

CLINICAL AND RADIOGRAPHIC ANALYSIS OF THE OPERATIVE PROCEDURE RESULTS ACCORDING TO THE METHOD OF MITCHELL AND KELLER USED FOR CORRECTION OF HALLUX VALGUS DEFORMITIES

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Abstract: The aim of this study is to make a correlation of the clinical and radiographic results after performing two different surgical procedures for correction of hallux valgus deformity.

Material and methods: The study included 70 patients having hallux valgus deformity of the foot, and they were divided into two groups. The first group (Group 1) was composed of 35 patients who were treated by osteotomy of the I-st metatarsal bone according to Mitchell, while the second group (Group 2) was also composed of 35 patients who were treated by resectional arthroplasty according to Keller. Clinical (pain and metatarsalgia, as well as most dominant symptoms) and radiographic examinations (I metatarsophalangeal angle and I intermetatarsal angle) were analysed comparatively during the evaluation. The analysis of the clinical and radiographic results was performed pre-operatively and post-operatively for the two groups.

Results: According to their sex, the patients were 5 men and 65 women. Using the method of Mitchell, pain as a clinical symptom post-operatively was found in only 3 patients out of the 35 with operated feet, while in the other group of patients treated by the method of Keller, there was no presence of pain in any of the patients. Comparatively, this does not present a statistically significant difference ($p > 0.05$). Nor do, the differences in the distribution of metatarsalgia incidence show a statistical significance between the two groups ($p > 0.05$). There is no significant difference ($p > 0.05$) in the patients of the two groups concerning the pre-operative mean dimension values of the I metatarsophalangeal angle and I intermetatarsal angle. However, the radiographic analysis of the same angles in both groups, one year post-operatively, showed a high statistically significant difference ($p < 0.001$).

Summary: Mitchell's operative technique could be recommended as an effective procedure for the correction of hallux valgus and metatarsus primus varus in young and middle-aged patients, while the resection arthroplasty according to the method of Keller is recommended for older patients with arthrotic changes.

Key words: hallux valgus deformity, Keller, Mitchell, foot.

Introduction

Hallux valgus is the most frequent and important deformity of the foot, and it is characterized by a valgus position of the big toe, enlarged I intermetatarsal angle, the appearance of pseudoegsostosis or bursitis in the area of the medial side of the head of the I metatarsal bone, and by an inside rotation of the big toe in more severe cases [4, 13]. This deformity is met in all nations and races, but somewhat more often in the advanced nations. Most often it can be found in the urban population, in the fourth decade of their lives, and more often in women than men. The ratio is 3 : 1. [2, 14, 18]

The first thorough description of hallux valgus deformity was published in 1871 by Carl Hueter. Since then the importance of the surgical correction of this deformity has been recognized. Although more than a century has passed, this deformity continues to be a difficult therapeutic problem and day by day challenge for the surgeon who treats it [4, 13, 15]. More than 100 surgical procedures have been described for the correction of this deformity. The numerous operative procedures and modifications point to the fact that no one of them can make a correction on every hallux valgus deformity [3, 7, 11].

This study deals with the patients having hallux valgus deformity, using the clinical and radiographic analyses pre- and post-operatively, according to surgical treatment by the methods of Mitchell and Keller. The essence of these surgical procedures is to correct the deformity, to make an effort to eliminate the anatomic potential for the origination of the deformity, and to create a normal position, direction and physiologically antagonistic function of the muscles which are not balanced [8, 10, 18].

Aim

The aim of this study is to make a pre- and post-operative analysis of the treated cases by using two different surgical procedures for the correction of hallux valgus deformity, and the clinical and radiographic results.

Material and Methods

The study was worked out at the University Orthopaedic Surgery Clinic, Faculty of Medicine in Skopje. The material for the investigation comprised 70 patients having hallux valgus deformity. The patients were divided into two groups of 35 patients each. They were treated by operative procedures according to the methods of Mitchell and of Keller. The operative procedures in both groups were performed under regional spinal anesthesia.

