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Incidence of deformity recurrence after surgical treatment of hallux valgus toe - risk factors and prevention

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Abstract

Introduction: Hallux valgus (HV) is a prevalent forefoot deformity, defined by lateral deviation of the great toe and medial displacement of the first metatarsal. When conservative measures fail, surgical correction is often required. Despite numerous refined techniques, postoperative recurrence remains a significant clinical challenge, with rates varying depending on the procedure and patient-specific factors.

Aim: This review systematically evaluates the incidence of HV recurrence after surgery, identifies anatomical, radiographic, and procedural risk factors, and assesses strategies to prevent relapse and optimize long-term outcomes.

Methods: A comprehensive literature review was conducted using PubMed, Google Scholar, Scopus, and ResearchGate.

Results and Conclusion: HV recurrence is influenced by multiple factors, particularly pre- and postoperative radiographic parameters such as hallux valgus angle (HVA), intermetatarsal angle (IMA), and sesamoid position. Effective prevention relies on individualized surgical planning, precise correction of deformities, and structured postoperative management, including physiotherapy and appropriate footwear. Recognizing modifiable risk factors and applying evidence-based strategies can reduce recurrence rates and improve patient satisfaction, highlighting the importance of tailored long-term care in HV management.

Keywords: Hallux valgus; Recurrence; Surgical treatment; Postoperative care

Introduction

Hallux valgus is characterized by medial deviation of the first metatarsal and lateral deviation of the proximal phalanx of the great toe. This deformity affects approximately 23% of the adult population aged 18–65, with a significantly higher prevalence among women [1]. In advanced cases, where conservative treatment proves ineffective, surgical intervention is employed to correct the deformity and restore normal foot biomechanics. Despite satisfactory functional outcomes, the recurrence rate ranges from 5% [2] to as high as 30% [3], depending on the surgical technique used.

Recurrence Criteria

Surgical intervention for hallux valgus deformity is typically reserved for patients experiencing pain, functional limitations, and unsuccessful outcomes from conservative treatments. Despite substantial advancements in operative techniques, the recurrence of the deformity following surgery continues to be a significant source of postoperative dissatisfaction among patients.

The definition of hallux valgus recurrence varies across the literature. The most commonly accepted criteria rely on radiographic assessments, particularly the measurement of the hallux valgus angle (HVA) on postoperative follow-up imaging. A threshold of HVA $\geq 20°$ is

frequently used to define recurrence. This criterion has been adopted in numerous studies, including those conducted by Choi G.W. et al. (2013) [4], Bock et al. (2015) [5], Castioni et al. (2019) [6], Okuda et al. (2007, 2009, 2011) [7][8][9], and more recently by Weigelt et al. (2024) [10], underscoring its clinical relevance in evaluating the long-term outcomes of hallux valgus surgery.

Overall Recurrence Rate

According to a meta-analysis encompassing 23 studies with a combined sample of 2,914 patients aged 18 to 84 years, the average recurrence rate following surgical treatment of hallux valgus was estimated at 24.86% (95% CI: 19.15–30.57), with substantial heterogeneity observed across the included studies (I^2 = 91.92%) [1]. These findings indicate that approximately one in four patients may experience a recurrence of the deformity after surgery.

Recurrence Based on Surgical Technique

The likelihood of recurrence is also influenced by the type of surgical technique employed.

Scarf Osteotomy

Scarf osteotomy is one of the commonly utilized procedures in the surgical management of hallux valgus. A systematic review encompassing 15 studies reported recurrence rates ranging from 3.6% to as high as 78%. However, most studies demonstrated recurrence rates within the range of 3.6%–11.3%. These discrepancies are likely attributable to variations in the definition of recurrence and differences in the length of postoperative follow-up. Notably, studies with extended follow-up periods of 10 to 14 years reported the highest recurrence rates—30% and 78%, respectively. [11]

