In Mitchell group 2 patients developed superficial wound infections, whereas in Golden group it was the case with 5 feet (p=0.268).

One patient in Mitchell group showed total relapse of their deformity, while in Golden group it was 3 feet (p=0.358) (Table 3).

Table 3.

Preoperative symptoms of metatarsalgia were observed in 41 (51%) feet in Mitchell group and postoperatively in 19 (16%) feet (p=0.741). In Golden group preoperative metatarsalgia was observed in 41 (53%) feet, and postoperatively in 18 (23%) feet (p=0.246) (Table 4).

Table 4.

**DISCUSSION**

Hallux valgus is the result of complex deviation in the structure and the function of the foot. In the operative treatment of moderate hallux valgus deformity distal and proximal metatarsal osteotomies are performed, and those procedures enable correction of most of the components of feet deformities. The purpose of the study was to compare distal metatarsal osteotomy by Mitchell to the proximal metatarsal osteotomy by Golden within roughly similar groups of patients.

Treating moderate and severe hallux valgus using nonoperative methods is, predominantly insufficient. The effects of the treatment of hallux valgus deformity are that much better if the patient undergoes surgery at the early stages of the disease, that is, before any arthritic changes appears in the first metatarsophalangeal joint.
Regardless of the fact that both were introduced the same year (1958), Golden method never became widely popular in treating hallux valgus unlike method by Mitchel.\textsuperscript{1} We haven’t found a study that compares these two methods in scientific literature.

Some limitations of this study pertain to multiple surgeons having performed the procedures, as well as the fact that two procedures performed in different rays of the first metatarsal bone were compared.

General preoperative status evaluation score was poor in all of the feet. Postoperatively, according to Hellal’s modification of Bonney and McNab classification, general status was improved in 78 (96%) feet in Mitchell group. The observed improvement represents the sum of excellent and good outcomes which is in correlation with the results provided by other authors. According to HMIS, improvement was demonstrated in 79 (97,5%) feet. Other authors indicated that in patients who had Mitchell method performed, 92 % of cases revealed good and excellent results.\textsuperscript{11,27}

Using Hellal’s modification of Bonney and McNab classification, it was observed that general status in Golden group improved in 71 (92,2%) feet, whereas according to HMIS, it was the case with 79 (97,4%) feet. Excellent results were obtained in 68 (88,3%) feet. In study of his own, Golden reported good and excellent outcomes in 78% of cases.\textsuperscript{13}

In patients who underwent the procedure by Mitchell method, the mean HVA correction of 21.85±2.15° was obtained, whereas in the IMA the mean correction was 7.83±1.07° which coincides with the findings of most of the authors who reported the correction in the HVA from 10 to 25°\textsuperscript{2,3,11,28} and IMA from 5 to 10°\textsuperscript{2,3,9,28}. In patients who had Golden, the mean correction of HVA and IMA was 19.66±3.31°, that is 6.86±1.69°, respectively, which is by 2.19°, that is, by 0,9° less than what was observed in Mitchell method. The values of obtained results are approximate results of other authors.\textsuperscript{10,18}

Malik J and Methison I indicated the importance of a role that sesamoid position play, along with radiographic images and IMA, in estimating hallux valgus deformity.\textsuperscript{16}

Sesamoid position in patients who underwent the procedure in Mitchell group changed from position 2 to position 0, and in Golden group it changed from position 2 to position 1. Some authors have indicated the importance of shortening of the first metatarsal bone in deformity correction procedure.\textsuperscript{5} Shortening of the first metatarsal bone in Mitchell procedure was 4.87±7.20 mm, whereas in Golden method it was 2.97±7.70 mm. As some authors suggest, shortening the first metatarsal bone to a greater extent can be one of the main causes of metatarsalgia. Merkel KD suggests that shortening the bone by more than
10 mm can cause metatarsalgia.\textsuperscript{19} Baba AN has observed metatarsalgia in patients who had the bone shortened by more than 8 mm and chronic pain in patients who had their metatarsal bone shortened by more than 10 mm.\textsuperscript{1} A number of authors do not support the concept that there is a correlation between metatarsalgia and the shortening of the first metatarsal bone.\textsuperscript{4,17} In our study, preoperative metatarsalgia in Mitchell group was detected in 51\% of feet, whereas in Golden group it was found in 53\% of feet. Other authors reported the incidence of preoperative metatarsalgia in 33\% of patients and 40\% of patients, respectively.\textsuperscript{24,25} In patients who had Mitchell procedure, metatarsalgia was found postoperatively in 13 feet (16\%), and in patients who underwent Golden procedure, it was the case with 18 feet (23\%). Some authors have indicated postoperative incidence of metatarsalgia in 27\% of cases.\textsuperscript{15} During this research no correlation between the shortening of the first metatarsal bone and incidence of metatarsalgia was found.

