International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

A Retrospective Study of Hallux Valgus Deformity Correction by Modified Mitchell Osteotomy and K - Wire Fixation

Waleed Arafat El Tohamey[1], Nehad Mahmoud El - Mahboub[2], Ahmed Farid Mahmoud Farid [3], Assem Bastawisy Ahmed[4]

[1, 2, 3, 4]Department of Orthopedic Surgery, Faculty of Medicine Misr University for Since and Technology

Email: *warafat73[at]hotmail.com*
Mobile: 01223911504

Email: *mahboubn[at]gmail.com*
Mobile: 01222197363

Email: *drbastawisy[at]hotmail.com*
Mobile: 01001427449

Email: *ahmedfarid237[at]gmail.com*
Mobile: 01144367835;

Abstract: ***Background: Hallux valgus (HV), also known as a bunion, it is considered to be one of the most common forefoot deformities. It manifests with the proximal phalanx deviating laterally and the first metatarsal head deviating medially. It is usually due to the adduction of the first metatarsus, called metatarsus primus Varus. The exact etiology is not fully understood. It tends to occur more commonly in women and those who wear tight shoes or high heels. HV deformity is typically diagnosable through a physical exam. However, imaging is important as it can evaluate whether there is damage to the first metatarsophalangeal (MTP) joint and to know the degree of deformity. Objective: To evaluate the clinical and radiological outcome of modified Mitchell technique with additional K wire fixation in patients with hallux valgus deformity. Patients and Methods: Fourty patients complaining of hallux valgus deformity after failure of conservative treatment were included in the study to undergo a modified Mitchell technique for treatment of their hallux valgus deformity, with follow up of 6 months to 18 months. The study included 30 females (60%) and 10 males (40%). The age of the patients ranged from 19 to 58 years with mean 47.8 years. There were 22 (55%) right - sided and 18 (45%) left - sided. Results: Regarding hallux IPJ motion (plantar flexion), at 3 - month follow up, 37 patients scored 5 points (No restriction) and 3 patients scored 0 point [severe restriction (less than 10)]. After 6 months, all patients scored 5 points. Regarding hallux MTP - IP stability (all directions), all patients scored 5 points (stable). Regarding callus related to hallux MTPJ or IPJ, all patients scored 5 points (no callus or asymptomatic callus). Regarding hallux alignment, 38 patients scored 15 points (good, hallux well aligned) and 2 patients scored 8 points (fair, some hallux malalignment, asymptomatic). Conclusion: The short - and long - term results of this modified Mitchell's osteotomy with fixation by a K - wire have been reported. It has been statistically proven to be a reliable, reproducible, cost - efficient surgical technique, with low complication rates with satisfactory clinical outcomes.***

Keywords: Hallux valgus, metatarsophalangeal

1. Introduction

Hallux valgus (HV), also known as a bunion, it is considered to be one of the most common forefoot deformities [(1).] It manifests with the proximal phalanx deviating laterally and the first metatarsal head deviating medially. It is usually due to the adduction of the first metatarsus, called metatarsus primus Varus. The exact etiology is not fully understood. It tends to occur more commonly in women and those who wear tight shoes or high heels [(2).] HV deformity is typically diagnosable through a physical exam. However, imaging is important as it can evaluate whether there is damage to the first metatarsophalangeal (MTP) joint and to know the degree of deformity.

Many procedures have been done for correction of hallux valgus including soft tissue procedure, distal metatarsal osteotomies and proximal metatarsal osteotomies

Mitchell's osteotomy, although first described by Hawkin in 1945 [(3),] bears his name after he described his results on more than 400 such osteotomies It is a double step - cut osteotomy through the neck of the first metatarsal, displacing the head fragment laterally and planter wards [(4).] Mitchell's osteotomy restores the load - bearing function of the feet to near normal [(5).]

Aim of the Study

The aim of this retrospective study is to evaluate the clinical and radiological outcome of modified Mitchell technique with additional k wire fixation in patients with hallux valgus deformity.

Patients and Methods

Fourty patients complaining of hallux valgus deformity after failure of conservative treatment were included in the study to undergo a modified Mitchell technique for treatment of their hallux valgus deformity, with follow up of 6 months to 18 months.

Preoperative data were collected from the medical records of the patients including both clinical and radiological evaluation, all patients were operated at the University Hospital of Misr University for Science and Technology and followed up at Orthopedic Outpatient Clinic of the Hospital.