Chevron Osteotomy

Chevron osteotomy is another widely adopted technique, typically indicated for patients with mild to moderate hallux valgus deformities. In a study involving 100 patients, recurrence was

defined as a hallux valgus angle (HVA) of ≥15°. The results showed that 56 feet (73%) demonstrated radiographic signs of recurrence. Among these, 11 cases (14%) were classified as mild recurrence (HVA < 20°), 44 cases (57%) as moderate (20° ≤ HVA < 40°), and 1 case (1%) as severe (HVA ≥ 40°). Importantly, all recurrences were asymptomatic, and none of the patients required revision surgery. [12]

Lapidus Osteotomy

The Lapidus procedure is primarily indicated for the correction of severe and advanced hallux valgus deformities, particularly in the presence of first ray hypermobility. This technique involves corrective arthrodesis of the first tarsometatarsal (TMT) joint, aiming to restore structural alignment and stability of the medial column of the foot.

Despite its efficacy, recurrence of deformity following Lapidus osteotomy is not uncommon. A retrospective study analyzing 126 Lapidus procedures reported that 46% of patients demonstrated radiographic signs of recurrence; however, only 12% of cases necessitated revision surgery. [13]

Another investigation, published in *Foot & Ankle Orthopaedics* in 2020, evaluated the outcomes of 127 Lapidus surgeries and found a 38% radiographic recurrence rate, a 24% rate of subjective recurrence (patient-reported), and a 9.5% rate of reoperation. [14] These findings highlight the importance of long-term follow-up and patient-reported outcomes in evaluating the durability of surgical correction.

ReveL Osteotomy

The ReveL osteotomy (Reversed L-shaped osteotomy) represents an alternative surgical technique for the correction of moderate to severe hallux valgus deformities. It involves creating a reversed L-shaped cut in the distal first metatarsal, allowing for stable correction through a standardized, simplified, and less invasive approach. [15]

A long-term follow-up study conducted at Balgrist University Hospital in Switzerland assessed the outcomes of this technique in 88 patients (131 feet), with a mean follow-up duration of 14.2 years (range: 10 to 18 years). The recurrence rate, defined as HVA ≥ 20°, was 13.7%. Postoperative satisfaction was high, with 94% of patients satisfied with the cosmetic outcome and 92% reporting significant pain relief. Notably, the leading indication for revision was symptomatic hardware irritation, accounting for 14.5% of reoperations. [10]

Risk Factors for Deformity Recurrence

Several anatomical and radiological features have been identified as significant risk factors for the recurrence of hallux valgus deformity. Among the most relevant are the preoperative values of the hallux valgus angle (HVA), intermetatarsal angle (IMA), distal metatarsal articular angle (DMAA), and the postoperative position of the sesamoid bones.

Preoperative HVA and IMA Values

According to a meta-analysis published in 2021, elevated preoperative values of the hallux valgus angle (HVA) and the intermetatarsal angle (IMA) are significantly associated with a higher risk of deformity recurrence following surgical correction.

The study found a moderate positive correlation between the preoperative HVA and recurrence ($r = 0.29$; 95% CI: 0.14–0.43) and a weaker, though still positive, correlation for the IMA ($r = 0.13$; 95% CI: 0.00–0.27). [1]

Further supporting these findings, a 2024 study conducted in Switzerland identified a preoperative HVA greater than 28° as a strong predictor of recurrence (odds ratio [OR] 9.1; $p = 0.02$) [10]. These results underscore the importance of careful radiological assessment before surgery and tailoring the surgical approach to the individual anatomical characteristics of each patient.

Postoperative Radiographic Parameters

The effectiveness of hallux valgus surgery depends not only on the precision of the operative technique but also on the postoperative radiographic outcomes. Several studies have demonstrated that suboptimal postoperative angular corrections significantly increase the risk of recurrence.