Removal of cast immobilization and the beginning of physical therapy in Mitchell group was performed after the mean time of 37.1±1.3 days. The reported outcome was in correlation with the results obtained by other authors who removed the cast in patients who underwent Mitchell procedure 5 to 7 weeks after the surgery.\textsuperscript{14} Removal of cast immobilization and the beginning of physical therapy in Golden group followed after the mean time of 44.1±1.3 days. In his study, Golden indicated that he preferred to remove the cast immobilization and start physical therapy 6 weeks after the procedure.\textsuperscript{12} Longer cast immobilization in Golden group is required for the relatively poorer fixation stability of the bone fragments secured with Kirschner wire.

Pain that occurs as a consequence of deformity and affects regular life activities of patients, is the main reason they decide to undergo the operative treatment. In 90.1\% of the patients who had Mitchell procedure, pain disappeared completely. These results are comparable to other author’s findings who reported the loss of pain in 80-95\% of the operated patients.\textsuperscript{7,8,22} In patients who underwent the procedure by Mitchell approach, chronic pain was observed in 3 cases, while in patients who had Golden method performed, chronic pain occurred with 6 feet.

**CONCLUSION**

Fig. 5.
Fig. 6.
The study has indicated that two different osteotomy, by Mitchell and by Golden, can achieve good clinical and radiographic results. Estimated treatment outcomes measured by two scoring systems, as well as other observed parameters: HVA; IMA; sesamoid position; metatarsalgia; complications; length of treatment, suggest that operative treatment of moderate hallux valgus deformity by Mitchell method provides better results. Whereas the value of the shortening of the first metatarsal bone indicated that the shortening was greater in Mitchell method, which goes in favor of Golden method. Regarding the flexion of the thumb of the feet operated on, there was no statistically significant difference.
Using sutures for maintaining position after Mitchell osteotomy, can eliminate the need for second surgery (removal of foreign body) which decreases the incidence of infections. In Golden method, stabilizing Kirschner wire requires removal at 5 weeks postoperatively, which entails prolonged treatment, and additional intervention, thus increased risk of infection.
Incidence of an infection in Mitchell method was also decreased by using single-incision in correcting deformity (Golden method uses two–incision technique).

REFERENCES


Table 1. General characteristics of the analyzed patients and feet and values of the radiographic outcomes before and after the surgery: Hallux valgus angle (HVA), Intermetatarsal angle (IMTA), sesamoid position, and shortening of the first metatarsal.

<table>
<thead>
<tr>
<th>Type of Surgery</th>
<th>Mitchell</th>
<th>Golden</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>49</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Bilateral operations</td>
<td>32 (65.3%)</td>
<td>28 (57.1%)</td>
<td>.407&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Number of feet</td>
<td>81</td>
<td>77</td>
<td></td>
</tr>
<tr>
<td>Age at surgery (years)</td>
<td>50.5±11.4</td>
<td>52.4±14.1</td>
<td>.470&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Number female</td>
<td>43 (87.8%)</td>
<td>46 (93.9%)</td>
<td>.487&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Number left side</td>
<td>43 (53.1%)</td>
<td>33 (42.9%)</td>
<td>.980&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Number both sides</td>
<td>32 (65.3%)</td>
<td>28 (57.1%)</td>
<td>.407&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Before surgery</td>
<td>33.99±3.60</td>
<td>34.47±3.71</td>
<td></td>
</tr>
<tr>
<td>After surgery</td>
<td>12.14±1.80</td>
<td>14.81±1.58</td>
<td>&lt;.001&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Difference (after - before)</td>
<td>21.85±2.15*</td>
<td>19.66±3.31*</td>
<td>&lt;.001&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>IMA (degrees)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before surgery</td>
<td>15.10±1.66</td>
<td>15.47±2.08</td>
<td>.223&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>After surgery</td>
<td>7.27±1.17</td>
<td>8.61±1.16</td>
<td>&lt;.001&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Difference (after - before)</td>
<td>7.83±1.07*</td>
<td>6.86±1.69*</td>
<td>&lt;.001&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Sesamoid position (values 0 - 3)</td>
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<td></td>
<td></td>
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<tr>
<td>Before surgery</td>
<td>2.19±.17</td>
<td>2.30±.19</td>
<td>&lt;.001&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>After surgery</td>
<td>0.90±.14</td>
<td>1.09±.12</td>
<td>&lt;.001&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Difference (after - before)</td>
<td>1.30±.06*</td>
<td>1.20±.11*</td>
<td>&lt;.001&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Shortening of the first metatarsal</td>
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<td></td>
<td></td>
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<tr>
<td>Before surgery (mm)</td>
<td>67.18±6.80</td>
<td>66.90±6.20</td>
<td>&lt;.001&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>After surgery (mm)</td>
<td>62.31±5.00</td>
<td>63.93±6.90</td>
<td>&lt;.001&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Difference (after - before)</td>
<td>4.87±7.20*</td>
<td>2.97±7.70*</td>
<td>&lt;.001&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Dorsi plantar move. of the thumb</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before (degrees)</td>
<td>40.41±6.13</td>
<td>39.01±4.64</td>
<td>.111&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>After (degrees)</td>
<td>76.56±9.64</td>
<td>74.71±6.12</td>
<td>.017&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>difference (after-before)</td>
<td>36.15±9.32*</td>
<td>35.70±6.06*</td>
<td>.723&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup>T test  <sup>b</sup>Mann-Whitney U test  <sup>c</sup>Chi-square test  *Significant difference before-after
Table 2. The analysis of preoperative and postoperative results of Mitchell and Golden osteotomies according to Hellal’s modification of Bonney and McNab classification in percentage, and HMIS in points

