ORIGINAL ARTICLE

Acta Orthop Traumatol Turc 2015;49(6):648–653
doi: 10.3944/AOTT.2015.14.0289

Modified Simmonds-Menelaus procedure for moderate or severe adult hallux valgus

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Objective: The purpose of this study was to present the clinical and radiological results of modified Simmonds-Menelaus technique, performed as a proximal, medially-based, open-wedge osteotomy of the first metatarsal, in cases of moderate or severe adult hallux valgus deformity.

Methods: Fifty-one feet of 47 patients underwent surgery due to hallux valgus. Mean age was 41.2±14.0 years, and mean follow-up period was 99.5±36.0 months. Patients were evaluated with standing anteroposterior (AP) and lateral radiographies obtained in the preoperative and early postoperative periods, and during final follow-up. The parameters of hallux valgus angle (HVA), intermetatarsal angle (IA), metatarsal distal phalangeal angle (MDPA), and first metatarsal length (ML) were measured. For clinical evaluation, American Orthopaedic Foot and Ankle Society (AOFAS) hallux metatarsophalangeal-interphalangeal (MTP-IP) scale was used.

Results: Mean preoperative HVA was 36.9°±7.3°, mean early postoperative HVA was 16.6°±6.2°, and mean final postoperative HVA was 28.9°±11.5°. Mean preoperative IA was 17.3°±4.5°, mean early postoperative IA was 8.8°±3.6°, and mean final postoperative IA was 14.3°±4.9°. Mean AOFAS hallux MTP-IP score was 71.9±20.1 at final follow-up.

Conclusion: From studies in the available literature, it is not clear whether the proximal open-wedge osteotomy technique itself is unsuccessful in adults or the lack of internal fixation led to failure. Application of an adequate fixation material should be used in order to avoid the collapse of the graft and to maintain the correction of the radiological parameters.

Keywords: Distal soft tissue release; hallux valgus; modified Simmonds-Menelaus procedure; proximal osteotomy.

Level of Evidence: Level IV Therapeutic Study

Hallux valgus is a common foot deformity, characterized by outstanding medial eminence, contracted soft tissue structures on the lateral side of the great toe, and increased intermetatarsal angle (IA) between the first and the second metatarsals.[1,2]

More than 150 surgical techniques have been described in the treatment of hallux valgus.[1,3] Operations are classified as soft tissue procedures, proximal or distal osteotomies, resection arthroplasties, or arthrodesis. To aid surgeons in choosing the ideal corrective surgical

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Submitted: August 15, 2014 **Accepted:** April 25, 2015

Available online at www.aott.org.tr
doi: 10.3944/AOTT.2015.14.0289
QR (Quick Response) Code

method, the required clinical and radiological evaluations have been comprehensively described.

Several internal fixation methods have been described for fixation of the osteotomy site, such as Kirschner wiring, application of compression or bioabsorbable screws, staple fixation, and locking plating.[4,5] However, these methods present risks such as implant failure, infection, articular damage, and local skin disorders with the application of implants.[6] In 1923, Trethowan first introduced opening base wedge osteotomy as a correction for severe bunion deformity in juvenile or adolescent patients.[7] The procedure included resection of the hypertrophic medial eminence and the use of it as bone graft for the proximal transverse opening wedge osteotomy, without fixation. Simmonds and Menelaus performed this procedure with distal soft tissue reconstruction.[8] They did not apply any internal fixation to fix the osteotomy. In 2002, Andreacchio et al. modified the procedure by performing the osteotomy incompletely, though they applied their technique only in adolescent patients.[9]

In this study, we present the clinical and radiological results of modified Simmonds-Menelaus technique performed with proximal open-wedge incomplete osteotomy of the first metatarsal bone, excision of the bunion, and distal soft tissue reconstruction at the first metatarsophalangeal joint in adult patients with moderate or severe hallux valgus deformity.

Patients and methods

One hundred twenty-four feet of 112 patients who underwent surgery due to hallux valgus, using the proximal metatarsal open-wedge osteotomy and soft tissue technique, during the period from March 1997 to March 2008 were included in this study. Informed consent was obtained from the patients. Fifty-one feet of the 47 patients of whom medical records could be accessed were included in the study. The remaining patients did not complete follow-up. Mean age was 41.2±14.0 years (median: 44 years; range: 24–68 years) at time of surgery. Forty-one of the patients (87.3%) were female, and 6 (12.7%) were male. Mean follow-up period was 99.5±36.0 months (median: 47 months; range: 60–192 months). According to Coughlin's classification, all patients had moderate (hallux valgus angle [HVA]>40°, IA>13°) or severe (HVA 41–50°, IA 16–20°) deformity.[10]