One study published in *The Journal of Bone & Joint Surgery* reported that a postoperative HVA ≥ 8° was associated with a 28-fold increase in recurrence risk compared to cases with HVA < 8°. [16]

Similarly, findings from the *Journal of Korean Foot and Ankle Society* indicated that a postoperative HVA > 16.7° and IMA > 8.2° may serve as significant predictors of recurrence. Recognizing these parameters may inform surgical modifications aimed at reducing recurrence rates. [17]

In addition, the previously mentioned study from Balgrist University Hospital identified a 6-week postoperative HVA > 15° as a significant risk factor for recurrence (OR 4.6; p = 0.03). [10]

Sesamoid Position

The position of the sesamoid bones beneath the head of the first metatarsal plays a critical role in the stability of the first metatarsophalangeal (MTP) joint. Incomplete postoperative reduction of the sesamoids has been identified as a potential risk factor for recurrence of hallux valgus deformity. [18]

To evaluate sesamoid alignment, the Hardy and Clapham classification system is frequently utilized. This system grades the medial sesamoid position relative to the longitudinal axis of the first metatarsal on a scale from I to VII, thereby providing a standardized method for assessing sesamoid displacement and estimating the risk of deformity recurrence. [19]

A retrospective study evaluating 65 feet with hallux valgus treated via proximal first metatarsal osteotomy used the Hardy and Clapham system to assess sesamoid positioning. The findings revealed that patients with incomplete sesamoid reduction (grades V–VII) demonstrated a significantly higher recurrence rate compared to those with complete reduction (grades I–IV). [8]

Consequently, surgeons should aim to achieve proper sesamoid alignment—defined as Hardy-Clapham grades I–IV—during corrective procedures, as this is considered optimal and may reduce the likelihood of recurrence.

DMAA

The distal metatarsal articular angle (DMAA) refers to the angle between the distal articular surface of the first metatarsal and the longitudinal axis of its shaft. In healthy individuals, a DMAA value below 10° is generally considered normal. [20] However, in patients with hallux valgus, elevated DMAA values are commonly observed. [21]

A study involving 87 patients with hallux valgus found that those with a postoperative DMAA greater than 11.3° exhibited a significantly increased risk of deformity recurrence. Notably, no recurrence was observed in cases where the postoperative DMAA was below 11.3°. [22]

Based on these findings, it is recommended that surgical correction of DMAA should aim for values below 11.3° to minimize the risk of recurrence and enhance long-term surgical outcomes.

Length of the First Metatarsal Bone

An additional factor that may influence the long-term outcome of treatment is the postoperative length of the first metatarsal bone. Increasing evidence suggests that excessive elongation of the first metatarsal may serve as a predictor of hallux valgus (HV) deformity recurrence.

Between 2008 and 2011, a total of 186 feet (105 left, 81 right) undergoing Chevron osteotomy combined with distal soft tissue procedures were analyzed. It was observed that the mean postoperative length of the hallux was 5.06 ± 0.39 cm in the recurrence group versus 4.84 ± 0.34 cm in the non-recurrence group ($p < 0.001$). Therefore, a postoperative first metatarsal length exceeding 4.9 cm may constitute a significant risk factor for HV deformity relapse. [23]

An article published in *The Foot* journal in 2021 also underscores the importance of appropriately planning the length of the first metatarsal in the context of surgical correction of hallux valgus. The authors emphasize that accurate determination of this length can contribute to minimizing the risk of postoperative deformity recurrence. [24]

Incorporating the first metatarsal length into preoperative planning and execution of hallux valgus corrective surgery appears to be a crucial prognostic factor. Accumulated data indicate that excessive postoperative length of the first metatarsal may be causally related to deformity recurrence. Accordingly, precise surgical planning regarding this parameter may not only enhance the stability of the correction but also reduce the risk of HV recurrence and improve long-term treatment outcomes.

Obesity

Obesity is a well-recognized predictor in numerous orthopedic procedures; however, current scientific evidence does not support a significant impact of obesity on the recurrence rate of hallux valgus deformity following surgical intervention.