<table>
<thead>
<tr>
<th>Type surgery</th>
<th>Mitchell</th>
<th>Golden</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of feet</td>
<td>81</td>
<td>77</td>
<td></td>
</tr>
</tbody>
</table>

**Good results**

- **Bonney and McNab (percentage)**
  - Preop: 0 (0%) 0 (0%)
  - Postop: 78 (96.3%) 71 (92.2%) <.001<sup>c</sup>

- **HMIS (points)**
  - Preop: 48.47±5.08 48.46±4.91 .989<sup>a</sup>
  - Postop: 95.85±8.08 93.44±11.48 .123<sup>a</sup>

**Postoperative results**

- **Bonney and McNab (percentage)**
  - Excellent: 29 (35.8%) 23 (29.9%) .320<sup>b</sup>
  - Good: 49 (60.5%) 48 (62.3%) .320<sup>b</sup>
  - Poor: 3 (3.7%) 6 (7.8%) .320<sup>b</sup>

- **HMIS (percentage)**
  - Excellent: 59 (72.8%) 53 (68.8%) .323<sup>b</sup>
  - Good: 16 (19.8%) 15 (19.5%) .323<sup>b</sup>
  - Satisfactory: 4 (4.9%) 3 (3.9%) .323<sup>b</sup>
  - Poor: 2 (2.5%) 6 (7.8%) .323<sup>b</sup>

**Duration of immobilization and beginning of physical therapy (days)**

- 37.1 ± 1.3 44.1 ± 1.3 <.001<sup>a</sup>

**Returning to regular life activities (days)**

- 57.1±1.3 68.1±1.3 <.001<sup>a</sup>

<sup>a</sup>T test  <sup>b</sup>Chi-square test  <sup>c</sup>Significant difference before-after
### Table 3. Complications after surgery

<table>
<thead>
<tr>
<th>Type surgery</th>
<th>Mitchell</th>
<th>Golden</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of feet</td>
<td>81</td>
<td>77</td>
<td></td>
</tr>
<tr>
<td>Superficial infections</td>
<td>2 (2.5%)</td>
<td>5 (6.5%)</td>
<td>.268</td>
</tr>
<tr>
<td>Recurrence of hallux valgus</td>
<td>1 (1.2%)</td>
<td>3 (3.9%)</td>
<td>.358</td>
</tr>
</tbody>
</table>

*Chi-square test

### Table 4. Pre- and Postoperative Metatarsalgia Comparison

<table>
<thead>
<tr>
<th>Group</th>
<th>Total</th>
<th>Metatarsalgia</th>
<th>With Metatarsalgia</th>
<th>No Metatarsalgia</th>
<th>With Metatarsalgia</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitchell`s</td>
<td>49</td>
<td>40 (49%)</td>
<td>41 (51%)</td>
<td>68 (84%)</td>
<td>13 (16%)</td>
<td>.741</td>
</tr>
<tr>
<td>Golden</td>
<td>49</td>
<td>36 (47%)</td>
<td>41 (53%)</td>
<td>59 (77%)</td>
<td>18 (23%)</td>
<td>.246</td>
</tr>
</tbody>
</table>

*McNemar test
Figure 1 - Operative technique described by Mitchell (sketch in the horizontal plane)

Figure 2 - Operative technique described by Golden (sketch in the horizontal plane)

Figure 3 Bilateral Golden osteotomy after the completed procedure.
Figure 4 Walking cast shoe after Golden osteotomy (postoperative wound check-up)

Figure 5 A-C. X-ray scan of a 53-year-old female patient; A-hallux valgus before surgery, B- postoperative scan of Mitchell osteotomy, C-two years after surgery scan

Figure 6 A-C. X-ray scan of a 49-year-old patient; A-hallux valgus before surgery, B- postoperative scan of Golden osteotomy, C-two years after surgery scan

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