

Modified Lindgren-Turan Osteotomy for Hallux Valgus Deformity – a Review of 60 Cases

Modifikovaná Lindgrenova-Turanova osteotomie pro hallux valgus – zhodnocení 60 případů

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ABSTRACT

PURPOSE OF THE STUDY

To evaluate the clinical and radiological results of a new modification of relatively less-known Lindgren-Turan osteotomy technique in HV deformity that is performed by combining bunionectomy and capsuloplasty.

MATERIAL AND METHODS

60 feet of 52 patients with moderate and heavy deformity who were operated between 2009 and 2014 were included in the study. The patients had clinically severe pain, did not respond to at least 6-month conservative treatment and had moderate and severe deformity before Hallux valgus angle (HVA), intermetatarsal angle (IMA), distal metatarsal joint angle (DMAA), proximal phalangeal joint angles (PPAA) and shortening amount in the first metatarsus were measured through preoperative and follow-up radiography. Clinical evaluations were conducted on all patients using American Orthopedic Foot and Ankle Society's (AOFAS) and visual analog scale (VAS). Data of the radiological and clinical evaluations in preoperative and follow-up periods were compared statistically. Statistical significance was accepted at $p < 0.05$.

RESULTS

42 (76.1%) and 10 (23.9%) of 52 patients were female and male, respectively. Mean age of the patients was 50.9 ± 15.52 years. Mean follow-up period of the patients was 43.3 ± 2.1 . Preoperative and last measurements: HVA: $36.34^\circ \pm 6.36^\circ - 15.6^\circ \pm 2.83^\circ$, IMA: $12.62^\circ \pm 2.24^\circ - 5.83^\circ \pm 1.32^\circ$, DMAA: $16.3^\circ \pm 3.45^\circ - 10.3^\circ \pm 2.24^\circ$, PFAA: $7.24^\circ \pm 1.32^\circ - 6.12^\circ \pm 0.84^\circ$ ($p < 0.001$). Shortness of first metatarsus was measured to be 5.94 ± 1.84 mm.

Mean VAS values of the patients which was 8.6 ± 0.4 before the operation was detected as 0.8 ± 0.04 after follow-up ($p < 0.001$). AOFAS score of the patients which was 42.4 ± 5.3 before the operation was found to be 88.9 ± 7.6 ($p < 0.001$). All patients started to work again within 5.22 ± 1.7 weeks. Union was completely seen along osteotomy line in all cases. Three patients had screw extraction. Two patients had superficial wound infection.

DISCUSSION

Capsule plication which we apply with osteotomy as part of our surgical procedure is a significant point in correcting deformity and raising stability. First metatarsophalangeal rigidity risk can be avoided with a controlled plication in operation and by giving the final decision after testing. Such flexibility shows that soft tissue contracture is not the main factor of deformity, so lateral release is not indicated. Thus, our opinion is that digital nerve damage and extra scar are avoided during lateral release. The osteotomy we applied which is extraarticular and subcapital, and protection of racket-shaped capsule cannot be attributed to finding no AVN case.

CONCLUSIONS

Modified Lindgren-Turan surgical procedure which is applied with capsuloplasty and bunionectomy is an effective and reliable method in treatment of moderate and severe HV deformities. It is recommended as a satisfactory option in HV treatment due to its ease in surgery, use of single incision and perfect clinical and radiological long-term results.

Key words: hallux valgus, osteotomy, Lindgren-Turan, capsuloplasty, capsulorrhaphy, bunionectomy, plication.

INTRODUCTION

Hallux valgus (HV) is one of the most common deformities that affect the first array of the foot. Subluxation of the first metatarsal joint is accompanied by lateral deviation of hallux and medial deviation of the first metatarsus. The most apparent feature of the deformity is a medial bunion. Pain and discomfort result from

damaged dorsal cutaneous nerve and inflammation of bursa at medial height (4, 5).

The operations that contain various soft tissue or bone procedures or combined procedures are performed as part of surgical treatment of HV. Particularly osteotomy operations are suggested in literature due to its high success rates and being a reliable treatment option (21).

The technique for correcting HV deformity should depend on the deformity and individual correction strength of a definite technique. Joint alignment, existence of arthritis, hallux valgus angle (HVA) of the first metatarsophalangeal joint (MTP), intermetatarsal angle (IMA) and distal metatarsal joint angle (DMAA) are basic factors used to determine the surgical technique (4, 5, 18). Proximal osteotomies are known to be stronger techniques for correcting HV deformities with high IMA (over 17–18 degrees) or it is advised that they are applied with distal osteotomies in cases of heavy deformity or they are used singly. Distal osteotomies are preferred in the event of moderate deformities which have joint alignment, especially for correcting DMAA angle.