The operative technique according to Mitchell is performed by incision of the skin in a form of an arch, 5 to 6 cm dorsomedially, in the area of the first metatarsophalangeal joint, after which the medial aspect of the joint is shown. An incision of the capsule in the form of the letter Y is made, where the stem is directed proximally, and the two arms are directed distally to the metatarsophalangeal joint. It is deperiostated in the area of the neck of the 1st metatarsal bone. Then an ablation of the exostosis is done. Two osteotomies are performed one centimeter proximally from the joint surface of the first metatarsal bone by electric saw. The proximal osteotomy is complete; it is transversal on the longitudinal axis of the metatarsal bone. Distal osteotomy for moderate deformities is done to 1/6 of the lateral surface of the metatarsal bone, while for severe deformities it is done to 1/3 of the lateral surface of the metatarsal bone. In this way it can be determined how much the head should be displaced laterally in order to correct the varus deformity of the metatarsal bone. Then the bone between the two osteotomies is resected, leaving a spike laterally. The resection is not greater than 2–4 millimetres in order to avoid the shortening of the metatarsal bone. Having done the osteotomies, the bearing surface of the metatarsal head is rotated slightly plantarward and is fixed. All prominences are extracted from the medial projection of the bone and restitution of the soft structures is done medially. The big toe is placed in a varus position with a flexion of 5 degrees. A thin dressing is put on and then a plaster immobilization. On the fourteenth day post-operatively a re-dressing of the foot is done, the stitches are taken out, and a plaster immobilization is put on again. This immobilization lasts for 6 weeks, or until the place where the osteotomy has been carried out is healed.

The operative treatment according to Keller is performed by incision of the skin in the form of an arch, dorsomedially in the area of the first metatarsophalangeal joint. Then, an incision of the capsule is made, and the capsule and the periost of the proximal phalange base is retracted in order to see its articular surface. The proximal phalange is dislocated from the metatarsal head. By an electric saw, a resection of the proximal half of the phalange (when the deformity is more severe it is necessary to resect the proximal two thirds of the phalange) is done in order to be able to put the rest of the part to in a varus position, without an impingement to the metatarsal head. Then an ablation of the exostosis and removal of the osteofites from the head of the I metatarsal bone are done in order to protect the bearing surface. A Kirschner's needle is applied longitudinally through the big toe and I metatarsal bone. Traction on the big toe and suture on the rest of the

periosteum, the capsule, and the rest of the soft tissue structures is done. A dressing is placed and also a plaster immobilization (low plaster boot). The Kirschner needle is removed after 2 weeks, and greater loading is allowed, or more exactly walking with specially-made orthopaedic shoes.

Concerning the clinical methods, pain as the most dominant symptom was evaluated, as well as the metatarsalgia, which most often appears in this deformity. It was proved by the accordion test, which is positive if during side pressure in the area of the metatarsal heads there is painful sensitivity because of the presence of an inter-digital neuron [3, 13].

Radiographic examination was done by the method of Hardy and Clapham. The dimension of the I metatarsophalangeal angle was determined by this angle (it is constructed by cutting the long bones of the first phalange and the first metatarsal bone). The dimension of the I intermetatarsal angle is also determined by this method (the angle is constructed by cutting the long bones of the I and II metatarsal bones). The clinical and radiographic examinations were done pre-operatively and post-operatively [2, 19].

Results

According to sex, the first group consisted of 3 (8.57%) male patients and 32 (91.43%) female patients, while the second group consisted of 2 (5.71%) males and 33 (94.29%) female patients.

The average age of the patients in group 1 was 41.94 ± 16.5 years, while for group 2 it was 56.29 ± 12.5 years. The difference in the mean age between the two groups is statistically highly significant (figure 1; $p < 0.001$).