A study published in *International Orthopaedics* analyzing the outcomes of SCARF osteotomy found no significant effect of overweight status on clinical and radiological outcomes. The authors suggest that overweight has a limited influence on the results of this procedure, although they acknowledge that a high body mass index (BMI) may contribute to the initial development of HV. [25]

In a retrospective study involving 532 feet undergoing percutaneous hallux valgus correction, no significant differences were observed in complication rates or reoperation frequencies between patients with BMI <30 and those with BMI ≥30. [26]

Age

Patient age may constitute a significant factor influencing the outcomes of surgical treatment. With the ongoing aging of the population, an increasing number of elderly patients undergo orthopedic procedures—not only involving major joints but also smaller corrective surgeries such as hallux valgus (HV) correction.

In a study involving 193 patients examining the impact of age on clinical and radiological outcomes of HV treatment, it was found that older patients demonstrated comparable clinical and radiological results to their younger counterparts, suggesting that age per se is not a decisive factor affecting the likelihood of deformity recurrence. [27]

Conversely, a 2017 study including 254 patients reported that advanced age at the time of the initial surgery was associated with a shorter interval to deformity recurrence. Specifically, the mean time to recurrence was approximately 14 years, with older patients exhibiting a reduced latency period. [28]

Furthermore, a study published in the *Journal of Clinical Medicine* in 2021 indicated that advanced age was indirectly associated with an increased risk of HV recurrence, representing a potential factor to consider during surgical planning. [1]

Current evidence therefore suggests that patient age may influence aspects related to the recurrence of hallux valgus postoperatively, although it is not definitively established as an independent predictor of this phenomenon.

Postoperative Recommendations

The success of hallux valgus surgery depends not only on the surgical technique but also critically on postoperative foot care.

Following corrective surgery for hallux valgus, the standard recommendation is the use of specialized postoperative footwear for a duration of 4 to 6 weeks. Immediate full weight-bearing postoperatively may result in loss of fixation and complications such as malunion or nonunion of the osteotomy. [29]

Utilization of appropriate footwear that allows safe ambulation without adversely affecting the surgical outcome is paramount immediately after the procedure. Postoperative rehabilitation is focused on supporting plantar pressure distribution on the first ray and preserving joint mobility. It constitutes an essential component of recovery after hallux valgus correction by facilitating restoration of physiological gait and foot function. [30]

A study published in *Foot and Ankle Surgery* demonstrated that following hallux valgus fixation surgery, postoperative shoes are recommended to reduce pressure on the first metatarsal head and heel, thereby preventing overload of the surgical site. The study analyzed changes in plantar load distribution with and without orthopedic footwear under increasing forces applied to the foot. Results showed that mean pressures on the heel and first metatarsal head differed significantly between groups ($P < 0.005$). Secondary analysis revealed that pressure without footwear was significantly higher than with any type of orthopedic shoe ($P < 0.005$). [31]

In summary, the use of specialized postoperative footwear after hallux valgus surgery represents a fundamental aspect of rehabilitation, contributing to pressure reduction in the forefoot, enhancing patient comfort, and minimizing the risk of postoperative complications.

Physiotherapy constitutes another essential component of comprehensive postoperative management, aimed not only at enhancing the function of the operated limb but also at reducing the likelihood of deformity recurrence. Appropriately planned and conducted rehabilitation facilitates optimization of the surgical outcomes in hallux valgus correction.

Results from a study published in *Physical Therapy* suggest that postoperative physiotherapy and gait training can improve function and load transfer of the first ray following HV surgery. [32]

The pivotal role of physiotherapy in achieving full recovery after surgery is also emphasized in a 2025 article published in the *International Journal of Medical Sciences and Research* (MEDIS). This study was conducted at the Femi Clinic Medical Center in Sofia, where postoperative physiotherapy was administered over an 18-month period to 26 patients undergoing surgical correction of hallux valgus. The study compared a standard physiotherapy protocol (control group) with an advanced, more eclectic approach (experimental group) incorporating various techniques such as proprioceptive neuromuscular facilitation (PNF), balance training, soft tissue mobilization, kinesiotaping, analytical exercises, and orthotic therapy. The results demonstrated that the experimental group experienced faster pain relief, improved range of motion, enhanced intrinsic foot muscle strength, and greater patient

