



Original article

# SERI Osteotomy vs. Soft-Tissue Tendon–Muscle Plastic Surgery for Hallux Valgus: A 2-Year Follow-up of Clinical and Radiological Outcomes

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## Abstract

Hallux valgus is a frequent deformity causing pain and functional limitations. The absence of a single standard among the majority of surgical techniques remains a subject of ongoing clinical interest and of choosing the most effective operative solution.

**The aim of this study:** To compare the long-term clinical and radiographic results of SERI osteotomy versus tendon-muscle plastic surgery (TMP) for hallux valgus correction over a 24-month follow-up.

**Methods.** This single-center retrospective study has included 60 patients (111 feet) treated with SERI and 42 patients (77 feet) with TMP. Functional outcomes (AOFAS Hallux scale) and radiographic parameters (HVA, IMA, DMAA) have been assessed at baseline and at 3, 6, and 24 months.

**Results.** Both groups showed significant functional improvement at 24 months (AOFAS: 55.32±9.80 to 79.46±15.28 in SERI; 56.26±10.02 to 83.57±13.49 in TMP; p<0.001). HVA improved in both groups, with significantly lower postoperative HVA in the SERI group at all follow-up points (p<0.05). IMA decreased significantly in both groups with no between-group differences. DMAA improved in both groups; postoperative DMAA values were lower in the TMP group at 3, 6, and 24 months (p≤0.001), though the overall change from baseline did not differ between the groups.

**Conclusion.** Both SERI and TMP provide significant functional improvement (AOFAS scores) and effective radiographic correction at 24 months. While SERI achieved greater HVA correction and TMP resulted in lower postoperative DMAA values, functional outcomes and IMA correction were comparable between the techniques.

**Keywords:** Hallux valgus, metatarsal, osteotomy, tendons/surgery, hallux varus.

## 1. Introduction

One of the most common deformities of the forefoot, which in itself can result in substantial levels of pain, function, and impact on quality of life, can be defined as hallux valgus (HV), described as the progression of lateral displacement of the hallmark and

medial displacement of the first metatarsal, thereby disturbing the biomechanics of the forefoot and influencing the abnormal loads within the metatarsophalangeal joint [1,2,3]. As the deformity progresses, patients often develop secondary

complications like metatarsalgia, transfer lesions, gait disturbances, and difficulty with footwear, all of which substantially affect daily activity and overall functional capacity [4-6].

Hallux valgus is recognized as one of the most widespread orthopedic pathologies, affecting between 23% and 35% of the global adult population, according to various studies. Epidemiological data indicate a clear correlation between the prevalence of the condition and age: while it affects approximately 23% of middle-aged individuals, this figure reaches 36% or higher among patients over the age of 65. Furthermore, a pronounced gender imbalance is observed across all age groups, with women suffering from this deformity significantly more often than men [7-9].

For instance, conservative measures that incorporate footwear, artificial devices, spacers, and activity modifications are regarded as the first line of treatment in managing hallux valgus [10-12]. Nevertheless, in situations where there are complaints of persistent pain, progressive deformity, and disabling functional problems, surgery offers a definitive and final treatment solution [13]. The aim of surgical intervention in managing hallux valgus is not just cosmetic; rather, healing enables biomechanical, anatomical, and painful correction [14].

More than one hundred surgical techniques have been described for hallux valgus correction, reflecting the multifactorial nature of the deformity and the lack of a universally accepted optimal procedure [15]. The assessment of surgical outcome in the contemporary era generally employs a combination of functional assessment and radiographic outcome parameters. The American Orthopedic Foot and Ankle Society (AOFAS) score is often employed as an effective functional assessment tool in evaluating the outcome of hallux valgus surgery [16], and in radiographic terms. Assessment is often carried out regarding the hallux valgus angle (HVA), intermetatarsal angle (IMA), and distal metatarsal articular angle (DMAA) [13]. Although functional improvement represents a key patient-centered outcome, radiographic evaluation

remains essential for objective assessment of deformity correction, joint congruency and the potential risk of recurrence [17].

Among the numerous available procedures, distal metatarsal SERI (Simple, Effective, Rapid, Inexpensive) osteotomy has gained increasing popularity as a minimally invasive technique based on bony realignment of the first metatarsal. This method is associated with limited soft-tissue trauma and favorable postoperative recovery [18]. In contrast, tendon-muscle plastic surgery (TMP), conceptually related to modified McBride-type procedures, represents a soft-tissue-oriented approach aimed at balancing deforming forces and improving stability and congruency of the first metatarsophalangeal joint [19,20]. Despite the widespread use of both techniques, they are based on fundamentally different biomechanical principles, and their comparative effectiveness remains insufficiently established.