Inclusion criteria: Age 18 - 70 years, hallux valgus angle > 20 measured by goniometer, patients with persistent pain after failure of conservative treatment after 6 months including shoe modification, pads and spacers for big toe.

Exclusion criteria: Young age than 18 years, previous forefoot surgery as neuroma removal and lesser toe deformities correction, metatarso - phalangeal joint osteoarthritis (MPJ OA), rheumatoid arthritis, metatarso - phalangeal (MTP) subluxation, neuromuscular diseases including Charcot joint, Duchene muscular dystrophy and poliomyelitis, hallux rigidus, failed previous hallux valgus surgery, gouty arthritis, hallux valgus angle < 20.

Indications for surgery:
Indications for surgical treatment were failed conservative treatment of at least six - month duration, with forefoot pain and HVA (hallux valgus angle) > 20. A HVA > 40 was not considered a surgical contraindication to undergoing this modified technique, and patients with osteoarthritis of the first metatarsophalangeal joint or with an IMA (inter - metatarsal angle) > 20 were treated by a different surgical procedure. Patients with a significantly short first metatarsal (Greek foot) with callosities identified under the heads of the lesser metatarsals were also treated by a different surgical technique.

Operative technique:
All the cases were operated by the same senior surgeon, with the use of a tourniquet and administration of standard prophylactic antibiotherapy consisting of cefazoline. A semi - curved dorsally skin incision is performed to avoid a medial scar that might be irritated by shoe wear, and care is taken to avoid iatrogenic injury to the dorsal cutaneous nerves. Soft tissue stripping is limited to the dorsal aspect of the distal metatarsal in order to safeguard the vessels, thereby maintaining adequate perfusion to the distal fragment and minimizing the risk of avascular necrosis.

The capsule of the metatarsophalangeal joint is exposed, and capsulotomy is performed in a V–Y shaped incision. The medial exostosis (figure 1a) is then excised by the use of an oscillating saw (figure 1b). Two metatarsal cuts are then made; an incomplete distal cut and a complete proximal one (figure 1c). The distance between the two cuts is around 2 mm with the aim of avoiding excessive shortening that can lead to the encountered complication of transfer metatarsalgia.

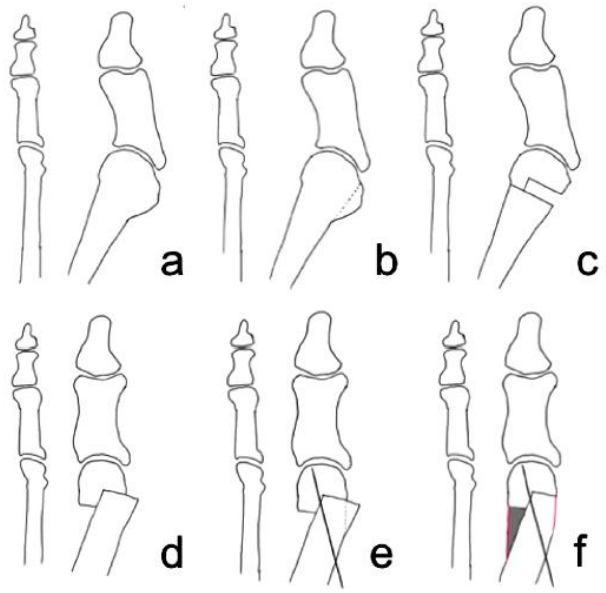

Figure (1): a) Hallux valgus deformity, **b)** Medial exostosis resection, **c)** Proximal complete and distal incomplete osteotomies, **d)** Lateral translation of the distal fragment, **e)** Fixation by K - wire, **f)** Bone grafting of the previously excised bunion into the lateral aspect of the cut, with excision and smoothening of the medial protruding edge.

In the sagittal plane, the cuts are made slightly oblique by orienting the cut from distal - dorsal to proximal - volar (figure 2). This step is important as it allows us to have a desired slight plantarward displacement of the distal fragment to counteract the shortening, as well as the fact that the orientation of this osteotomy prevents unwanted dorsiflexion of the distal fragment and enhances stability of the osteotomy.