Clinicians should endeavor to ensure the ideal alignment and correction. Used in HV deformity, Lindgren-Turan osteotomy is a subcapital and transverse replacement osteotomy of the first metatarsus which is especially recommended for moderate cases and does not require additional capsular repair (13).

Purpose of our study is to evaluate the clinical and radiological results of a new modification of relatively less-known Lindgren-Turan osteotomy technique in HV deformity that is performed by combining bunionectomy and capsuloplasty, among the patients with moderate and heavy deformity.

MATERIAL AND METHODS

60 feet of 52 patients with moderate and heavy deformity who were operated between 2009 and 2014 were included in the study. In all cases, the patients had clinically severe pain, did not respond to at least 6-month conservative treatment and had moderate and severe deformity before (HVA: 20°–40°, > 40°; IMA: < 16°, > 16°) (3). The patients who had the history of degenerative arthritis, peripheral vasculopathy, diabetes mellitus, neuromuscular disorders, disorders of general joint laxity, inflammatory arthritis and foot surgery or foot fracture were excluded from the study.

Weightbearing anteroposterior and lateral radiographs of the entire foot preoperatively, immediate postoperatively and at the latest follow-up were used for the radiographical examination. The third author, who did not perform surgery, measured the angles. Hallux valgus angle (HVA), intermetatarsal angle (IMA), distal metatarsal joint angle (DMAA), proximal phalangeal joint angles (PPAA) and shortening amount in the first metatarsus were measured through preoperative and follow-up radiography (Fig. 1).

HVA was measured as the angle between the antero-posterior line that connects the centers of the first metatarsal base and metatarsal head, and the line that connects the centers of proximal and distal joint surfaces of proximal phalanx (14).



Fig. 1. Radiological measurements.

Measured IMA was the angle between the line that halves the diaphysis part of the first metatarsus and the second metatarsus.

DMAA describes the relationship between the joint surface of the first metatarsal distal joint and long axis of metatarsus in antero-posterior radiography. The points which are placed the most medial and the most lateral side of the first metatarsal head are used to determine DMAA. A line that connects these two points which define "lateral slope" of distal metatarsal joint surface is drawn. Afterwards, a line which is perpendicular to that line is drawn. The angle that is determined with this perpendicular line by longitudinal diaphysis axis of the first metatarsal defines DMAA (16).

PPAA is the angle between the joint surface of proximal phalanx and longitudinal axis of proximal phalanx.

Shortening of the first metatarsus was measured with Grace method (7).

During preoperative and last controls, clinical evaluations were conducted on all patients using American Orthopedic Foot and Ankle Society's (AOFAS) and visual analog scale (VAS). AOFAS was discussed as pain (40 points), joint alignment (15 points) and functional evaluation (45 points).

In statistical analyses, Statistical Package for Social Sciences (SPSS) software (version 21.0, SPSS Inc., Chicago, IL, USA) was used. The paired Student's *t* test was used to compare the preoperative and postoperative outcomes. Statistical significance was accepted at $p < 0.05$.

Data of the radiological and clinical evaluations in preoperative and follow-up periods were compared statistically.

Surgical technique

Operations were performed under the guidance of fluoroscopy and a pneumatic tourniquet was used at thigh level during the process. Modified Lindgren-Turan surgery was applied with an anteromedial skin incision of 5 cm via MTP joint (Fig. 2). A flap in the form of a racket was removed in a way that a base will form on proximal phalanx with capsule periost, and bunionectomy was applied (Fig. 3). A horizontal line was marked at



Fig. 2. Surgical incision.

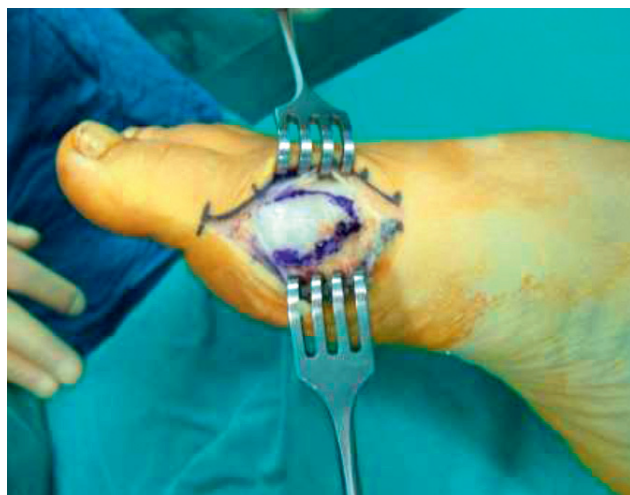


Fig. 3. Racket-shaped flap.