satisfaction compared to the control group. The advanced rehabilitation program significantly improved recovery outcomes, including functional capabilities and overall foot health. [33]
Exercise interventions have been shown to increase mobility and reduce pain in patients with advanced hallux valgus, decrease the deformity angle in mild to moderate cases, and are effective in preventing and correcting early-stage deformities. [34]
Postoperative physiotherapy following hallux valgus surgery is indispensable for effective convalescence. Tailored rehabilitation programs can substantially enhance clinical outcomes, alleviate patient pain, restore normal gait biomechanics, and reduce the risk of deformity recurrence.

Conclusion

Despite advances in surgical techniques for hallux valgus correction, recurrence of deformity remains a significant clinical challenge. Literature data indicate that the risk of recurrence may be substantially modulated by a variety of preoperative and postoperative factors. Increased hallux valgus angle (HVA) and intermetatarsal angle (IMA), incomplete sesamoid reduction, inappropriate length of the first metatarsal, and inadequate correction of the distal metatarsal articular angle (DMAA) are important predictors of recurrence. The influence of demographic factors such as age and obesity remains equivocal.
Selection of the appropriate surgical technique and meticulous preoperative planning based on radiological analysis are critical to minimizing the risk of recurrence. Equally important is adherence to postoperative recommendations, including the use of specialized footwear and appropriately prescribed physiotherapy, which can favorably impact correction stability and proper foot function. These findings underscore the importance of an interdisciplinary approach and highlight the need for continued research aimed at optimizing treatment methods and secondary prevention of hallux valgus.

Disclosure

Author's contribution

Conceptualization: Aleksandra Szeliga and Tomasz Karol Książek; Methodology: Kinga Kozłowska; Software: Natalia Dzieszko; Check: Paulina Kulasza and Maciek Borowski;

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References:

(1) Ezzatvar Y, López-Bueno L, Fuentes-Aparicio L, Dueñas L. Prevalence and predisposing factors for recurrence after hallux valgus surgery: a systematic review and meta-analysis. J Clin Med. 2021 Dec 9;10(24):5753. doi: 10.3390/jcm10245753.

(2) Barg A, Harmer JR, Presson AP, Zhang C, Lackey M, Saltzman CL. Unfavorable outcomes following surgical treatment of hallux valgus deformity: a systematic literature review. J Bone Joint Surg Am. 2018 Sep 19;100(18):1563-1573. doi: 10.2106/JBJS.17.00975.

(3) Weigelt L, Davolio N, Torrez C, Haug F, Kühne N, Wirth SH. Long-term results after hallux valgus correction with distal metatarsal reversed-L (ReveL) osteotomy: factors that influence recurrence and the clinical outcome. JB JS Open Access. 2024 Sep 13;9(3):e24.00042.
doi: 10.2106/JBJS.OA.24.00042..

(4) Choi GW, Choi WJ, Yoon HS, Lee JW. Additional surgical factors affecting the recurrence of hallux valgus after Ludloff osteotomy. Bone Joint J. 2013 Jun;95-B(6):803-8. doi: 10.1302/0301-620X.95B6.31172..

(5) Bock P, Kluger R, Kristen KH, Mittlböck M, Schuh R, Trnka HJ. The Scarf osteotomy with minimally invasive lateral release for treatment of hallux valgus deformity: intermediate and long-term results. J Bone Joint Surg Am. 2015 Aug 5;97(15):1238-45. doi: 10.2106/JBJS.N.00971.

(6) Castioni D, Fanelli D, Gasparini G, Iannò B, Galasso O. Scarf osteotomy for the treatment of moderate to severe hallux valgus: analysis of predictors for midterm outcomes and recurrence. Foot Ankle Surg. 2020 Jun;26(4):439-44. doi: 10.1016/j.fas.2019.05.013.