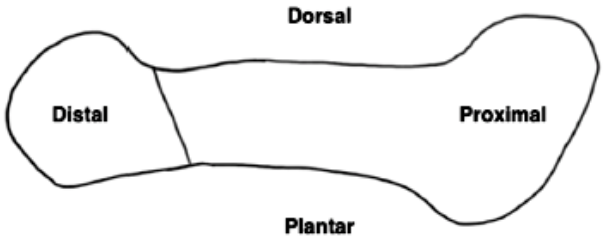

Figure 2: Viewed medially, the cut is made slightly oblique by orienting the cut from distal - dorsal to proximal - volar

As for the mediolateral width of the made step, it should not exceed 25% of the metatarsal width, in order to preserve enough bone contact between the two fragments. After the cuts are made as previously described, lateral translation of the distal fragment is completed (figure 3).

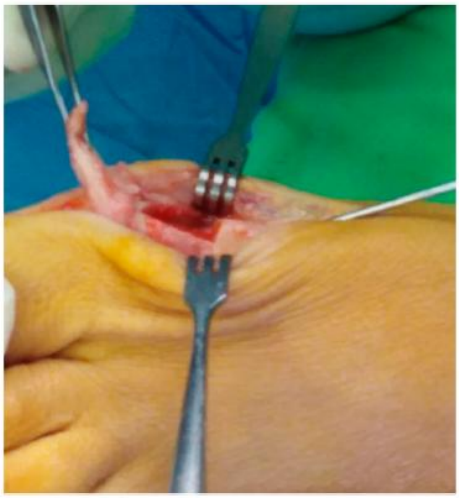

Figure 3: Superiorly observed lateral translation of the distal fragment, with fixation by a single K - wire

Fixation of the translated fragments is done using one smooth 2.0 mm K - wire placed from the proximal - medial cortex to the distal - lateral subchondral bone of the metatarsal head, and the protruding medial edge of the cut is resected to smooth the bony prominences.

The cancellous bone is harvested from the previously excised exostosis and bony steps and is used as bone graft placed at the level of the lateral aspect of the cut, which promotes for better bone healing by widening the contact surface of the bone.

Intra - operatively, the decision is made whether additional lateral soft tissue release is needed or not, this is done by traction on the medial joint capsule proximally. If traction does not reduce the subluxated MTP joint lateral capsular release is done from inside the joint without adding a second lateral incision and further compromising the distal vascularity of the head.

Medial capsulorrhaphy is then done by anchoring and tightening of the capsule to the medially protruding K - wire by two resorbable vicryl 0 sutures, and the correction is adjusted with capsular tension (figure 4). The K - wire is kept exposed for an easy removal after bony union is achieved.

Figure 4: Medial capsulorrhaphy is done by anchoring and tightening of the capsule to the medially protruding K - wire

Postoperative care:

A sterile dressing is applied, and a toe cast is placed to protect the K - wire and stabilize to the osteotomy. The patient is allowed immediate full weight bearing starting with Barouk therapeutic shoes. The sutures are removed at two weeks postoperatively and afterwards the wound is checked every two weeks. At six weeks, an x - ray is done to confirm the bony union at the level of the osteotomy, and the protective toe cast and the K - wire are both removed. All patients were allowed to ambulate with comfortable shoes.

Follow up:

The follow–up strategy will focus on radiological evaluation to determine the union and angles of correction followed up weekly for one month then monthly for six months, clinical assessment for pain range of motion and finally the functional assessment using American Orthopedic Foot and Ankle Socity score (AOFAS score) which developed in 1994, the clinician - based AOFAS covers four different regions of the foot: The ankle - hind foot, midfoot, metatarsophalangeal (MTP) - interphalangeal (IP) for the hallux, and MTP - IP for the lesser toes. These four anatomic regions have their own version of the AOFAS survey. Each one is designed to be used independent of the others [(6).] However, each measure is comprised of nine questions and cover three categories: pain (40 points), function (50 points) and alignment (10 points). These are all scored together for a total of 100 points.

The surveys include a mixture of questions that are both subjective and objective in nature. The pain category which asks patients a single question about their level of pain is subjective, while the alignment category (to be answered by the physician) is objective. However, the function category consists of 5 - 7 questions and requires completion by both the patient and the physician. Unlike other outcome measures which fall into a single category, AOFAS is a clinician reporting tool that requires both patient and provider participation to be fully complete [(7).]

Radiological studies will be evaluated by measuring pre - operative and post - operative HVA and IMA angles as well as any shortening of the 1st ray which was measured as the

change in the distance between the mid - point of the distal articular surfaces of fourth and second MPJ [8].

The HVA was determined by bisecting the shafts of the first proximal phalanx and of the first metatarsal. The IMA should be determined by bisecting the shafts of the first and second metatarsals. Postoperatively, the IMA measurement was modified to account for the surgical displacement of the first metatarsal head by measuring the angle formed by the diaphyseal axis of the second metatarsal and a line joining the center of the laterally displaced first metatarsal head with the center of the first metatarsal base [8].