However, comparative studies focusing on both SERI osteotomy and tendon muscle plastic surgery are still extremely scarce up to this date. Specifically, comparative studies focusing on both functional and standardized radiographic outcomes and including multiple time points are being lacked. The effectiveness of these procedures has been documented, but the methodology and outcome variability make comparison challenging to assess.

Thus, the objective of the current study is to evaluate and compare the functional and radiological outcomes of SERI osteotomy and tendon-muscle plastic surgery in hallux valgus patients after a period of 24 months. The functional outcomes have been measured and compared by using the AOFAS score. The correction and comparison of the radiological outcomes have been measured by using standardized measurements of HVA, IMA, and DMAA at 3, 6, and 24 months. The hypothesis was based on the perception that both techniques would yield better functional improvements as compared to traditional techniques. However, at the same time, some differences are expected in the level of correction obtained.

## 2. Materials and methods

### *Study design*

The goal of this study is to compare the clinical and radiological results achieved after two different surgical methods used in the treatment of hallux valgus deformity. The results achieved after SERI osteotomy and tendon muscle plastic surgery (TMP) have been compared. The SERI group includes 60 female patients (111 feet) who underwent distal minimally invasive SERI osteotomy at the Orthopedic Department of the National Scientific Center of Traumatology and

Orthopedics named after Academician N.D. Batpenov from 2014 to 2018. The mean age in this group was  $53 \pm 17.5$  (21–74) years old. The TMP group consisted of 42 female patients (77 feet) who underwent tendon-muscle plastic surgery using the author's technique at the Traumatology Department of the "City Multidisciplinary Hospital No. 2" in Astana from 2014 to 2018. The mean age in this group was  $50 \pm 11.75$  (26–73) years. The procedures conducted were based on the standard treatment protocols. The informed consent

process was governed by local ethical legislation in the absence of prospective studies that used anonymized medical data. The research was performed in accordance with local institutional ethical standards and the principles defined in the Helsinki Declaration. The study protocol and ethical aspects of its implementation were officially approved by the local ethics committee of "Astana Medical University" (Protocol No. 6, dated March 21, 2019).

*Patient selection*

Patients were identified through a review of hospital clinical and radiographic databases. To be included in the study, patients were required to meet the following criteria:

- a confirmed diagnosis of hallux valgus requiring surgical correction;
- treatment with either SERI osteotomy or TMP as the primary operative procedure;
- availability of complete clinical assessments and standardized weight-bearing radiographs before surgery and at postoperative follow-up visits at 3, 6, and 24 months.

Exclusion criteria included previous surgery on the forefoot, inflammatory arthritis such as rheumatoid arthritis, severe neuromuscular disorders, the presence of a local infection, and insufficient follow-up data to allow for longitudinal analysis.

After application of these criteria, eligible patients were assigned to either the SERI or TMP group based on the surgical technique that had been performed as part of routine clinical care.

*Surgical techniques*

All procedures were performed under general or spinal anesthesia using a pneumatic tourniquet.

*SERI osteotomy*

The SERI procedure was performed in accordance with the technique described by Giannini et al. [18]. After application of the tourniquet, a 1-cm incision was made over the medial eminence of the first metatarsal head, and the bone was accessed through the skin and subcutaneous tissues. A distal first metatarsal osteotomy was created using a standard pneumatic oscillating saw with a 9.5 × 25 × 0.4 mm blade. Through an adjacent soft-tissue incision, a 2-mm Kirschner wire was inserted along the longitudinal axis of the hallux using a standard drill bit. The wire was advanced so that it exited at the medial tip of the toe, approximately 5 mm distal to the medial edge of the nail plate.

The wire was then passed across the osteotomy site, allowing controlled manipulation of the distal fragment to achieve adequate deformity correction. Final stabilization was achieved by advancing the Kirschner wire proximally into the diaphyseal canal of the first metatarsal until its proximal end reached the base of the bone. In two cases, slight anterior displacement of the metatarsal head was performed to address associated metatarsalgia. When medial protrusion of the proximal osteotomy fragment was observed, a small bone wedge was resected to improve alignment. Skin closure was achieved with a single 3-0 absorbable suture, and the external portion of the K-wire was bent and trimmed. Operative time was recorded for all cases.