(7) Okuda R, Kinoshita M, Yasuda T, Jotoku T, Kitano N, Shima H. The shape of the lateral edge of the first metatarsal head as a risk factor for recurrence of hallux valgus. J Bone Joint Surg Am. 2007 Oct;89(10):2163-72. doi: 10.2106/JBJS.F.01455.

(8) Okuda R, Kinoshita M, Yasuda T, Jotoku T, Kitano N, Shima H. Postoperative incomplete reduction of the sesamoids as a risk factor for recurrence of hallux valgus. J Bone Joint Surg Am. 2009 Jul;91(7):1637-45. doi: 10.2106/JBJS.H.00796..

(9) Okuda R, Kinoshita M, Yasuda T, Jotoku T, Shima H, Takamura M. Hallux valgus angle as a predictor of recurrence following proximal metatarsal osteotomy. J Orthop Sci. 2011 Nov;16(6):760-4. doi: 10.1007/s00776-011-0136-1.

(10) Weigelt L, Davolio N, Torrez C, Haug F, Kühne N, Wirth SH. Long-term results after hallux valgus correction with distal metatarsal reversed-L (ReveL) osteotomy: factors

that influence recurrence and the clinical outcome. JBJS Open Access. 2024 Sep 13;9(3):e24.00042. doi: 10.2106/JBJS.OA.24.00042.

(11) Clarke TAC, Platt SR. Treatment of hallux valgus by Scarf osteotomy - rates and reasons for recurrence and rates of avascular necrosis: a systematic review. Foot Ankle Surg. 2021 Aug;27(6):622-8. doi: 10.1016/j.fas.2020.08.009.

(12) Pentikainen I, Ojala R, Ohtonen P, Piippo J, Leppilahti J. Preoperative radiological factors correlated to long-term recurrence of hallux valgus following distal chevron osteotomy. Foot Ankle Int. 2014 Dec;35(12):1262-7. doi: 10.1177/1071100714548703.

(13) Galli SH, Johnson N, Davis WH, Anderson RB, Jones CP, Cohen BE. Radiographic outcomes and recurrence following 126 primary Lapidus surgeries for hallux valgus. Foot Ankle Orthop. 2020 Jul 7;5(2):2473011420S00005. doi: 10.1177/2473011420S00005.

(14) Galli SH, Johnson N, Davis WH, Anderson RB, Jones CP III, Cohen BE. Patient reported outcomes and recurrence following 127 primary Lapidus surgeries for hallux valgus. Foot Ankle Orthop. 2020 Nov 6;5(4):2473011420S00222. doi: 10.1177/2473011420S00222.

(15) Espinosa N, Meyer DC, Von Campe A, Helmy N, Vienne P. A new modified distal first metatarsal osteotomy for the treatment of hallux valgus deformity: the reversed L-shaped osteotomy. Tech Foot Ankle Surg. 2006 Sep;5(3):190-7. doi: 10.1097/01.btf.0000221101.31792.8b

(16) Park CH, Lee WC. Recurrence of hallux valgus can be predicted from immediate postoperative non-weight-bearing radiographs. J Bone Joint Surg Am. 2017 Jul 19;99(14):1190-7. doi: 10.2106/JBJS.16.00980

(17) Suh JW, Kim SH, Park HW. Radiographic risk factors of recurrent hallux valgus deformity after modified Scarf and Akin osteotomy. J Korean Foot Ankle Soc. 2019;23(4):159-65.

(18) Okuda R, Kinoshita M, Yasuda T, Jotoku T, Kitano N, Shima H. Postoperative incomplete reduction of the sesamoids as a risk factor for recurrence of hallux valgus. J Bone Joint Surg Am. 2009 Jul;91(7):1637-45. doi: 10.2106/JBJS.H.00796.