Fig. 4. Fixation of osteotomy with 2.7-mm screw.

the bottom of metatarsal head and a 30°-inclined osteotomy was performed transversely at about 1.50-cm proximal from metatarsal head. Fixation was ensured with 2.7-mm compression screw by obtaining a suitable alignment after lateralization of maximum distal segment



Fig. 5. Capsule traction.



Fig. 6. Postoperative view of the foot.

(Fig. 4). Capsuloplasty was carried out. The first suture (2-0 Vicryl) was moved back initially on the plane between the capsule and skin from proximal direction of the patient and then at almost 10-mm distal (Fig. 5). Suture was repeated from a proximal distance of approximately 5–10 mm. Applied medial capsule was fastened to capsule part and fastening process was performed as the deformity was held in completely-corrected position. Then, movements of the first MTP joint were tested and it was verified that capsule does not lead to limitation of movement and overcorrection of varus position. Subcutaneous tissue and skin were closed in a standard way. None of our patients was applied lateral release (Fig. 6).



Fig. 7. AP X-ray image after union.



Fig. 8. Loosening of the screw in the left foot.



Fig. 9. Operated hallux valgus after removal of screw.

Post-operative management

Operated area was covered with support bandage after the operation and any plaster or splint was not used for the patients. Bandage was used for three weeks to support the neutral alignment following the operation. Patients were encouraged to use special hallux valgus shoes as much as they tolerate.

RESULTS

Fourty-two (76.1%) and 10 (23.9%) of 52 patients were female and male, respectively. Mean age of the patients was 50.9 ± 15.52 (Distribution: 35–71) years. Mean follow-up period of the patients was 43.3 ± 2.1 (Distribution: 12–62) months.

Mean VAS values of the patients which was 8.6 ± 0.4 before the operation was detected as 0.8 ± 0.04 after follow-up and a statistically significant decrease was found ($p < 0.001$) (Table 1). AOFAS score of the patients which was 42.4 ± 5.3 before the operation was found to be 88.9 ± 7.6 and such increase was statistically significant ($p < 0.001$) (Table 1). On average, the following decrease were found out during the preoperative and last measurements: HVA: $36.34^\circ \pm 6.36^\circ - 15.6^\circ \pm 2.83^\circ$, IMA: $12.62^\circ \pm 2.24^\circ - 5.83^\circ \pm 1.32^\circ$, DMAA: $16.3^\circ \pm 3.45^\circ - 10.3^\circ \pm 2.24^\circ$, PFAA: $7.24^\circ \pm 1.32^\circ - 6.12^\circ \pm 0.84^\circ$. There was a statistically advanced significant difference between the results ($p < 0.001$) (Table 2). Mean shortness value along the first metatarsus was measured to be 5.94 ± 1.84 mm (Range: 2–10) (Table 2). It was observed that all patients started to work again within 5.22 ± 1.7 weeks (Range: 4–8) (Table 2). All patients could perform their preoperative activities successfully in postoperative week 12. Union was completely seen along osteotomy line in all cases (Fig. 7). Screw extraction was applied under local anesthesia upon one patient's complaint about pain due to loosening screw in month 23 (Fig. 8). and two patients' complaint about not wearing narrow and closed-toe shoes because of screw irritation (Fig. 9). It was observed that two patients had superficial wound infection which recovers with antibiotic therapy and dressing.

Table 1. Clinical evaluation

	Preoperative	Postoperative	P ^x value
AOFAS	42.4 ± 5.3	88.9 ± 7.6	< 0.001
VAS	8.6 ± 0.4	0.8 ± 0.04	< 0.001

Table 2. Radiological evaluations

Angle	Preoperative	Postoperative	P ^x value
HVA	34.3 ± 6.3	15.6 ± 2.8	< 0.001
IMA	12.6 ± 2.1	5.8 ± 1.3	< 0.001
DMAA	16.3 ± 3.4	10.3 ± 2.2	< 0.001
PPAA	7.2 ± 1.3	6.1 ± 0.8	< 0.001

Table 3. Additional evaluations

Metatarsal shortening	5.94 ± 1.84 mm
Back to work	5.22 ± 1.7 weeks

DISCUSSION

Main goal of HV treatment is to kill the pain, to correct deformity and to enable comfortable movement with standard shoes (7). First and second metatarsus are generally approached during surgery as proximal phalanx is aligned with the first metatarsus. Surgical methods used in the treatment of hallux valgus contain MP joint soft tissue reconstructions, distal or proximal osteotomies of the first metatarsus, cuneiform osteotomy, MP joint arthrodesis, excisional arthroplasty and joint prostheses. Even though there are identified standard algorithms, each patient should be evaluated individually.