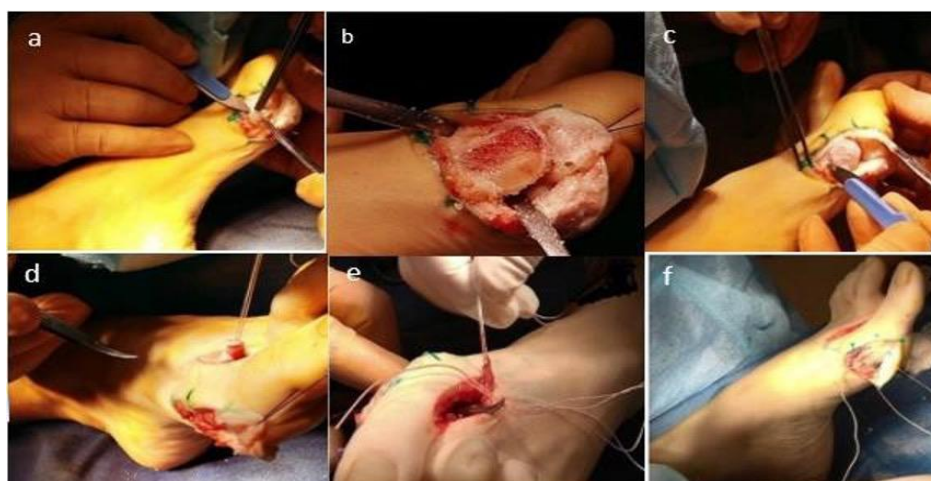


Figure 1 - TMP (Tendon-muscle plastic surgery)

*Tendon-muscle plastic surgery (TMP)*

In the TMP group, a pneumatic tourniquet was applied to the lower limb, and the procedure was performed as illustrated in Figure 1. A tongue-shaped flap was isolated (a). The exostosis on the medial

surface of the first metatarsal head along Herbert's sulcus was dissected (b). Partial excision of the aponeurotic tendon of the abductor hallucis muscle was performed. The medial portion of the transverse ligament was then isolated and released from the

medial aspect of the patellar surface (c). A longitudinal incision was made in the first intermetatarsal interval with preservation of the deep peroneal nerve branch (d). The aponeurotic and tendinous portion of the adductor hallucis muscle was isolated in the form of a “petal,” which was used to create a tendon–muscle graft on two limbs. Intra-articular scar tissue intimately fused with the sesamoid hammock was dissected. The graft was then transposed to the sub-capital region of the first metatarsal bone, and a Z-shaped suture was additionally applied to the first intermetatarsal space (e). The resulting tendon–muscle complex was rigidly fixed to restore the transverse arch, and the lower part of the medial capsule was attached to the tendon–muscle graft (f).

#### *Postoperative care*

Postoperative management protocols were standardized for each surgical group.

#### *SERI group:*

On the second postoperative day, dressing changes were performed around the surgical site and the Kirschner wire. Patients began protected weight-bearing in Baruk postoperative shoes on the second or third day after surgery. Magnetotherapy was prescribed to reduce edema. Analgesia consisted of non-steroidal anti-inflammatory drugs, with opioid analgesics administered when necessary. The average hospital stay was 4–5 days. Sutures were removed on postoperative day 10. The Kirschner wire was removed on the 42nd postoperative day. After wire removal, patients transitioned from Baruk shoes to comfortable footwear with arch support for approximately one week. Therapeutic exercises were then initiated to improve mobility of the first metatarsophalangeal joint.

#### *TMP group:*

A sterile dressing was applied immediately after surgery and changed on the second postoperative day. From the second day, patients began protected heel-weight-bearing in Baruk shoes to eliminate pressure on the forefoot. Magnetotherapy was used to reduce postoperative swelling. Pain control was achieved with non-steroidal anti-inflammatory medications as needed. The average hospital stay was 6–7 days. Sutures were removed between postoperative days 10

and 12, after which therapeutic exercises were started to restore mobility of the metatarsophalangeal joint. Patients continued to wear Baruk shoes for approximately 4 weeks and then transitioned to comfortable footwear for a period of 3–6 months while continuing rehabilitation exercises.

#### *Outcome assessment*

Clinical outcomes were evaluated at the patient level using the American Orthopaedic Foot and Ankle Society (AOFAS) Hallux-Metatarsophalangeal-Interphalangeal scale, which ranges from 0–100 scale points, where a high numerical result indicates reduced levels of pain and better functional levels [21]. The AOFAS was utilized in 60 patients of the SERI and 42 patients of the TMP group. The assessment was done pre-operatively and at 3, 6, and 24 months post-operatively. The assessment of the radiographic results was done based on the foot levels by using standardized weight-bearing anteroposterior radiographs. In the SERI group, the number of feet with available measurement from the radiograph was 111. In the TMP group, the number of available measurements from the radiographs was 77. At each of the time points, the parameters to be considered are the hallux valgus angle (HVA), the intermetatarsal angle (IMA), and the distal metatarsal articular angle (DMAA) [13]. The baseline radiographs were taken before the operation, while the follow-up measurements were taken at 3, 6, and 24 months post-operatively. Statistical analysis

*The statistical analysis* was carried out by applying conventional statistical analysis methods. For continuous variables, the descriptive statistical analysis was carried out by simply expressing the data as mean  $\pm$  standard deviations. For the comparison at various time points, Welch’s t-test was used, taking into consideration the differences in the number of groups. Comparison of baseline and 24 months was done by t-test. For the entire analysis, a “two-tailed test” was used, and the value was considered significant if “ $p < 0.05$ .” The analysis was carried out using conventional statistical analysis software. The analysis was carried out at the foot level, and in the case of a bilateral procedure, every foot was considered separately.

