

Comparison between Transosseous Capsulorrhaphy and Akin Osteotomy in the Management of Hallux Valgus

Adnan A Faraj^{1*} and Chad Chang²

Department of Trauma and Orthopaedics, Scarborough General Hospital, Scarborough, UK

*Corresponding author: Adnan A Faraj, Consultant Orthopaedic Surgeon, Scarborough Hospital, Scarborough, UK, E-mail: dariofaraj@hotmail.com

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Abstract

Introduction: Hallux valgus is a common forefoot deformity requiring surgical correction. It is most commonly corrected with first metatarsal osteotomy. Additional procedures may be necessary if there is inadequate correction of hallux valgus. Akin osteotomy was intended for correction of hallux valgus interphalangeus. However, it is now commonly considered as an additional procedure in hallux valgus correction. This study aims to evaluate radiological and clinical outcomes of patient undergoing Akin osteotomy and transosseous capsulorrhaphy.

Method: We evaluated 18 consecutive patients (23 feet) operated upon within a 4-month period. Retrospective analysis of preoperative and postoperative radiograph of 23 feet with first metatarsal osteotomy with either Akin osteotomy (n=10) or transosseous capsulorrhaphy (n=13) was performed. Several new radiological forefoot measurements were devised for this study. Complication and clinic outcomes were also recorded.

Results: Average hallux valgus angle correction from Akin osteotomy is 13.21° and for transosseous capsulorrhaphy is 15.11° (p=0.54). Mean hallux valgus interphalangeus angle increased in Akin group by 0.47° and for transosseous capsulorrhaphy 1.53° (p=0.49). There is no statistical difference between all preoperative radiological measurements between the Akin group and transosseous capsulorrhaphy group. There is statistical significance (p=0.02) between the two groups in changes to the first web space from their respective procedures. All patients were satisfied with the surgery with no complications recorded.

Conclusion: There is no significant advantage adding Akin osteotomy to first metatarsal osteotomy unless there is a pre-existing anomaly of the distal metatarsal articular angle (DMAA) and hallux valgus interphalangeus. Transosseous capsulorrhaphy is a safer alternative.

Keywords: Akin; Capsulorrhaphy; Hallux valgus; Hallux valgus interphalangeus correction; Osteotomy

Introduction

Hallux valgus deformity, colloquially known as a bunion, is the commonest deformity affecting the first metatarsophalangeal joint (MTPJ). Hallux valgus is defined as a deviation of the hallux laterally in the transverse plane from the first metatarsal, forming an increased hallux valgus angle (HVA), measured as the angle between the mid-axis line of the first metatarsal and the mid-axis of the proximal phalanx. There is also an occasional associated eversion deformity of the hallux (Figure 1).

Anatomically the first metatarsal has very little muscular attachments. The first dorsal interossei originates from the lateral part of the first metatarsal and attaches to the medial aspect of the second proximal phalanx and into the aponeurosis of the corresponding extensor digitorum longus tendon. This muscular attachment, along with the splinting force of the abductor hallucis muscle, provides stabilization of the first metatarsal. The medial and lateral collateral ligaments at the level of the first MTPJ prevent subluxation of the first proximal phalanx on the first metatarsal bone.

The abductor hallucis and adductor hallucis muscles are inserted in the base of the proximal phalanx, and have no attachments on the first

metatarsal. Consequently, with the exception of the aforementioned splinting action, there is very little control on the medial movement of the first metatarsal. During gait or weight-bearing, the increased pressure on the first metatarsal head will result in the movement of metatarsal mediodorsally, which increases the HVA and intermetatarsal angle (IMA) (Figure 2). Upon chronic strain, the medial collateral ligament may weaken and rupture, leading to subluxation and deformity described as hallux valgus.