Any postoperative complications as stiffness, metatarsalgia, mal union, non - union, recurrence, infection, deformity and avascular necrosis (AVN) of the joint were collected.

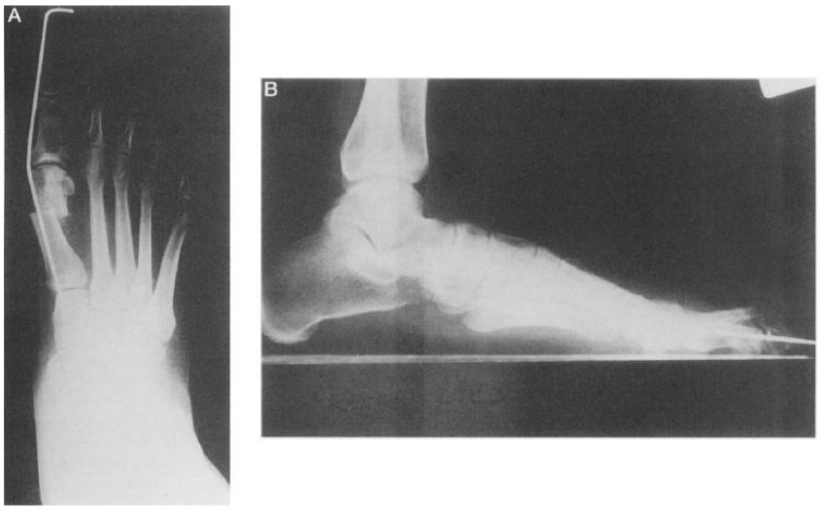

Figure 5: Dorsoplantar and lateral standing X - rays, 4 weeks postoperatively

2. Results

We have forty patients underwent hallux valgus correction by modified Mitchell technique. the mean age 47.8 ranging 19 to 58). male patients represent 40% and female patients are 60%. Right feet were 22 cases which represent 55% comparing to left feet 18 (45%) with no statistically significant difference. the pin tract infection is a common complication and represent 10% and managed by removal of k - wire at the time and a short term antibiotics was administrated. otherwise no deep infection, hypothesis , nonunion, osteonecrosis of the first metatarsal head were recorded.

Case presentation

A 44 - year - old male Patient present with pain on the medial aspect of the forefoot. pain of the lesser toes associated with hammertoe deformity and bump on the medial aspect of the forefoot and complaints of difficulty with certain types of footwear persistent symptoms despite already attempting footwear or activity modifications.

The physical examination foot evaluation in both a seated and standing position. Inspected for any skin changes or lesions, toe The aim of this retrospective study is to evaluate the clinical and radiological outcome of modified Mitchell technique with additional k wire fixation in patients with hallux valgus deformity. Nail changes, and general position of the first ray tenderness at the medial eminence generalized pain at the first MTP joint, pain related to lesser toe deformities, or pain at the lesser metatarsal heads neurovascular was intact on examination

The first ray assessed for range of motion, ligamentous laxity or contractures, and passive correction of the deformity

The first MTP joint evaluated for any skin changes, pain, crepitus, or decreased motion consistent with arthritic changes. It is important to evaluate for any other concomitant processes including hammertoe deformity, pes planus, equinus of the Achilles complex, or first ray hypermobility.

Figure 6: Photo showing left foot of male patient with moderate Hallux valgus and 2nd toe hammering and bunion

Figure 7: x - ray showing Hallux Valgus correction

Figure 8: x - ray showing Hallux Valgus correction

Figure 9: Post - operative photo showing Hallux Valgus correction

Figure 10: Post - Operative x ray showing Hallux Valgux post correction

3. Discussion

The term hallux valgus refers to the combination of medial deviation of the first metatarsal associated with a medial bony and soft tissue prominence, and lateral deviation of the hallux. It is a complex first ray deformity with presence of an imbalance of the adductor and abductor muscles, rotation of the hallux, anomalous foot mechanics that largely occurs in populations who wear shoes and that is rarely seen in populations that are mostly barefoot. The incidence rate of the hallux valgus deformity varies according to age, with the incidence increasing from 7.8% among the population under the age of 18, to 35.7% in people older than 65 [(3).]