### **3. Results**

#### *Study sample and baseline comparability*

The baseline characteristics are fairly well matched between the two groups. There is no significant difference in the patient age, preoperative AOFAS scores, or the baseline radiographic severity measured

with regard to HVA, IMA, and DMAA among all groups. The implication hereby is that both groups started from a comparable clinical and radiographic condition prior to surgery.

Table 1 - Baseline characteristics

	Parameter	SERI	TMP	P value	Test
Patient-level	Patients (n)	60	42	-	-
	Age (years)	49.9±13.33	48.52±12.17	0.5725	Welch t-test
	AOFAS before	55.32±9.80	56.26±10.02	0.7101	Welch t-test
Feet-level	Feet (n)	111	77	-	-
	HVA before	30.48±6.58	29.09±5.69	0.1382	Welch t-test
	IMA before	15.98±3.76	15.30±3.78	0.2117	Welch t-test
	DMAA before	12.44±3.80	11.74±2.91	0.1705	Welch t-test

Overall, the samples were similar in both groups with respect to demographic, clinical, and radiographic parameters, with all individual analyses showing a p-value > 0.05.

#### Radiographic Outcomes

Both surgical techniques resulted in a substantial radiographic correction by postoperative month 3, and this correction was maintained throughout the 24-month long-term follow-up (Table 2).

Table 2 - Radiographic outcomes (foot-level)

Parameter	SERI (n=111) mean±SD	TMP (n=77) mean±SD	P value	Test
HVA before surgery (°)	30.48±6.58	29.09±5.69	0.1382	Welch t-test
HVA 3 months (°)	18.25±4.85	19.82±3.46	0.0145	Welch t-test
HVA 6 months (°)	18.42±4.91	20.10±3.07	0.0039	Welch t-test
HVA 24 months (°)	18.49±4.85	20.20±2.87	0.0022	Welch t-test
ΔHVA 24 months (°)	-12.00 ±5.13	-8.87±5.00	0.0269	Welch t-test
IMA before surgery (°)	15.98±3.76	15.30±3.78	0.2117	Welch t-test
IMA 3 months (°)	9.54±2.41	9.25±2.70	0.4436	Welch t-test
IMA 6 months (°)	9.54±2.41	9.44±2.46	0.7846	Welch t-test
IMA 24 months (°)	9.61±2.40	9.52±2.46	0.7957	Welch t-test
ΔIMA 24 months (°)	-6.37±2.76	-5.78±3.09	0.1677	Welch t-test
DMAA before surgery (°)	12.44±3.80	11.74±2.91	0.1705	Welch t-test
DMAA 3 months (°)	7.85±2.63	6.52±1.95	p<0.001	Welch t-test
DMAA 6 months (°)	7.85±2.63	6.79±1.91	p<0.001	Welch t-test
DMAA 24 months (°)	7.91±2.56	6.81±1.91	0.0010	Welch t-test
Δ DMAA 24 months (°)	-4.52±2.32	-4.94±2.45	0.2380	Welch t-test

*Radiographic Results*

Regarding the Hallux Valgus Angle (HVA), there were no statistically significant differences between the two groups preoperatively ( $P = 0.1382$ ). Following surgery, both groups demonstrated a reduction in HVA; however, the SERI group maintained significantly lower mean HVA values compared to the TMP group at 3 months ( $18.42 \pm 4.91^\circ$  vs.  $20.10 \pm 3.07^\circ$ ;  $P = 0.0145$ ), 6 months ( $P = 0.0039$ ), and 24 months ( $P = 0.0022$ ). The mean correction of the HVA ( $\Delta$ HVA) at the 24-month follow-up was  $-12.00 \pm 5.13^\circ$  in the SERI group and  $-8.87 \pm 5.00^\circ$  in the TMP group ( $P = 0.0269$ ).

The Intermetatarsal Angle (IMA) values were comparable between the groups before the intervention ( $15.98 \pm 3.76^\circ$  for SERI and  $15.30 \pm 3.78^\circ$  for TMP;  $P = 0.2117$ ). Postoperatively, a stable decrease in IMA was observed at all follow-up intervals with no statistically

significant differences between the groups. By the 24-month mark, the mean IMA was  $9.61 \pm 2.40^\circ$  in the SERI group and  $9.52 \pm 2.46^\circ$  in the TMP group ( $P = 0.7957$ ), and the overall magnitude of correction ( $\Delta$ IMA) did not differ significantly between the cohorts ( $P = 0.1677$ ).