Patients were evaluated with standing anteroposterior (AP) and lateral radiographies of the feet obtained in the preoperative and early postoperative periods, and at final follow-up (Figure 1). The parameters of HVA, IA, metatarsal distal phalangeal angle (MDPA), first metatarsal length (ML) distal metatarsal articular angle (DMAA), and proximal phalangeal articular angle (PPAA) were measured. Sesamoid position was used for evaluation of the congruency of the articular surface and the presence of arthrosis. Clinical evaluation was performed using the American Orthopaedic Foot and Ankle Society (AOFAS) hallux metatarsophalangeal-in-

Fig. 1. Postoperative AP radiographies of a patient: **(a)** preoperative, **(b)** early postoperative, **(c)** at final follow-up.

terphalangeal (MTP-IP) scale. To measure satisfaction rate, patients were asked if they were satisfied with the procedure or not. Range of motion (ROM) of the first metacarpophalangeal (MP) joint was measured with a hand-held goniometer. Cuneiform-first metatarsal joint stability and the presence of callosities were determined. An HVA ≥20° at final follow-up was considered a recurrence.[11]

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 10.0 software (SPSS Inc., Chicago, IL, USA). The level of significance was determined as $p<0.01$. Results are given as mean±standard deviation. When the data were considered to be in normal distribution, paired-sample t-test was performed to determine differences between the 2 groups (preoperative and final follow-up). In addition, Pillai's trace test was used when evaluating multiple dependent variables, such as HVA and IA parameters, with regard to decent time periods. In other cases, Wilcoxon signed-rank test was used to compare the differences between preoperative and postoperative joint congruency and sesamoid congruency so does not assume normality in the data.

Surgery was performed under spinal or general anesthesia, with application of a tourniquet on the thigh. This procedure was performed through 2 incisions. The first incision was approximately 2 cm in length and made dorsally in the intermetatarsal space to release the adductor hallucis tendon, the deep transverse ligament, and the lateral capsule of the MP joint to allow the passive medial deviation of the hallux. The second incision was started on the medial side of the first metatarsal basis and extended 5 to 6 cm to the proximal side of the first metatarsal. During the surgical exposure, the extensor hallucis longus tendon, dorsal, and plantar sensory nerves of the hallux were protected. Periosteal stripping was avoided as much as possible. The osteotomy was performed perpendicular to the metatarsal shaft from the medial cortex to the lateral, 1.5 to 2 cm distally from the medial aspect of the first tarsometatarsal joint. Preservation of the lateral cortex was attempted. However, in some cases, cortical cracks extended from the osteotomy site. These cracks did not affect preoperative stability; most were noticed in early postoperative X-rays. Local bone graft obtained by resection of the bunion was routinely added, as described in the original technique. The medial capsule was plicated using nonabsorbable sutures. The tissues were enclosed anatomically. Short leg cast immobilization was performed for 3 weeks postoperatively. During this period, weight-bearing was not permitted.

Results

Thirty (58.8%) of the 51 feet were right and 21 (41.2%) were left. Four of the patients were operated bilaterally. Mean preoperative HVA was 36.9°±7.3° (range: 20–55°), mean early postoperative HVA was 16.6°±6.2° (range: 6–35°), and mean final follow-up HVA was 28.9°±11.5° (range: 8–54°). According to Pillai's trace test, when the early postoperative HVA was compared with the preoperative HVA, it was found to have significantly decreased ($p<0.01$), and when the final follow-up HVA was compared with the preoperative HVA, it was also found to have significantly decreased ($p<0.01$). However, when the final follow-up HVA was compared with the early postoperative HVA, it was found to have significantly increased ($p<0.01$).

Mean preoperative IA was 17.3°±4.5° (range: 7–28°), mean early postoperative IA was 8.8°±3.6° (range: 1–18°), and mean final postoperative IA was 14.3°±4.9° (range: 6–28°). According to Pillai's trace test, when the early postoperative IA was compared with preoperative IA, it was found to have significantly decreased ($p<0.01$), when the final follow-up IA was compared with the preoperative IA, it was found to have significantly decreased ($p<0.01$), and when the final follow-up IA was compared with the early postoperative IA, it was found to have significantly increased ($p<0.01$).

Mean preoperative MDPA was 90.2°±4.8° (range: 80–108°), mean early postoperative MDPA was 97.0°±6.6° (range: 84–115°), and mean final follow-up MDPA was 92.5°±5.6° (range: 80–105°). According to Pillai's trace test, the early postoperative MDPA was found to have significantly increased in comparison with the preoperative MDPA ($p<0.01$), the final follow-up MDPA was found to have increased in comparison with the preoperative MDPA (the differences were not significant; $p>0.01$), and the final follow-up MDPA was found to have significantly decreased in comparison with the early postoperative MDPA ($p<0.01$).