The initial treatment of this condition is non operative, and non - surgical care should especially be contemplated in people with general hypermobility or ligamentous laxity, neuromuscular disorders, or flatfeet with a pronated first ray because of the high recurrence rate [(9).]

There are currently more than 100 surgical procedures for the treatment of hallux valgus which is due to the fact that it is a complex deformity with no uniformly ideal procedure, and the optimal treatment needs to be decided on a case by case basis by assessing the appearance and the degree of the deformity.

Distal metatarsal osteotomies should be done when no osteoarthritis of the metatarsophalangeal joint is present. Distal osteotomies were proven to correct the HV deformity in 82%–95% of cases, and Mann (1989) has reported good and excellent results in 91% and 97% of patients, as shown in an analytic retrospective study of more than 400 cases.

Mitchell's procedure, which consists of a double step - cut osteotomy at the level of the first metatarsal neck was first described in 1945 by Hawkins, is one of the most commonly used distal metatarsal osteotomies, and multiple modifications to the original technique have been proposed since its original inception to avoid the encountered complications of this technique. Some of the well - known complications include transfer metatarsalgia, malunion, nonunion, recurrent deformity, and avascular necrosis of the first metatarsal head [(10).]

Complications related to this technique have also been reported, including inadequate correction, loss of correction, osteotomy nonunion, injury of the digital nerves of the great toe, avascular necrosis of the metatarsal head, and transfer metatarsalgia [11].

With Mitchell's original procedure, in which the osteotomy site is stabilized by a cerclage suture, the reported incidence of nonunion and loss of correction range from 4% to 7%. Both complications depend not only on the type of osteotomy, but are also related to the method of fixation, which does not assure a firm stabilization [12].

In order to avoid these complications, several fixation techniques were later used for better fixation such as crossed pins, Steinman pins, screws, staples, and one K - wire medially buttressing the distal fragment. This procedure is generally indicated in IMAs ≤20 as it is a distal osteotomy, however some surgeons performed it for HVA <40 (moderate hallux valgus) while others also performed it for HVA > 40 with good long - term results (severe hallux valgus), which is also shown in a long term follow up study on more than 200 cases [13].

Particularly, the use of a Kirschner wire to stabilize the osteotomy fragments was described in a brief note by **Szaboky and Raghaven** [14] without detailed clinical information on their series of patients. **Blum** [15] used a Steinmann pin through the osteotomy site, while **McDonald and Stevens** [16] treated an adolescent population with a Kwire positioned in the first web space. The latter technique was suggested by **Canale et al.** [17] in order to improve their results of adolescent hallux valgus correction with the standard Mitchell procedure.

Teli et al. [18] have previously reported on the use of cerclage wiring to stabilize Mitchell's osteotomy: the results were limited both by persisting pain attributed to the first ray (7.3%) and by wire intolerance leading to reoperation for removal of hardware (14.2%).

The aim of this retrospective study is to evaluate the clinical and radiological outcome of modified Mitchell technique with additional K wire fixation in patients with hallux valgus deformity.

Fourty patients complaining of hallux valgus deformity after failure of conservative treatment were included in the study to undergo a modified Mitchell technique for treatment of their hallux valgus deformity, with follow up of 6 months to 18 months. The study included 30 females (60%) and 10 males (40%).

Teli et al. [18] evaluated 45 patients (60 feet) (42 females and 3 males) affected by hallux valgus and treated with a distal metatarsal osteotomy. **Ayoubi et al. (2021)** assessed the clinical and radiographic outcomes of a modified Mitchell's technique. All patients were females.

In our study, the age of the patients ranged from 19 to 58 years with mean 47.8 years. Also, **Teli et al. (**[18] found that mean age at operation was 53 years (range, 27 - 65 years) and **Ayoubi et al.** [19] found that the mean age at surgery was 47.8 years (range, 19 to 78).

Our study found that there were 22 (55%) right - sided and 18 (45%) left - sided. **Ayoubi et al.** [19] found that 32 of 67 feet were left and 35 were right feet.

We followed up all the patients for postoperative pain, function, footwear requirement, walking distance, gait abnormality and alignment using the AOFAS score. The patients remained in the hospital overnight, and prophylactic parenteral antibiotics were administered for the first 24 hours postoperatively. Next day after surgery, patients were allowed for non - weight - bearing crutch ambulation.