The baseline Distal Metatarsal Articular Angle (DMAA) showed no significant difference between the study groups ( $P = 0.1705$ ). In the postoperative period, the TMP group exhibited significantly lower DMAA values at 3 months ( $6.52 \pm 1.95^\circ$  vs.  $7.85 \pm 2.63^\circ$ ;  $P < 0.001$ ), 6 months ( $P < 0.001$ ), and 24 months ( $6.81 \pm 1.91^\circ$  vs.  $7.91 \pm 2.56^\circ$ ;  $P = 0.0010$ ). However, the difference in the total change of the angle ( $\Delta$ DMAA) at the 24-month final follow-up did not reach statistical significance between the SERI and TMP groups ( $P = 0.2380$ ).

Functional outcomes improved substantially in both cohorts over time (Table 3; Figure 2).

Table 3 - Clinical outcomes (The American Orthopedic Foot and Ankle Society scale, patient-level)

Parameter	SERI (n=60) mean±SD	TMP (n=42) mean±SD	P value	Test
AOFAS before surgery	55.32±9.80	56.26±10.02	0.7101	Welch t-test
AOFAS 3 months	77.19±16.09	80.36±16.99	0.3207	Welch t-test

In the SERI group (n=60), the mean AOFAS score increased from a baseline of  $55.32 \pm 9.80$  to  $77.19 \pm 16.09$  at 3 months postoperatively. This improvement continued through the 6-month follow-up, reaching  $79.00 \pm 15.28$ , and remained stable at the final 24-month

assessment with a mean score of  $79.46 \pm 15.28$ . The total mean improvement from the preoperative state ( $\Delta$ AOFAS) was  $24.14 \pm 14.96$  points, representing a mean percentage improvement of  $46.30 \pm 31.42\%$ .

Table 3 (continued) - Clinical outcomes (The American Orthopedic Foot and Ankle Society scale, patient-level)

Parameter	SERI (n=60) mean±SD	TMP (n=42) mean±SD	P value	Test
AOFAS 6 months	79.00±15.28	84.38±13.07	0.0562	Welch t-test
AOFAS 24 months	79.46±15.28	83.57±13.49	0.1351	Welch t-test
$\Delta$ AOFAS 24 months	24.14±14.96	27.31±12.98	0.2017	Welch t-test
% improvement	46.30±31.42	51.78±30.92	0.3203	Welch t-test

For the TMP group (n=42), the preoperative AOFAS score was  $56.26 \pm 10.02$ . Following the intervention, a substantial increase was observed at 3 months ( $80.36 \pm 16.99$ ), which further progressed to  $84.38 \pm 13.07$  at 6 months. At the 24-month final follow-up, the mean score was recorded at  $83.57 \pm 13.49$ .

The overall mean gain in functional score ( $\Delta$ AOFAS) at 2 years was  $27.31 \pm 12.98$  points,

corresponding to a mean percentage increase of  $51.78 \pm 30.92\%$ . In both SERI and TMP groups, all radiographic and functional parameters showed statistically significant improvement at the 24-month follow-up compared to baseline ( $p < 0.001$ ).

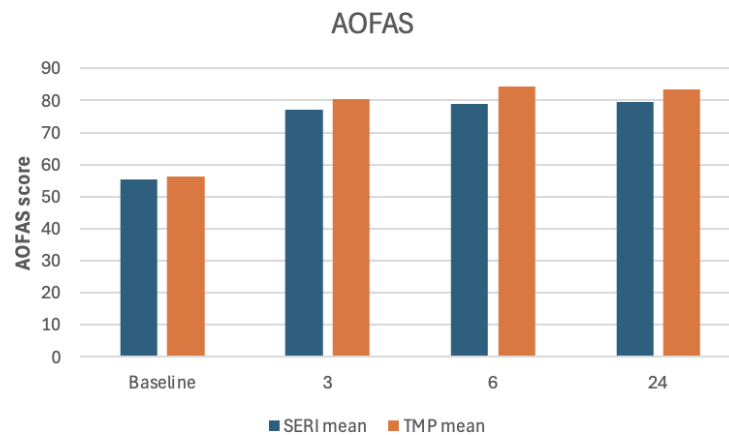


Figure 2 - The American Orthopedic Foot and Ankle Society scale

Table 4 - Complications in the postoperative period

Types of complications	TMP group	SERI group
Nonunion	-	1.8 % (2 feet)
Kirschner wire migration	-	7.2 % (8 feet)
Soft-tissue inflammation around wire	-	7.2 % (8 feet)
Phlegmon	-	0.9% (1 foot)
Recurrence of hallux valgus	-	4.5 % (5 feet)
Acquired hallux varus	9.1% (7 feet)	-

Note: Values are reported as n (%) per foot (SERI: 111 feet; TMP: 77 feet)

The pattern of postoperative complications differed between the two surgical approaches.