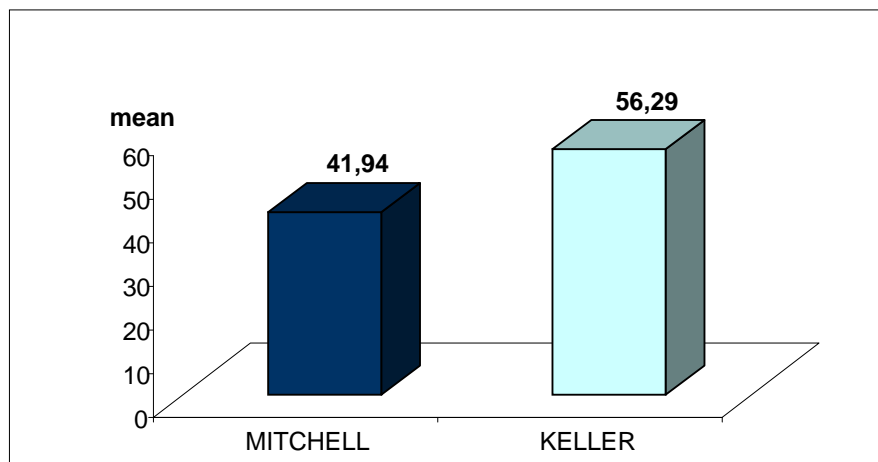


Figure 1 – Age of the patients

The majority of the patients from both groups complained of pain in the area of medial eminence, namely there was pain in 33 (94.3%) patients operated by the method of Mitchell, and in 34 (97.1%) patients operated by the method of Keller. A statistically significant difference was not registered ($p > 0.05$). Having done the operative intervention by the method of Mitchell, pain in the area of the front foot was felt by 3 (8.8%) patients, while the patients operated by the method of Keller did not suffer any pain after the operation. This difference in the patient distribution concerning those with and without pain after the correction of the foot deformity, and depending on the applied surgical technique, is certainly insufficient to be proved statistically, either ($p > 0.05$).

Metatarsalgia was registered in 25 (71.4%) patients operated by the method of Mitchell, and in 27 (77.1%) patients operated by Keller's technique. The tested difference for the presence and absence of metatarsalgia in the patients treated by the two different operative techniques was verified by the χ^2 test as statistically not significant ($p > 0.05$). Post-operatively, metatarsalgia was registered in 11 (32.3%) patients from the first group and 4 (11.8%) patients from the second group. In both groups, the majority of the patients did not have this symptom after the operative intervention, namely 23 (67.6%) patients treated by Mitchell's technique and 30 (88.2%) patients treated by Keller's technique. The differences concerning the presence and absence of metatarsalgia showed to be statistically not significant ($p > 0.05$) in both groups of patients.

An average dimension of the I metatarsophalangeal angle of 40.31 ± 7.6 degrees was measured in the group of patients treated by the method of Mitchell, before the operation, and it is not significantly greater ($p > 0.05$) than the average dimension of the same angle in the group of patients treated by the method of Keller, where its value is 37.49 ± 9.7 degrees (Table 1). The dimension of the I metatarsophalangeal angle in all patients was measured post-operatively during the follow-up examinations, namely 3 months and 1 year after the intervention. The average dimension of the I metatarsophalangeal angle in the patients operated by the method of Mitchell after 3 months was 16.97 ± 3.8 degrees, while in the patients operated by the method of Keller this average dimension was smaller and was 15.0 ± 1.7 degrees. This difference tested by the t test for independent samples was statistically highly significant, or important ($p < 0.01$). During the second follow-up examination, 1 year post-operatively, the average dimension of the I metatarsophalangeal angle in the patients in the first group was 18.66 ± 4.0 , and 15.83 ± 1.9 degrees in the patients in the second group. This difference was statistically highly significant, or important ($p < 0.001$; Table 2).