The American Orthopedic Foot and Ankle Society (AOFAS) midfoot score was used. There was a rapid improvement in the AOFAS scores in the first 3 months post - surgery. **Teli et al. (**[18] found that the mean preoperative AOFAS score was 44.6 points, ranging from 32 to 91 points, The AOFAS ratio was not used at the 4 - week clinical evaluation, since the presence of the Kirschner wire could remarkably influence the scores. At follow - up, the AOFAS score averaged 83.2 points, ranging from 65 to 91 points. Fifty - five out of 60 feet (92%) scored 75/100 or more points at the follow - up evaluation, with a significant improvement between values obtained preoperatively and after a minimum of 12 months. The average increase between preoperative and follow - up scores was 38.6 points (range, 15 - 51). **Ayoubi et al.** [19] found that global AOFAS score improved from 45.3 (range, 34 to 64) preoperatively to 88.8 (range, 52 to 100).

Regarding pain, in first 3 - month follow up, 10 patients scored 30 points (mild pain) and 30 patients scored 40 points (no pain). After 6 months, 37 patients achieved 40 points while 3 patients achieved 30 points. **Teli et al.** [18] achieved relief of bunion - related *pain* at follow up in 54 feet (90%).

Regarding function, after 3 - month follow up, 27 patients achieved 10 points (no limitations, no support), 10 patients achieved 7 points (no limitation of daily activity, limitation of recreational activity, support) and 3 patients achieved 4 points (limitation of daily and recreational activities, cane). After 6 months, all patients achieved 10 points.

Regarding footwear requirements, after 3 - month follow up, 35 patients scored 5 points (fashionable, conventional shoes, no insert required) and 5 patients scored 3 points (comfortable footwear, shoe insert). After 6 months, 38 patients scored 5 points and 2 patients score 3 points.

Regarding maximum walking distance, at 3 - month follow up, 33 patients scored 10 points (more than 600 meters) and 5 patients scored 7 points (400 – 600 meters). After 6 months, all patients scored 10 points.

Regarding walking surfaces, at 3 - month follow up, 35 patients scored 10 points (no difficulty on any surface), while 5 patients scored 5 points (some difficulty on uneven terrain, stairs, inclines, ladders). After 6 months, all patients scored 10 points.

Regarding gait abnormality, all patients scored 10 points (none, slight) at 3 months of follow up and after 6 months of follow up.

Regarding alignment, all patients scored 16 points (good, plantigrade foot, midfoot well aligned) at 3 months and at 6 months of follow up. **Teli et al.** [18] achieved satisfactory *alignment* of the first ray in 49 feet (82%).

Regarding total first MTPJ motion (dorsiflexion plus plantarflexion), at 3 - month follow up, 33 patients scored 10 points [normal or mild restriction (75 or more)] and 5 patients scored 5 points [Moderate restriction (30–74)]. After 6 months, all patients scored 10 points.

Teli et al. [18] found that preoperatively, the first MTP angle mean value was 31.7° (range, 24°_ 40 °), the first - second IMT angle mean value was 15.40 (range, 11° - 21°), and the PASA mean value was 11.30 (range, 5°_ 16°). Four weeks after surgery, the mean val ues of first MTP, IMT, and PASA angles were res pec tive ly 16.9° (range, 10° - 28°), 8.6° (range, 5 - 13°) and 7.10 (range, 4°_ 10°). All showed a significant difference compared to the preoperative values, and a tren d toward the accepted normal values. The mean shortening of the first metatarsal was 3.5 mm (ran ge, 2.8 - 5.3 - mm). No significant changes of these measurements were observed at the radiographic evaluation performed at follow - up compared to the 4week values.

Regarding hallux IPJ motion (plantar flexion), at 3 - month follow up, 37 patients scored 5 points (No restriction) and 3 patients scored 0 point [severe restriction (less than 10)]. After 6 months, all patients scored 5 points.

Regarding hallux MTP - IP stability (all directions), all patients scored 5 points (stable). Regarding callus related to hallux MTPJ or IPJ, all patients scored 5 points (no callus or asymptomatic callus).

Regarding hallux alignment, 38 patients scored 15 points (good, hallux well aligned) and 2 patients scored 8 points (fair, some hallux malalignment, asymptomatic).

Ayoubi et al. [19] found that Mean HVA improved from 37.0 pre - operatively to 10.2 post - operatively, mean IMA improved from 12.1 pre - operatively to 5.6 post - operatively. Whereas, the mean metatarsal shortening was 3.0 mm (range, 0–6.0 mm). The statistical analysis showed that the comparison of the preoperative to the postoperative values of the HVA, IMA and AOFAS showed a statistically significant difference in all of them. Also, there is no significant correlation between preoperative HVA and IMA angles with neither postoperative shortening, metatarsalgia, AOFAS scores nor the difference between the preoperative and postoperative AOFAS scores.