(19) Su P-H, Lin C-W, Chiang C-H, Wang W-C, Yeh C-W, Chen H-T, Fong Y-C, Kuo C-C. Sesamoid bone reduction in hallux valgus: comparing radiological outcomes of hallux valgus following distal chevron osteotomy and modified McBride procedure. J Clin Med. 2024;13(24):7590. doi: 10.3390/jcm13247590

(20) Lau B, Allahabadi S, Palanca A, Oji D. Understanding radiographic measurements used in foot and ankle surgery. J Am Acad Orthop Surg. 2021;30(2):e139-54. doi: 10.5435/jaaos-d-20-00189

(21) Encinas R, Hall S, Edelman D, et al. Correction of distal metatarsal articular angle in hallux valgus surgery utilizing a minimally invasive extra-articular metaphyseal distal transverse osteotomy. Foot Ankle Spec. 2025;0(0). doi: 10.1177/19386400251317597

(22) Suh JW, Park SG, Kim SH, Park HW. Radiologic recurrence of hallux valgus deformity after Scarf and Akin osteotomy in patients with high distal metatarsal articular angle. Foot Ankle Orthop. 2019 Nov 4;4(4):2473011419S00415. doi: 10.1177/2473011419S00415.

(23) Li X, Guo M, Zhu Y, Xu X. The excessive length of first ray as a risk factor for hallux valgus recurrence. PLoS One. 2018 Oct 10;13(10):e0205560. doi: 10.1371/journal.pone.0205560.

(24) Wirth SH, Espinosa N, Stouggar M, et al. Planning tool for first metatarsal length in hallux valgus surgery. Foot. 2021;46:101774.

(25) Milczarek MA, Milczarek JJ, Tomasik B, et al. Being overweight has limited effect on SCARF osteotomy outcome for hallux valgus correction. Int Orthop. 2017;41:765–72. doi: 10.1007/s00264-017-3419-0

(26) Carlucci S, Cafruni VM, Alberti M, Verbner JM, Santini-Araujo MG, Conti LA, Sotelano P, Carrasco NM. Is obesity a risk factor in percutaneous hallux valgus surgery? Foot Ankle Surg. 2021 Jul;27(5):577-80. doi: 10.1016/j.fas.2020.07.013.

(27) Goh GS, Tay AYW, Thever Y, Koo K. Effect of age on clinical and radiological outcomes of hallux valgus surgery. Foot Ankle Int. 2021;42(6):798-804. doi: 10.1177/1071100720982975

(28) Beck D, Raikin S, Park A. Recurrent hallux valgus: 15 year single surgeon series. Foot Ankle Orthop. 2017;2(3). doi: 10.1177/2473011417S000116.

(29) Kristen KH, Berger K, Berger C, Kampla W, Anzbock W, Weitzel SH. The first metatarsal bone under loading conditions: a finite element analysis. Foot Ankle Clin. 2005;10(1):1–14

(30) Polastri M. Postoperative rehabilitation after hallux valgus surgery: a literature review. Foot Ankle Online J. 2011;4(4).

(31) Navarro-Cano E, Guevara-Noriega KA, Lucar-Lopez G, Reina F, Carrera A. A comparison of two designs of postoperative shoe for hallux valgus surgery: a biomechanical study in a cadaveric model. Foot Ankle Surg. 2021 Jan;27(1):82-6. doi: 10.1016/j.fas.2020.02.010.

(32) Schuh R, Hofstaetter SG, Adams SB, Pichler F, Kristen KH, Trnka HJ. Rehabilitation after hallux valgus surgery: importance of physical therapy to restore weight bearing of the first ray during the stance phase. Phys Ther. 2009 Sep;89(9):934-45. doi: 10.2522/ptj.20080375.

(33) Physiotherapy after hallux valgus surgery. MEDIS – Int J Med Sci Res. 2025;4(1):89–92. Available from: https://medisij.com/index.php/mij/article/view/16

(34) Pawłowski B, Madej A, Haczkur-Pawłowska K, Kowal A, Jasiński K, Kuzio A, et al. Orthoses and other conservative methods in hallux valgus. Quality in Sport [Internet]. 2024 Sep. 30 [cited 2025 May 28];23:54937. Available from: https://apcz.umk.pl/QS/article/view/54937