There is a non-significant difference in the pre-operative average values in the dimensions of the I intermetatarsal angle in the patients in both groups. Its value was 15.26 ± 3.9 degrees in the patients treated by the method of Mitchell and 14.97 ± 4.0 degrees in the patients treated by the method of Keller (Table 1). The average dimension of the I intermetatarsal angle, 3 months after the opera-

tion, was 10.83 ± 2.4 degrees (Mitchell), and it is significantly less ($p < 0.001$) than the average dimension of this angle treated by the method of Keller, which was 14.97 ± 4.0 degrees. This statistically significant difference ($p < 0.001$) in the average dimension of the I intermetatarsal angle between the two groups was confirmed 1 year after the operation, too (Table 3).

Table 1

I metatarsophalangeal / intermetatarsal angle – pre-operatively

Before operation	Mean M	SD M	Mean K	SD K	t-value	p
I metatarsophalangeal angle	40.31	7.6	37.49	9.7	1.36	0.18
I intermetatarsal angle	15.26	3.9	14.97	4.0	0.3	0.76

Table 2

I metatarsophalangeal angle – 3 months / 1 year post-operatively

After operation	Mean M	SD M	Mean K	SD K	t-value	p
I metatarsophalangeal angle – 3 months	16.97	3.78	15.0	1.66	2.82	0.006
I intermetatarsal angle – 1 year	18.66	3.99	15.83	1.93	3.77	0.00034

Table 3

I intermetatarsal angle – 3 months / 1 year post-operatively

After operation	Mean M	SD M	Mean K	SD K	t-value	p
I metatarsophalangeal angle – 3 months	10.83	2.36	14.97	4.0	-5.27	0.000001
I intermetatarsal angle – 1 year	11.26	2.58	14.97	4.0	-4.61	0.000018

Discussion

An important place is given to this deformity in the world literature as a complex orthopaedic problem. It has been a subject of numerous clinical studies during the past decades. This study resulted from the fact that this deformity is insufficiently elaborated in our environment, and it will contribute either in orthopaedic theory or orthopaedic practice.

Hallux valgus is the most frequent deformity of the foot. It presents a complex and progressive deformity which affects the front part of the foot, where the most emphatic change is the lateral deviation of the big toe. Concerning the type of deformity, the static one was the most prevalent in our study, but it is also represented in all scientific studies for this deformity [1, 12, 17].

The world literature data show a more frequent incidence of this deformity in women compared to men, which is the case in our study, too [4, 14, 19]. The mean age of the patients is 41 and 56 years of age, according to Mitchell and Keller respectively.

The diagnosis of hallux valgus deformity is based on the personal symptoms of the patient, at the clinical examination, and on the radiographic analysis. In the symptomatology, according to the available literature, the most frequent symptom is pain, while the other symptoms are found in a lesser or greater percentage [4, 13, 14]. In this study, too, pain is the dominant symptom, but although the pain lessens drastically after the operation in both groups, it does not represent a statistically significant difference ($p > 0.05$). The presence of metatarsalgia was highly prevalent in both groups of patients pre-operatively, but post-operatively it was less prevalent, especially in group 2, which can be explained by the change in the anatomic structures of the front foot. Statistic analysis of metatarsalgia between the groups did not show a significant difference ($p > 0.05$).

Based on the clinical parameters and radiographic variables, we can make a correct evaluation of the type and degree of the deformity. The angles and distances are manifested variables for studying the degree of the deformity. Radiographic findings should always be in correlation to clinical findings. Based on the clinical-radiographic analysis of the foot with hallux valgus, systematic following and adequate treatment of this deformity is possible [2, 3, 4, 19]. Our study, too, showed the usefulness of the classification according to Hardy and Clapham (1952) for the determination of the hallux valgus deformity degree in respect to the dimension of I metatarsophalangeal angle and I intermetatarsal angle pre- and post-operatively. The mean dimension of I metatarsophalangeal angle and I intermetatarsal angle post-operatively, in both groups, showed as significantly highly important ($p < 0.001$).