The modifications to the original technique included:

The distance between the proximal and distal cuts didn't exceed 2–3 mm to avoid excessive shortening.
The orientation of the osteotomy was distal - dorsal to proximal - volar which is a protective factor against dorsal displacement of the distal fragment.
The width of the step didn't exceed 25% of the whole metatarsal width, which ensured a proper surface of bone contact for bone healing.

Fixation was done with a smooth K - wire.

Autologous bone grafts were harvested from the resected exostosis and bone cuts, this bone graft was placed on the lateral aspect of the osteotomy to promote union.

The medial capsulorrhaphy was tightened around the K - wire, this allowed us to adjust our correction as needed.

Lateral release of the metatarso - phalyngeal joint was done through the joint under traction, sparing a lateral incision and decreasing the risk of avascular necrosis.

This modified technique has been previously described, showing promising results with satisfactory long term follow up [20]. In our study on a Middle - Eastern population, the addition of intra - articular lateral soft tissue release, preventing an additional lateral incision, along with the use of autologous bone graft adjacent to the osteotomy stump to improve union, have increased the control over correction as well as improving the rates of union.

Briggs et al. [21] obtained satisfactory results with the use of staples and highlighted the importance of early mobilization.

Blum [15] treated a large number of patients with Steinmann pin fixation and stressed the value of a careful preoperative assessment of the radiographic angles to decrease the incidence of complications. He also described the stress fractures of the lateral metatarsals as late complications of the procedure.

Wu [22] reported a decrease in complications rate by using a Herbert screw to fix the osteotomy, and **Kuo et al.** [23] extensively described the advantages and complications of cross - pin fixation, and suggested concomitant lesser metatarsal osteotomy to treat metatarsalgia and painful callosities.

Teli et al. [18] concluded that stabilization of the Mitchell osteotomy with a Kirschner wire proved safe and effective for the surgical correction of mild to moderate hallux valgus.

van der Woude et al. [24] identified the clinical and radiological outcome of a modified Mitchell osteotomy with a distal soft tissue release for a severe hallux valgus deformity. They indicated that a modified Mitchell osteotomy combined with a distal soft tissue procedure is a predictable and safe alternative for treatment of severe hallux valgus deformity. They achieved and satisfying radiological and clinical correction with content patients after a median follow up of 36 months.

Ayoubi et al. [19] assessed the clinical and radiographic outcomes of a modified Mitchell's technique. They have reported short - and long - term outcomes of this modified Mitchell's osteotomy. These modifications proved to result in very good clinical and radiological outcomes even in severe cases with HVA>40. It has shown to be reliable,

reproducible, and cost - efficient with low complication rates.

There are some limitations in the current study. This study treated patients with a wide age range. Only one technique was used and there were no control groups.

4. Conclusion

The short - and long - term results of this modified Mitchell's osteotomy with fixation by a K - wire have been reported. It has been statistically proven to be a reliable, reproducible, cost - efficient surgical technique, with low complication rates with satisfactory clinical outcomes.

References

[1] **Sharma J, Aydogan U.** Algorithm for severe hallux valgus associated with metatarsus adductus. Foot Ankle Int.2015; 36 (12): 1499 - 503

[2] **Choi YR, Lee S - J, Kim JH, et al.** Effect of metatarsal osteotomy and open lateral soft tissue procedure on sesamoid position: radiological assessment. J Orthop Surg Res 2018; 13 (1): 11.

[3] **Nix S, Smith M, Vicenzino B.** Prevalence of hallux valgus in the general population: a systematic review and meta - analysis. J Foot Ankle Res.2010; 3: 21.

[4] **N. Mikic, D. Grujoska - Veta, G. Cobeljic, I.** Gavrankapetanovic, Z. Vukasinovic, I. Soldatovic, et al., Mitchell and Golden metatarsal osteotomies for the treatment of moderate hallux valgus deformity: a comparative analysis, Vojnosanitetski pregled Military Medical and Pharmaceutical Journal of Serbia 76 (4) (2019) 404–411.

[5] **Menz HB, Roddy E, Marshall M, et al.** Epidemiology of shoe wearing patterns over time in older women: associations with foot pain and hallux valgus. J Gerontol A Biol Sci Med Sci.2016; 71: 1682 - 1687

[6] **Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS and Sanders M.** Clinical rating systems for the ankle - hindfoot, midfoot, hallux, and lesser toes. Foot Ankle Int 1994; 15 (7): 349 - 353.