In the TMP group, 7 feet (9.1%) developed iatrogenic hallux varus. These cases required revision surgery using intertarsal ligament plasty. At final follow-up, neutral alignment was restored in all cases; however, three patients had residual limitation of motion in the first metatarsophalangeal joint.

In the SERI group (111 feet), complications were primarily related to the percutaneous fixation technique. These included nonunion in 2 feet (1.8%), Kirschner wire migration in 8 feet (7.2%), and superficial soft-tissue inflammation around the wire in

8 feet (7.2%). One case of phlegmon (0.9%) required surgical drainage. Recurrence of hallux valgus occurred in 5 feet (4.5%) and was managed with corrective osteotomy of the proximal phalanx. Migration of the Kirschner wire was controlled by immobilization, whereas inflammation was controlled with antibacterial drugs.

Systemic complications were not evident in either group. Overall, it has been concluded that both techniques presented an acceptable safety profile. However, the type of complications varied with each type of surgery.

#### 4. Discussion

The principal finding is that both techniques produced clinically meaningful and statistically significant improvements in functional status (AOFAS) and radiographic alignment (HVA, IMA, DMAA). However, the pattern of correction differed between procedures: SERI achieved greater correction of hallux valgus angle (HVA), whereas TMP resulted in more favorable postoperative distal metatarsal articular angle (DMAA) values, suggesting a relatively stronger effect on articular orientation and joint congruency.

##### Interpretation of radiographic outcomes

The two techniques examined in this study represent fundamentally different surgical philosophies: SERI relies on bony realignment through minimally invasive osteotomy [18], whereas TMP focuses on soft-tissue balancing and restoration of joint congruency [20,21].

In our cohort, SERI demonstrated a significantly greater reduction in HVA at all postoperative time points and a larger overall magnitude of correction ( $\Delta$ HVA) compared with TMP.

This finding is consistent with the biomechanical rationale of osteotomy-based procedures, which directly modify the axis of the first metatarsal and allow controlled angular correction [18]. Similar observations have been reported in studies comparing osteotomy techniques with soft-tissue procedures, where bony realignment generally provides more pronounced correction of the hallux valgus angle [15].

Correction of the intermetatarsal angle (IMA) has been substantial and comparable between groups. Both techniques have produced significant reduction in IMA with no statistically significant between-group differences at any follow-up interval. As IMA is a critical determinant of overall forefoot alignment and long-term stability [13,17], the equivalent performance of SERI and TMP in this domain indicates that both approaches can adequately address the transverse plane component of the deformity. In our review of the relevant literature, we could not find series directly comparing McBride myofascial plastic surgery (TMP) and Chevron osteotomy. In their series, Johnson et al. (1991) compared a modified McBride procedure with Chevron osteotomy and noted a statistically significant difference in IMA correction in favor of the Chevron osteotomy [19]. Nevertheless, our results demonstrate that modern TMP techniques can provide IMA correction comparable to that of osteotomy. This confirms the effectiveness of the soft-tissue method, provided that there is appropriate patient selection.

An opposite trend has been observed with respect to DMAA. Postoperative DMAA values were consistently lower in the TMP group, indicating more favorable articular orientation following soft-tissue balancing. Restoration of joint congruency is a central goal of McBride-type procedures [20,21], and the present findings support the concept that TMP may be particularly effective in optimizing the alignment of the metatarsophalangeal joint surface. Although the overall change in DMAA from baseline did not differ significantly between techniques, the lower postoperative DMAA values observed with TMP may be clinically relevant, as excessive residual DMAA has been associated with suboptimal joint mechanics and risk of recurrence [21].

Collectively, these radiographic results suggest that SERI and TMP exert different corrective emphases: SERI appears more effective for direct angular realignment (HVA), whereas TMP may offer advantages in articular set and joint congruency (DMAA). The comparable correction of IMA highlights that both techniques can successfully address the metatarsal varus component of hallux valgus.

#### *Functional outcomes*

In a patient-centered perspective, both techniques have showed considerable levels of functional recovery. There are considerable levels of improvement in AOFAS from the beginning to 24 months for all the participants. Although TMP has demonstrated a slight postoperative improvement at later time points, the results are not statistically significant. This is commensurate with previous literature reviews, which indicate that different surgical methods for treating hallux valgus have led to comparable functional results despite different outcomes in terms of radiographs [14, 16].

There has been no direct relationship between radiographic superiority and functional advantage. This reiterates an important concept in hallux valgus correction, i.e., patient satisfaction and relief have not been achieved through correction in angle only, and several other factors contribute to patient satisfaction postoperatively.