The changed ratios of the foot can be determined by the help of radiography, and in the later stages secondary arthrotic and reactive changes can also be determined [1, 2, 19]. The secondary arthrotic and reactive changes (subchondral sclerosis, degenerative cysts) in the area of I metatarso-phalangeal joint were not a frequent occurrence in the patients treated by the method of Mitchell, neither pre-operatively nor post-operatively. They were registered in 6 patients pre-operatively and in 7 patients after the intervention. Secondary arthrotic and reactive changes in the area of I metatarso-phalangeal joint were diagnosed pre-

operatively in 30 patients in the group surgically treated by the method of Keller, and that was the case with 31 patients post-operatively. In our study, as well as in world literature, the operative method of Keller showed as the “golden standard” for patients with arthrotic changes.

The treatment of hallux valgus is surgical. Numerous surgical procedures for the correction of this deformity have been described. They can be simple ablations with capsulographies up to complex operations such as arthrodesis, transfer of tendons, resection arthroplasty and different osteotomies of the I metatarsal bone. The operative procedure must protect the integrity of the anatomical structure of the joint [5, 6, 8, 17]. Another important deciding factor is the presence or absence of arthrosis in the joint. Especially important for indication a surgical procedure is always to bear in mind what the patient’s expectations are from the operation [9, 16, 20].

Conclusion

Clinical and radiographic analyses are of special importance in order to make a final decision for the type of operative treatment. In this study, the operative technique according to Mitchell showed to be an effective procedure for hallux valgus and metatarsus primus varus in young and middle-aged patients, while the resectional arthroplasty according to Keller’s method is a good procedure for correction of hallux valgus deformity in older patients having arthrotic changes.

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Резиме

**КЛИНИЧКА И РАДИОГРАФСКА АНАЛИЗА НА РЕЗУЛТАТИТЕ
ОД ОПЕРАТИВНИТЕ ПРОЦЕДУРИ СПОРЕД МЕТОДИТЕ
НА MITCHELL И KELLER ЗА КОРЕКЦИЈА
НА HALLUX VALGUS ДЕФОРМИТЕТ****Георгиева Д.¹, Попоска А.¹, Зафирова-Ивановска Б.²**

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Вовед: Целта на студијата е да се направи корелација на клиничките и радиографските резултати по примената на две различни хируршки процедури за корекција на hallux valgus деформитетот.

Материјал и методи: Во оваа студија беа вклучени 70 испитаници со hallux valgus деформитет на стапалото поделени на две групи. Првата група од 35 испитаници беа третирани со остеотомија на I метатарзална коска според Mitchell, додека другата група од 35 испитаници беа третирани со ресекциона артропластика според Keller. Во евалуацијата на испитаниците компаративно беа анализирани според клиничките (болка и метатарзалгија, како најдоминантни симптоми) и радиографските иследувања (I метатарзофалангеален агол и I интерметатарзален агол). Анализата на клиничките и радиографските резултати се изврши предоперативно, како и постоперативно меѓу двете групи.

Резултати: Според полот испитаниците беа застапени со 5 мажи и 65 жени, со просечна возраст $41,94 \pm 16,5$ години. Кај методот според Mitchell од оперираните 35 стапала постоперативно болката како клинички симптом беше застапена кај 3 испитаници, додека во другата група кај испитаниците оперирани според Keller болката не била присутна кај ниту еден пациент, што компаративно не дава статистички сигнификантна разлика ($p > 0,05$). Исто така и разликите во дистрибуцијата на застапеноста на метатарзалгијата не покажа статистичка значителност меѓу групите ($p > 0,05$). Испитаниците од двете групи несигнификантно ($p > 0,05$) се разликуваат во предоперативните просечни вредности на големината на I метатарзофалангеален агол и I интерметатарзален агол. Додека, радиографската анализа на истите агли кај двете групи една година постоперативно покажа високо статистички сигнификантна разлика, односно значителна ($p < 0,001$).

Заклучок: Mitchell оперативната техника може да се препорача како ефективна процедура за корекција на hallux valgus и metatarsus primus varus кај

млади и средовечни пациенти, додека ресекционата артропластика според Keller се препорачува кај повозрасни пациенти со артрозни промени.

Клучни зборови: hallux valgus деформитет, Keller, Mitchell, стапало.

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