Mean preoperative DMAA was 16.1°±6.4° (range: 5–38°), mean final follow-up DMAA was 18.4°±7.5° (range: 8–42°); the differences were significant, according to paired-sample t-test ($p<0.01$).

Mean preoperative PPAA was 2.8°±3.4° (range: 0–10°), mean final follow-up PPAA was 3.1°±3.6° (range: 0–12°); the differences were not significant, according to paired-sample t-test ($p>0.01$).

Mean preoperative ML was 51.2±4.8 mm (range: 52–70 mm), and mean final follow-up ML was 52.2±5.7 mm (range: 52–74 mm). Final follow-up ML was found to have significantly increased in comparison with preop-

Table 1. The outcomes obtained in the preoperative and early postoperative periods, and at final follow-up.

	Preoperative	Early postoperative	Final follow-up	Statistical analysis
Hallux valgus angle (HVA)	36.9°±7.3° (20–55°)	16.6°±6.2° (6–35°)	28.9°±11.5° (8–54°)	p<0.01 Pillai's trace test
Intermetatarsal angle (IA)	17.3°±4.5° (7–28°)	8.8°±3.6° (1–18°)	14.3°±4.9° (6–28°)	p<0.01 Pillai's trace test
Metatarsal length (ML)	51.2±4.8 (52–70) mm	–	52.2±5.7 (52–74) mm	p<0.01 Paired t-test
Joint congruency	27 patients (52.9%) congruent	–	18 patients (35.3%) congruent	p>0.01 Wilcoxon signed-rank test
	24 patients (47.1%) incongruent	–	33 patients (64.7%) incongruent	

erative ML, according to paired-sample t-test (p<0.01).

Although differences of the joint congruency were significant (p<0.01), differences of the sesamoid congruency were not significant (p>0.01, Wilcoxon signed-rank test). The results are summarized in Table 1.

Mean AOFAS hallux MTP-IP scale value was 71.9±20.1 (range: 20–100) at final follow-up. Mean first metatarsophalangeal joint (MTPJ) dorsiflexion was 36.5°±19.5° (range: 5–50°), and mean plantar flexion was 17.1°±12.2° (range: 0–40°). Satisfaction rate was found as 78% (40 feet), and the remaining 22% of patients (11 feet) were not satisfied with the procedure

There were recurrences in 37 cases (72%). Transfer lesions developed in 2 cases (4%), in which the patients experienced pain under the second metatarsal head and had plantar callus. One patient developed hallux varus due to overcorrection. Superficial infection developed in 1 patient during the early postoperative period. Oral antibiotherapy was given, and it healed without sequela.

Discussion

The most common indication for a proximal first metatarsal osteotomy joined with distal soft tissue reconstruction is reported as a moderate or a severe hallux valgus deformity (HVA>35°, IA>13°) with subluxation of the first MP joint.[12] An osteotomy at the base of the metatarsal has several advantages. Cancellous bone and wide contact surface of the osteotomy line allow quick healing and stability. Small angular changes at the osteotomy side may provide adequate correction at the distal end of the metatarsal. Proximal metatarsal osteotomy that directs the first metatarsal to deviate laterally causes reduction in the IA. Thus, a correction in greater intermetatarsal angles can be achieved. Usually, 1 mm of opening in the osteotomy site causes 3° of IA reduction.[13] In our series, the early postoperative radiographies demonstrate the reduction of the deformity, with the IA reduced from 17.3° to 8.8°.

Proximal metatarsal osteotomies are rotational osteotomies. Therefore, all proximal osteotomies cause an increase in DMAA, and high DMAA is a contraindication for rotational osteotomies.[14] Our study additionally demonstrated the increase of DMAA postoperatively.