To the best of our knowledge, this is the first study to directly compare the clinical and radiographic outcomes of the SERI technique and tendon-muscle plastic (TMP) surgery. While no direct comparisons exist in the current literature, our findings align with broader trends observed in studies of other distal metatarsal osteotomies versus soft-tissue procedures. Specifically, Choi et al. [20] compared a distal chevron osteotomy with a modified McBride procedure for mild to moderate hallux valgus. Their results mirrored our observations: the osteotomy-based approach provided significantly greater correction of radiographic angles (HVA and IMA) than the soft-tissue procedure. Crucially, despite these radiographic differences, Choi et al. reported comparable levels of patient satisfaction and willingness to undergo the surgery again, which aligns with the equivalent functional recovery (AOFAS) seen in our cohort.

Finally, although the AOFAS score is widely used to measure patient outcomes, it should be noted that this scoring system has its drawbacks in patient reporting, i.e., it may not be able to capture adequately all aspects of patient-related quality of postoperative life [16, 21].

#### *Temporal pattern and durability of correction*

Both techniques demonstrated a similar temporal pattern of recovery. The majority of radiographic correction and functional improvement occurred within the first three postoperative months and remained stable through 24 months. This trajectory aligns with previous observations that early postoperative alignment is generally predictive of mid-term stability in hallux valgus surgery [15]. The maintenance of correction over two years provides

reassuring evidence regarding the durability of both approaches, although longer follow-up is necessary to assess late recurrence.

#### *Complications and procedure-specific risks*

The two procedures have exhibited distinct complication profiles. TMP has been associated with iatrogenic hallux varus in 5.7% of patients, necessitating revision surgery. While neutral alignment is restored in all cases, residual joint stiffness has persisted in several patients. Hallux varus is a recognized risk of aggressive soft-tissue balancing procedures and has been previously reported in the context of modified McBride techniques [19,20]. This emphasizes the need for careful intraoperative tensioning and balanced correction when performing TMP.

In contrast, complications after SERI have been primarily hardware- and wound-related, including Kirschner wire migration and superficial inflammation. These events were generally minor and manageable with conservative measures. The pattern is consistent with known risks of minimally invasive percutaneous fixation techniques [18]. No major systemic complications were observed in either group, and overall safety was acceptable for both methods.

#### *Clinical implications*

The present findings have practical relevance for surgical decision-making. SERI may be particularly advantageous when maximal correction of HVA is

required or when a minimally invasive bony realignment strategy is preferred. TMP may be more suitable for patients in whom restoration of joint congruency and articular alignment is prioritized, as reflected by lower postoperative DMAA values. As IMA correction and functional improvement were comparable, selection of technique should be individualized based on deformity pattern, surgeon experience, and patient expectations.

#### *Limitations*

Several limitations should be acknowledged. The retrospective-prospective design introduces potential selection bias, as operative technique was chosen according to clinical judgment rather than randomization. First, the study was retrospective-prospective in nature and therefore the techniques might have been selectively biased in the process. Also, the radiographic results were performed on the feet, whereas the functional results were performed on the patient level, which might result in statistical non-independence in bilateral cases. Third, the functional results were based on the AOFAS score, which is not entirely a patient-based score and also has well-recognized methodologic limitations and issues [16,21]. Finally, the study was performed for a maximum of 24 months, and the results might not definitively assess long-term results in terms of recurrence and degeneration.

## 5. Conclusions

This study shows that both SERI osteotomy and tendon-muscle plastic surgery are effective and safe options for the surgical management of hallux valgus, providing significant and durable improvement in functional status and radiographic alignment over a 24-month period.

SERI osteotomy achieved greater correction of the hallux valgus angle, indicating stronger angular realignment through its osteotomy-based mechanism. TMP surgery produced more favorable postoperative DMAA values, suggesting a superior effect on articular orientation and joint congruency. Correction of the intermetatarsal angle and improvement in AOFAS scores were comparable between techniques, highlighting that both approaches can deliver meaningful functional recovery.

These two operations highlighted different, although acceptable, complication rates, TMP being associated with iatrogenic hallux varus potentially requiring revision, whereas hardware complications in the SERI approach were acceptable and easily manageable. These results suggest that neither method is inherently superior to the other; however, both have

unique benefits depending on the unique characteristics of the deformity.

Colloquially, SERI could be the preferred choice if maximum correction of the HVA and minimal invasive bony correction are desired, whereas TMP could have advantages if restoration of joint congruency appears important. The individual approach to surgical strategy would require consideration of the radiographic phenotype, the type of expectations, and post-operative expertise.