Lindgren-Turan technique is a distal metatarsal osteotomy method. Distal part is fastened by sliding distal part to lateral after the osteotomy which is performed with 30-degree angle from the lower metatarsal head in classical procedure. Thus the space between two metatarsus is narrowed. Capsule is not opened and any soft tissue intervention is not applied additionally. It is

defined as a simple and effective procedure relatively. Shortening amount was minimized by narrowing angle of osteotomy. In literature, it is stated that a satisfactory correction is achieved at HVA and IMA and successful functional results are obtained by using this procedure (2, 6, 13, 22).

Another commonly-used procedure among the alternatives of distal osteotomy is chevron osteotomy. In this osteotomy technique that is preferred particularly for stability in our opinion, double-plane bone incision has technical drawbacks compared to Lindgren-Turan osteotomy in which a single-plane incision is used. We think an advantage of single-plane osteotomy is that better cosmetic results are reached with an additional external rotation of almost 5 degrees especially in cases with high DMMA. Although original technique does not include rotational correction, we apply it especially to correct the cases of severe hallux valgus.

Importance of medial capsule for HV deformity was evaluated in a study on cadaver. According to result of the study, medial capsule is an important component for stabilizing the first MTP joint. It was suggested that medial capsular plication should be performed in HV surgery (11). In a study, it was reported that capsule plication allows further correction of deformity and contributes to alignment of proximal phalanx and re-positioning of sesamoids (15). That's why we advise that capsule plication should be applied to align proximal phalanx especially in severe cases. We want to underline that capsule plication which we apply with osteotomy as part of our surgical procedure is a significant point in correcting deformity and raising stability, and its contribution to long-term satisfactory outcomes is undeniable. A criticized aspect of capsulotomy and capsule plication is that it may lead to limitation of MP joint movements. In particular, dorsiflexion of MTP joint is important for the women to wear high-heel shoes. In literature, limitation and rigidity ratio of MTP joint movements varied between 0% and 37.8% in osteotomies that are applied through open surgery technique containing capsulotomy (1). In our study, any limitation of movement in MTP joint was not seen among our patients during the application of the surgical procedure. We think that rigidity risk can be avoided with a controlled plication in operation and by giving the final decision after testing.

Another debated point of HV surgery is the application of lateral release (9). None of the cases was subjected to lateral release in our series. In literature, complications such as decreased movement range of the first MTP joint, dorsal or plantar lateral digital nerve damage and cosmetic dissatisfaction due to extra scar were reported after this lateral release procedure. In this regard, our criterion is that deformities with HV can be corrected passively through manual flat traction of toe. We believe

such flexibility shows that soft tissue contracture is not the main factor of deformity, so lateral release is not indicated. Thus, our opinion is that digital nerve damage and extra scar are avoided during lateral release.

Greatest expectations of patients from HV surgery is killing the pain, increase in walking ability and using shoes with no pain (10, 19). We consider that AOFAS scoring is sufficient for evaluating these issues extensively. We suggest that considerably significant increase in postoperative AOFAS values of the patients who were treated with our surgical procedure is an important criteria for showing the effectiveness of the surgical treatment.

Greatest criticism brought to surgical procedures in which joint capsule is opened is that they cause the formation of avascular necrosis. Essential points of the surgery for minimizing the avascular necrosis (AVN) risk of the first metatarsal head is to protect the placement of joint capsule and preventing over-penetration of lateral cortex (8, 17, 20). We advocate the osteotomy we applied which is extraarticular and subcapital, and protection of racket-shaped capsule cannot be attributed to finding no AVN case in metatarsal head among all patients in our study.

Our study contains several limitations. The first limitation is relatively low number of patients. The second one is that rate of patients with heavy deformity in our study group was low. We think that higher number of patients and longer follow-up periods are required for supporting the safety of this procedure particularly in patients with severe deformities. However, we assert at the end of our study that applying Lindgren-Turan osteotomy efficiency of which was proved in cases of moderate HV, in company with capsuloplasty is more effective on the correction of deformity and can be an alternative for the patients with severe deformities.

CONCLUSIONS

Our study demonstrated that (modified) Lindgren-Turan surgical procedure which is applied with capsuloplasty and bunionectomy is an effective and reliable method in treatment of moderate and severe HV deformities. It is recommended as a satisfactory option in HV treatment due to its ease in surgery, use of single incision and perfect clinical and radiological long-term results.

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