The deformity associated with hallux valgus can lead to pain from several causes: medial bursa inflammation, entrapment of the medial dorsal cutaneous nerve and shifting of plantar weight-bearing points due to the deformity. As the patient shift their weight bearing points, there may be changes to plantar callus distribution, leading to discomfort. The excessive pressure and compression from the hallux valgus deformity on the adjacent second toe can lead to hammer or claw toe, causing further deformities. The deformity can cause distress secondary to symptoms related to cosmesis and function, as patients frequently describes inability to wear sandals or heeled-shoes. Its prevalence increases with age, affecting 23% in adults between age 18-65 and 35.7% above age of 65 [1]. The condition is considered to be more common in the female population and is of multifactorial etiology [2,3].

It has been reported that there are over 100 procedures described in the literature for hallux valgus correction. This ranges distally from

corrective osteotomy of the proximal phalanx, to proximal fusion of tarsometatarsal joint. However, the contemporary operative hallux valgus corrections typically involve the use of first metatarsal osteotomy of variable techniques dependent on the severity of the hallux valgus deformity. Additional procedures are used in combination to further correct deformities, these include lateral soft tissue release, relocation of sesamoids, Akin osteotomy, and various capsulorrhaphy techniques [4,5].



In 1925, Akin described a procedure involving the resection of the medial exostosis of the first metatarsal head and a portion of the base of the proximal phalanx. Several articles have described the various aspects of the procedure since. Most of these have addressed the indications for the procedure, as well as variations on placement, shape, and fixation of the actual osteotomy. It is noted that the use of Akin osteotomy as a single method of hallux valgus correction has resulted in poor outcomes in function and appearance [6]. As a result, Akin's procedure is now commonly used in combination with other procedures in hallux valgus correction as an additional procedure when there is insufficient correction from the first metatarsal osteotomy.

The original procedure presented by Akin was proposed as a correction for hallux valgus interphalangeus (valgus deformity of the distal phalanx on the proximal phalanx), rather than as a technique for hallux valgus correction [7].

Excessive varus deformity at the level of interphalangeal joint is a potential concern with the current trend of the indiscriminate use of Akin osteotomy as an additional procedure to further correct hallux valgus deformities. Upon review of literatures for complication following hallux valgus surgery, hallux varus is the greatest single cause of dissatisfaction among patients. This complication is often attributed to overcorrection of hallux valgus, lateral release, malpositioning of the sesamoids and Akin osteotomy [8-10].



Therefore, alternative methods for further correction of hallux valgus deformity should be considered. Different techniques of this have been reported to help in improving the hallux valgus correction [10,11].

An example of such method is transosseous capsulorrhaphy (TOC). The technique used in this study is as described by Johannsen et al. [11], which involves raising a V-shaped capsular flap through making distally based V-shaped incision on the medial aspect of the first MTPJ capsule proximal to the joint. Once the V-shaped flap is raised, a Kessler suture is passed through the flap and suture thread passed through a 2 mm vertical drill hole made through the first metatarsal. Final capsular reefing and tightening is performed with the hallux held in the corrected position.

The primary outcome of this study is to compare the radiological outcomes of two groups of patients who underwent first metatarsal osteotomy for hallux valgus correction with an additional procedure of either Akin osteotomy or transosseous capsulorrhaphy.

Material and Methods

This retrospective clinical analysis was performed on 18 patients (23 feet) operated by a single surgeon in a four-month period.

Data collection

Retrospective data collection was carried out for all elective primary hallux valgus correction performed by the senior author (AF) in the department of Trauma and Orthopaedics in Scarborough General Hospital between the dates of 01/01/2015 to 01/05/2015.

All Orthopaedics surgical lists were reviewed and cases identified via the trust patient management software, Core Patient Database. For each identified case, the following were reviewed: pre-operative and

post-operative radiographs, electronic operation note and follow up clinical letter.

The following information were recorded: age at time of surgery, laterality, operation date, follow-up date, first metatarsal osteotomy type, Akin osteotomy, lateral release, transosseous capsulorrhaphy and pre/post-operative measurements of the forefoot as discussed below. For all osteotomy fixation, FRS screws (Wright Medical) between the size of 2.5 mm and 3 mm were used.

