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Research Progress of Fixation Strategies in Scarf-Akin Osteotomy for Hallux Valgus

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Abstract

Scarf-Akin osteotomy is a widely used joint-preserving procedure for the correction of hallux valgus and provides strong three-dimensional correction through combined first metatarsal and proximal phalangeal osteotomies. Although this technique has demonstrated reliable outcomes in pain relief, functional improvement, and radiographic correction, it is technically demanding, and the choice of fixation method remains controversial. Among the available options, externalized Kirschner wire fixation may offer advantages, including lower implant cost, ease of removal, and avoidance of retained hardware, but current clinical evidence remains limited. This review summarizes the advantages and challenges of the Scarf-Akin osteotomy and compares screw fixation, Kirschner wire fixation, bioabsorbable fixation, and non-fixation techniques in terms of indications, stability, complications, reoperation rates, and cost-effectiveness. The aim is to provide a reference for perioperative management and individualized fixation selection after hallux valgus correction.

Keywords

Hallux Valgus, Scarf-Akin Osteotomy, Kirschner Wire, Screw, Fixation

1. Introduction

Hallux valgus (HV) is one of the most common forefoot deformities in adults, with a higher prevalence in women and an incidence that generally increases with age [1]-[4]. Although a wide variety of surgical procedures are available for the correction of hallux valgus, considerable variation among foot and ankle surgeons persists in the choice of classic procedures, osteotomy designs, fixation methods, and postoperative rehabilitation protocols [5]. Notably, various osteotomy techniques, using different fixation devices and implants, can achieve satisfactory corrective outcomes. In recent years, continuous advances in fixation devices and re-

lated techniques have made earlier rehabilitation and functional recovery after hallux valgus osteotomy increasingly feasible. Adequate correction of the hallux valgus deformity is a key determinant of surgical success, whereas reliable fixation is essential for maintaining correction, promoting bone healing, and reducing the risk of loss of correction [2]. Fixation failure may directly lead to the recurrence of deformity. Previous studies have shown that the major complications of hallux valgus surgery are closely related to the osteotomy site, the osteotomy's intrinsic stability, postoperative alignment, and the fixation method used. Continuous improvements in fixation techniques have therefore become an important factor in improving overall surgical outcomes. With the widespread use of realignment osteotomies in the treatment of hallux valgus, more stable fixation methods have been gradually developed to maintain correction, accelerate bone healing, and support earlier postoperative rehabilitation [2]. Among the various corrective procedures for hallux valgus, Scarf-Akin osteotomy has become one of the most commonly used combined procedures for moderate-to-severe deformities because of its strong corrective ability, broad applicability, and relatively low complication rate [6]-[10]. Moderate hallux valgus is defined as HVA 20° - 40° and IMA 11° - 16°, severe as HVA ≥ 40° or IMA > 16°, and very severe as HVA ≥ 60° [11]. However, this technique is technically demanding and places high requirements on fixation quality. Different fixation strategies vary in stability, implant-related discomfort, reoperation rates, and cost-effectiveness. At present, the main fixation options used in clinical practice include screws, Kirschner wires, bioabsorbable implants, and non-fixation techniques, but there is still no consistent evidence that any single fixation method is universally superior. In addition, postoperative patient satisfaction after hallux valgus surgery remains lower than that reported for other typical orthopedic procedures [12]. Therefore, a systematic review of fixation strategies after Scarf-Akin osteotomy is of practical significance for optimizing fixation selection and improving clinical outcomes, and it has also become a topic of growing interest. This review summarizes research progress on fixation strategies in Scarf-Akin osteotomy to provide a reference for optimizing fixation selection and improving clinical outcomes.

2. Scarf-Akin Osteotomy

Scarf osteotomy is a first metatarsal shaft osteotomy with strong three-dimensional corrective capacity and remains a mainstream procedure for hallux valgus correction. When combined with Akin osteotomy, it can be used to correct severe and even very severe deformities, particularly in complex cases associated with an increased distal metatarsal articular angle (DMAA) or hallux pronation [6] [13]. This combined procedure can effectively improve the hallux valgus angle (HVA), intermetatarsal angle (IMA), and distal metatarsal articular angle (DMAA) [6]-[8]. Although Scarf-Akin osteotomy has inherent stability, reliable fixation remains essential to maintain correction and support postoperative recovery [14] [15].