Simmonds and Menelaus performed 33 operations in patients aged between 9 and 18 years.[8] They reported good results in 26 cases, moderate results in 4 cases, and poor results in 3 cases. They proposed this technique as an appropriate procedure in the treatment of hallux valgus in adolescent patients and recommended the operation to be performed between the ages of 11 and 15 years for the best results.[8] Andreacchio et al.[9] modified Simmonds and Menelaus' surgical technique, leaving the lateral cortex of the first metatarsal bone intact. Surgery was performed in 20 feet of 11 patients; mean age was 12.4 years, and mean follow-up period was 2.9 years. Mean preoperative hallux valgus angle was 31.2°, which was reduced to 17.8° postoperatively. Mean IA improved from 13.5° to 11.3°. Andreacchio et al. suggested that the stability obtained with an incomplete osteotomy site where the lateral cortex was left intact was greater than that of complete osteotomy. A non-weight-bearing (NWB) below knee cast was applied for 3 weeks in all patients. According to functional evaluation, the authors had 4 excellent and 16 good results.[9] We performed this modification of the technique in adult patients due to high potential of deformity correction and the practical application. The rationales for performing this procedure, even when application of an implant was absent, were the high potential of the proximal osteotomy to correct the deformity, to avoid implant related complications and a second surgery to remove the implants, and to decrease the cost of surgery, as an implant was not applied. Unfortunately, although the technique was practical to perform, the clinical and the radiological results were not as satisfactory as expected. Although the explanation for failure can be attributed to the lack of stability provided by an internal fixation device, it is not possible to determine this to be the main factor, as the present study did not include a control group with internal fixation.

In their study, Badekas et al. used a similar technique in 107 feet of 85 patients with a mean age of 56 and a mean follow-up period of 4 years.[15] While they used bone fragment extracted from the bunion as an autograft, they chose a wedge locking plate with a central spacer to fix the osteotomy site. In their results, mean IA was found to have decreased from 15.8° (range: 12–22°) preoperatively to 7.8° (range: 2–12°) postoperatively, and this angle remained constant from the time of union to final follow-up. Mean preoperative HVA was 39° (range: 21–52°), and mean postoperative HVA was 11.8° (range: 6–19°). Mean HVA at final follow-up was 12.7° (range: 6–30°). They found a recurrence rate of 1.8%.

Nery et al. performed a similar proximal osteotomy technique, with application of a wedge locking plate with a central spacer, in 70 feet.[16] In their study, mean age was 52 years at the time of the surgery. Although they performed a proximal osteotomy similar to ours, they did not perform a distal soft tissue procedure, and in some patients they performed a distal chevron or Akin osteotomy. They reported that they obtained a statistically significant correction of HVA, IA, and DMAA. The correction remained constant in this study.

In our series, although adequate correction was achieved in the early postoperative period in HVA and IA, at final follow-up it, was found that an amount of correction in IA was lost after the early postoperative period. In addition, there was a relatively high rate of recurrence (72%). When compared with the studies of Badekas et al. and Nery et al., it seems that the lack of a stable fixation in our patients led to the collapse of the graft in the osteotomy site.

An opening wedge proximal metatarsal osteotomy may modestly lengthen the metatarsal.[13] Badekas et al. reported a metatarsal lengthening of 1.2 mm in their study.[15] Similarly, our study confirms that proximal opening wedge osteotomy lengthens the metatarsal. We found a modest lengthening of the metatarsal following opening wedge osteotomy. Mean lengthening was 0.9 mm. These differences did not have a negative effect on the functional results. According to our results, metatarsal length seemed to continue to increase after the early preoperative period. However, this finding is not possible, and we attribute it to measurement errors. In 2 patients (4%), new transfer lesions were observed postoperatively. When evaluated, it was found that the patients with transfer lesions were the ones in whom the metatarsal length did not change at final follow-up. Toth et al. reported that development of metatarsalgia after correction of the hallux valgus was highly correlated with shortening of the first metatarsal.[17]

Only 51 cases of 124 operated feet could be evaluated. The remaining did not complete follow-up. It is not certain if these patients failed to complete follow-up due to good results or recurrences that required operation in other institutions. This aspect is a weak point of our study. The other limitations of the study are the retrospective design and lack of preoperative AOFAS scores, as well as the lack of comparison with a group in which the same procedure had been performed using internal fixation materials. The strong points of the study are the homogenous patient group and the long follow-up period.

In conclusion, in comparing our results with those in the literature, we concluded that proximal metatarsal osteotomy and soft tissue reconstruction via modified Simmonds-Menelaus procedure is an easy and practical technique in the treatment of moderate and severe hallux valgus deformity. However, with a very high rate of recurrence and low rates of patient satisfaction, it is not a convenient method in older patients, as it cannot sufficiently maintain correction of the radiological and clinical parameters in the long term. When compared with the results of studies which achieved good results in adolescents and with the use of internal fixation methods, it is not clear whether the proximal open-wedge osteotomy technique itself is unsuccessful in adults or the lack of internal fixation led to failure. The application of an adequate fixation material should be performed in order to avoid collapse of the graft and to maintain the correction of the radiological parameters. However, new studies with control groups, in which the same technique is performed using internal fixation methods, are required for a more definitive conclusion.

Conflics of Interest: No conflicts declared.

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