[7] **Menz HB, Roddy E, Marshall M, et al.** Epidemiology of shoe wearing patterns over time in older women: associations with foot pain and hallux valgus. J Gerontol A Biol Sci Med Sci 2016; 71: 1682 - 1687

[8] **Pentikainen I, Ojala R, Ohtonen P, Piippo J, Leppilahti J.** Preoperative radiological factors correlated to long - term recurrence of hallux valgus following distal chevron osteotomy. Foot Ankle Int 2014; 35 (12): 1262 - 1267.

[9] **Coughlin MJ, Jones CP.** Hallux valgus: demographics, etiology, and radiographic assessment. Foot Ankle Int 2007; 28 (7): 759 - 77.

[10] **Huang S, Cheng Y, Chen C and Huang P.** Modified Mitchell osteotomy with screw fixation for correction of hallux valgus. Foot and Ankle International 2012; 33 (12): 1098 - 1102.

[11] **O'Malley MJ, Chao W, Thompson FM.** Treatment of established nonunions of Mitchell osteotomies. Foot & ankle international.1997 Feb; 18 (2): 77 - 80.

[12] **Meier PJ, Kenzora JE.** The risks and benefits of distal first metatarsal osteotomies. Foot & ankle.1985 Jul; 6 (1): 7 - 17.

[13] **Dermon A, Tilkeridis C, Lyras D, Tryfonidis M, Petrou C, Tzanis S, Kazakos K, Petrou G.** Long - term results of Mitchell's procedure for hallux valgus deformity: a 5 - to 20 - year followup in 204 cases. Foot & Ankle International.2009 Jan; 30 (1): 16 - 20.

[14] **Szaboky GT, Raghaven VC.** Modification of Mitchell's lateral displacement angulation osteotomy. JBJS.1969 Oct 1; 51 (7): 1430 - 1.

[15] **Blum JL.** The modified Mitchell osteotomy - bunionectomy: indications and technical considerations. Foot & Ankle International.1994 Mar; 15 (3): 103 - 6.

[16] **McDonald MG, Stevens DB.** Modified Mitchell bunionectomy for management of adolescent hallux valgus. Clinical Orthopaedics and Related Research®.1996 Nov 1; 332: 163 - 9.

[17] **Canale PB, Aronsson DD, Lamont RL, Manoli A.** The Mitchell procedure for the treatment of adolescent hallux valgus. A long - term study. JBJS.1993 Nov 1; 75 (11): 1610 - 8.

[18] **Teli M, Grassi FA, Montoli C, Moalli S, Pazzaglia UE.** The Mitchell bunionectomy: a prospective study of 60 consecutive cases utilizing single K - wire fixation. The Journal of foot and ankle surgery.2001 May 1; 40 (3): 144 - 51.

[19] **Abboud G, Maalouly J, Tawk A, Aouad D, Ayoubi R, Najm T, El - Hajj G, El Rassi G, Nehme A.** Intertrochanteric fractures treated by diaphyseal support arthroplasty with hook plate vs cerclage wires only: A retrospective cohort study. Annals of Medicine and Surgery.2021 Dec 1; 72: 103075.

[20] **Dennis NZ, De SD.** Modified Mitchell's osteotomy for moderate to severe hallux valgus—an outcome study. The Journal of foot and ankle surgery.2011 Jan 1; 50 (1): 50 - 4.

[21] **Briggs TW, Smith P, McAuliffe TB.** Mitchell's osteotomy using internal fixation and early mobilisation. The Journal of Bone and Joint Surgery. British volume.1992 Jan; 74 (1): 137 - 9.

[22] **Wu KK.** Modified Mitchell's bunionectomy (Wu's bunionectomy). Orthopedics.1997 Mar 1; 20 (3): 253 - 7.

[23] **Kuo CH, Huang PJ, Cheng YM, Huang KY, Chen TB, Chen YW, Lin SY.** Modified Mitchell osteotomy for hallux valgus. Foot & ankle international.1998 Sep; 19 (9): 585 - 9.

[24] **van der Woude P, Keizer SB, van der Flier RE, Thomassen BJW.** Outcome of a Modified Mitchell Osteotomy for Severe Hallux Valgus Deformity. Clin Res Foot Ankle 2015; 3 (3): 176.