3. Fixation Strategies in Scarf-Akin Osteotomy

Reliable internal fixation is a key prerequisite for achieving favorable outcomes after Scarf-Akin osteotomy. In this combined procedure, fixation not only determines whether correction can be maintained during the critical period of bone healing, but also directly influences bone union, loss of correction, complication rates, and postoperative rehabilitation. Previous studies have shown that successful hallux valgus correction depends not only on adequate deformity correction but also on achieving stable fixation [2] [5] [16]. Continuous advances in fixation techniques have therefore become an important factor in improving surgical outcomes. With the ongoing development of classic osteotomy procedures such as the Scarf and Chevron techniques, fixation strategies have also evolved from earlier approaches that relied less on implants toward modern concepts that emphasize stable fixation, early weight-bearing, and faster functional recovery [2] [5] [16]. At present, the main fixation options for Scarf-Akin osteotomy include screw fixation, K-wire fixation, bioabsorbable implant fixation, or non-fixation techniques. Among these, metallic screw fixation remains the most widely used method and has the most established evidence base [12] [17] [18]. In general, screw fixation places greater emphasis on initial stability and interfragmentary compression; however, long-term retention of metallic implants may also lead to soft-tissue irritation, foreign-body sensation, and the need for secondary implant removal. Some studies have reported that the rate of screw removal due to implant-related discomfort or other reasons may exceed 26% [12]. For patients who are concerned about long-term retention of metallic implants or are reluctant to undergo secondary removal surgery, Kirschner wires, bioabsorbable implants, and selected techniques that avoid long-term hardware retention may improve patient acceptance and postoperative satisfaction.

3.1. Screw Fixation

Screw fixation remains the standard method for Scarf osteotomy and is still the preferred option for most foot and ankle surgeons [12] [17] [18]. Its main advantage is that it provides strong initial stability and interfragmentary compression, which help maintain correction, promote bone healing, and support early rehabilitation [7]. In practice, Scarf osteotomy is usually fixed with two screws, although some modified techniques use a single screw [12] [17]. Akin osteotomy is most commonly fixed with a single screw, and an oblique osteotomy line is often preferred because it allows the screw to cross the osteotomy plane more perpendicularly. Headless cannulated screws have also gained popularity due to their smaller profile and lower risk of soft-tissue irritation. Sanhudo noted [2] that single-screw fixation remains the most common method for Akin osteotomy, whereas cannulated and headless screws may reduce soft-tissue irritation and improve the convenience of fixation [5] [19]. However, metallic screw fixation also has limitations. Long-term retained implants may cause soft-tissue irritation, a foreign-body sensation, and the need for secondary removal [5] [12] [19]. In ad-

dition, successful screw fixation depends on adequate bone quality, proper osteotomy design, and accurate screw placement. Despite these limitations, screw fixation remains the most established and widely used strategy in Scarf-Akin osteotomy.

3.2. Kirschner Wire Fixation

Direct evidence for Kirschner wire fixation specifically in Scarf-Akin osteotomy is limited. Most supporting studies come from Chevron osteotomy, isolated Akin osteotomy, or other first metatarsal osteotomies. K-wire fixation is a traditional and widely used method. In hallux valgus surgery, it is more often used as a short-term temporary fixation rather than as a permanently retained implant. Its main advantages are technical simplicity, low cost, and easy removal, making it attractive for patients who wish to reduce implant burden [16] [20]-[22]. Ben-Ad also emphasized its ease of use and low cost [5]. Although Kirschner wires do not provide interfragmentary compression comparable to screws, they can still offer adequate stability across selected osteotomy or fusion sites, especially when the osteotomy itself has some inherent stability [2]. Most studies on temporary Kirschner wire fixation have focused on Chevron and related osteotomies, whereas direct evidence in Scarf-Akin osteotomy remains limited. Externalized Kirschner wire fixation allows percutaneous retention during the critical healing period and simple removal after healing, thereby reducing implant-related discomfort and avoiding secondary hospitalization for implant removal. This "less-implant" concept has become an important direction in optimizing fixation strategies for hallux valgus. In an Akin osteotomy, crossed Kirschner wires or single-wire fixation while preserving the lateral cortex are feasible options. In some first metatarsal osteotomies, supplementary longitudinal Kirschner wires may further increase rigidity, particularly in patients with poor bone quality [2]. Ben-Ad also noted that two Kirschner wires placed at an angle can significantly improve stability [5]. However, compared with screw fixation, Kirschner wire fixation provides weaker compression and less control of motion parallel to the wire direction, and its overall stability is generally lower. In addition, loosening, migration, skin irritation, and pin tract management remain concerns [16] [23]. Despite these limitations, percutaneous externalized Kirschner wire fixation remains a practical option for selected patients, especially those who wish to avoid long-term hardware retention or secondary implant removal surgery [16] [22] [23].