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## Hallux Valgus кезіндегі SERI остеотомиясы мен сіңір-бұлшықет пластикасын салыстыру: Клиникалық және рентгенологиялық нәтижелерді 2 жылдық бақылау

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### Түйіндеме

Hallux valgus (табанның бірінші бақайының вальгусты деформациясы) — ауырсыну мен функционалдық шектеулерді тудыратын жиі кездесетін деформация. Көптеген хирургиялық әдістердің ішінде бірыңғай стандарттың жоқтығын ескерсек, ең тиімді оперативті шешімді таңдау өзекті клиникалық мәселе болып қала береді.

Зерттеудің мақсаты: 24 айлық бақылау кезеңінде Hallux valgus коррекциясы үшін SERI остеотомиясы мен сіңір-бұлшықет пластикасының (СБП) ұзақ мерзімді клиникалық және рентгенологиялық нәтижелерін салыстыру.

Әдістері. Бұл бір орталықты ретроспективті зерттеуге SERI әдісімен емделген 60 науқас (111 табан) және СБП әдісімен емделген 42 пациент (77 табан) енгізілді. Функционалдық нәтижелер (AOFAS шкаласы) және рентгенологиялық параметрлер (HVA, IMA, DMAA) бастапқы деңгейде және 3, 6, 24 айдан кейін бағаланды.

Нәтижелер. Екі топта да 24 айдан кейін айтарлықтай функционалдық жақсару байқалды (AOFAS: SERI тобында 55,32±9,80-ден 79,46±15,28-ге дейін; СБП тобында 56,26±10,02-ден 83,57±13,49-ға дейін;  $p < 0,001$ ). HVA көрсеткіші екі топта да жақсарды, бұл ретте SERI тобында отадан кейінгі HVA барлық бақылау нүктелерінде айтарлықтай төмен болды ( $p < 0,05$ ). IMA бұрышы екі топта да топтар арасындағы айырмашылықсыз айтарлықтай төмендеді. DMAA көрсеткіші екі топта да жақсарды; отадан кейінгі DMAA мәндері 3, 6 және 24 айдан кейін СБП тобында төмен болды ( $p \leq 0,001$ ), дегенмен бастапқы деңгейден жалпы өзгеріс шамасы топтар арасында ерекшеленбеді.

Қорытынды. SERI де, СБП да 24 ай ішінде айтарлықтай функционалдық жақсаруды (AOFAS көрсеткіштері) және тиімді рентгенологиялық коррекцияны қамтамасыз етеді. SERI әдісі HVA-ның жоғарырақ коррекциясына қол жеткізсе, ал СБП кейінгі DMAA мәндерінің төмендеуіне ықпал етті. Дегенмен, функционалдық нәтижелер мен IMA коррекциясы екі әдісте де ұқсас болды.

**Түйін сөздер:** hallux valgus, табан сүйектері, остеотомия, сіңір/хирургиясы, hallux varus.

## Остеотомия SERI в сравнении с сухожильно-мышечной пластикой при Hallux Valgus: 24-месячное наблюдение клинических и рентгенологических результатов

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## Резюме

Цель исследования: сравнить отдаленные клинические и рентгенологические результаты остеотомии SERI и сухожильно-мышечной пластики (СМП) при коррекции hallux valgus в течение 24 месяцев наблюдения.

Методы. В данное одноцентровое ретроспективное исследование были включены 60 пациентов (111 стоп), пролеченных методом SERI, и 42 пациента (77 стоп), пролеченных методом СМП. Функциональные результаты (шкала AOFAS) и рентгенологические параметры (HVA, IMA, DMAA) оценивались исходно, а также через 3, 6 и 24 месяца.

Результаты. В обеих группах наблюдалось значительное функциональное улучшение через 24 месяца (AOFAS: с 55,32±9,80 до 79,46±15,28 в группе SERI; с 56,26±10,02 до 83,57±13,49 в группе СМП;  $p<0,001$ ). Показатель HVA улучшился в обеих группах, при этом послеоперационный HVA был значительно ниже в группе SERI во всех точках наблюдения ( $p<0,05$ ). Угол IMA значительно снизился в обеих группах без межгрупповых различий. Показатель DMAA улучшился в обеих группах; послеоперационные значения DMAA были ниже в группе СМП через 3, 6 и 24 месяца ( $p\leq 0,001$ ), хотя общая величина изменений относительно исходного уровня между группа не различалась.

Выводы. Как SERI, так и СМП обеспечивают значительное функциональное улучшение (по шкале AOFAS) и эффективную рентгенологическую коррекцию к 24 месяцам. В то время как метод SERI позволил достичь большей коррекции HVA, а метод СМП обеспечил более низкие послеоперационные значения DMAA, функциональные результаты и коррекция IMA были сопоставимы при использовании обеих техник.

**Ключевые слова:** hallux valgus, плюсневые кости, остеотомия, сухожилия/хирургия, hallux varus.