3.3. Bioabsorbable Fixation

Bioabsorbable fixation has attracted increasing attention as a potential alternative to metallic implants. Its main advantage is avoiding long-term retained hardware, which may reduce the need for secondary removal surgery. Some studies have suggested that biodegradable screws may achieve early clinical and radiographic outcomes comparable to those of metallic screws [21]. However, bioabsorbable materials still have important limitations, including higher cost and insufficient

evidence regarding long-term safety and broader clinical applicability [16] [21]. Therefore, despite their potential value, they have not replaced metallic screws or Kirschner wires as routine fixation options in Scarf-Akin osteotomy.

3.4. Non-Fixation Techniques

Non-fixation techniques have attracted attention because they avoid the need for implanted hardware, reduce implant-related complications, and may lower overall costs by eliminating secondary removal surgery [15]. In selected cases, they may also shorten the hospital stay and facilitate an earlier return to full weight-bearing.

However, displacement remains the most common complication of Scarf osteotomy without internal fixation, and the success of this strategy depends heavily on surgical expertise and reliable intraoperative stability assessment. Liszka *et al.* reported that in carefully selected patients, non-fixation achieved outcomes comparable to screw fixation in HVA, IMA, and AOFAS improvement, while also reducing operative time and overall cost [14]. They further emphasized the importance of modified techniques and intraoperative manual stability testing [14] [15]. Previous studies have shown that non-fixation Scarf osteotomy can provide good mid-term functional outcomes and correction of moderate to severe deformities [14] [15]. However, potential drawbacks include excessive shortening of the first metatarsal and an increased risk of postoperative transfer metatarsalgia in more severe cases. Leemrijse *et al.* also demonstrated that a stable, non-fixation Scarf osteotomy could be achieved through technical modifications, such as a distal step-shaped notch and a proximal interlocking design [15]. Overall, non-fixation techniques may achieve acceptable results in selected patients, but they require good bone quality, advanced surgical skill, and careful intraoperative assessment. Therefore, they are not suitable as a routine option for most cases.

3.5. Comparison of Different Fixation Methods

To better understand the trade-offs among fixation strategies, the following comparison summarizes key outcomes, including maintenance of correction, bone union, hardware irritation, additional operation for implant removal, pin-related issues, and cost. In summary, screws provide the most reliable stability but carry a notable risk of reoperation for hardware removal. K-wires reduce long-term implant burden and avoid the need for additional surgery, although pin-tract care is required. Bioabsorbable screw is more expensive and not routinely indicated. Non-fixation eliminates hardware but is feasible only under strict patient selection and surgical expertise. These trade-offs should guide clinical decision-making.

4. Limitations

This review has several limitations. First, there are relatively few comparative studies specifically evaluating different fixation methods in Scarf-Akin osteotomy. Most available evidence derives from studies of Scarf osteotomy alone, Chevron

osteotomy, isolated Akin osteotomy, or arthrodesis, and direct extrapolation to the combined Scarf-Akin procedure may not be fully valid. Second, outcome measures and reporting standards vary widely across studies (e.g., different radiographic parameters, follow-up durations, and patient-reported outcome tools), making direct comparison challenging. Third, the heterogeneity of surgical techniques (e.g., osteotomy design, number of screws, use of lateral soft-tissue release) confounds the assessment of the isolated effect of fixation method. Fourth, the evidence for bioabsorbable, plate, and non-fixation techniques remains limited to small case series or short-term follow-up studies. Finally, publication bias may exist, as studies with favorable results are more likely to be published. Therefore, the conclusions of this review should be interpreted with caution, and prospective randomized trials specifically focusing on the Scarf-Akin osteotomy are needed to provide higher-level evidence.

5. Prospect

Screw fixation remains the most established option because of its stability and broad clinical use, but implant-related discomfort and secondary removal remain concerns. Kirschner wire fixation may reduce long-term implant burden due to its lower cost and ease of percutaneous removal, although its stability and postoperative management still require attention. Bioabsorbable fixation is another promising option, but current evidence remains limited, and the cost is relatively high. Current studies suggest that different fixation methods can achieve satisfactory outcomes in selected cases, but no single method has been proven superior in all patients. Future research should focus on direct comparisons of fixation strategies in Scarf-Akin osteotomy, with particular attention to temporary Kirschner wire fixation, bioabsorbable fixation, broader clinical endpoints, health economic evaluation, and individualized fixation selection based on patient characteristics.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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