Exclusion

The exclusion criteria included the following: revision hallux valgus correction (n=1), patients who under concurrent Akin osteotomy and transosseous capsulorrhaphy (n=6), and insufficient radiographic exposure of the whole foot on pre or post-operative radiograph to allow for accurate measurement (n=2).

Radiologic measurements

Analysis of the hallux valgus measurements was performed on Agfa IMPAX picture archiving and communications systems (PACS), undertaken by the same author throughout (CC). Standing preoperative and postoperative radiographs of eligible patients were reviewed and standardised set of measurements were made according to a predefined protocol as set out in Table 1. Statistical analysis of all preoperative measurements revealed no statistical significant differences in the two groups.

Hallux Valgus Angle (HVA)	Angle between mid-axis of 1st metatarsal and mid-axis of 1st proximal phalanx
Hallux Valgus Interphalangeus Angle (HVI)	Angle between mid-axis of proximal phalanx and mid-axis of distal phalanx.
Intermetatarsal Angle (IMA)	Angle between mid-axis of 1st metatarsal and mid-axis of 2nd metatarsal
Distal Metatarsal Articular Angle (DMAA)	Represents the angle formed by the distal articular surface and the long axis of the first MT
Foot Width: Toe Distance (Dist T)	Horizontal distance between the medial condyle of the 1st proximal phalanx and the lateral condyle of the 5th proximal phalanx
Foot Width: MT Distance (Dist MT)	Horizontal distance between the medial condyle of the 1st metatarsal and the lateral condyle of the 5th metatarsal
1st Web space Distance (1WD)	Mid-point of 2nd toe middle phalanx to nearest point along the mid-axis of the hallux.

Table 1: Description of different angles used in the measurement

Results

Patient demographics and clinical outcome

Eighteen patients were identified during the study period; five of these patients had bilateral hallux valgus correction performed at the same time. The patients were all female with average age of 58.86 years (Range 18-76 years) (Table 2). Average follow up was 6 months (range 5-10 months). There were no recorded intraoperative or postoperative complications, and general reported outcome by patients were positive regardless of the surgical technique used to for hallux valgus correction.

Average postoperative healing time is 7 weeks (range 4-10 weeks). Healing of osteotomy is defined clinically as the absence of tenderness on palpation of the osteotomy site and radiologically if evidence of healing is observed over the osteotomy site on postoperative radiographs (i.e. callous formation or bone bridging across osteotomy).

Patient Number	18	
Case Number	23	
Sex Ratio (F:M)	18:0	
Laterality Ratio (L:R)	11:12	
Average Age	58.86	
Average Follow Up	27.67	
Akin Osteotomy	Yes	10
	No	13
Lateral Release	Yes	18
	No	5
Transosseous Capsulorrhaphy	Yes	13
	No	10

Table 2: Patient Demographic and Operative Techniques

Hallux valgus angle (HVA)

The average preoperative HVA for the Akin group is 31.45° and 31.68° for the TOC group. Statistical analysis with independent samples T-test revealed no statistical significance (p=0.97) between the two groups. Postoperative HVA for the Akin group is 18.24° and 16.58° in the TOC group, indicating a change in HVA of 13.21° for the Akin group and 15.11° in the TOC group. There is no statistical significance (p=0.54) to the changes of HVA for both TOC and Akins group. Average combined HVA measurements is 31.58° preoperatively and 17.3° postoperatively.

Hallux valgus interphalangeus angle (HVI)

The average preoperative HVI for the Akin and TOC group are 5.86° and 5.14° respectively. There is no statistical significance in the two groups (p=0.26). Postoperative HVI for the Akin group is 6.33° and 6.67° for the TOC group. Combined analysis of Akin and TOC group showed no difference in HVI changes (p=0.49). The HVI angle correction was minimal because the intention of the procedures (i.e. Akin osteotomy or TOC) was to correct the hallux valgus deformity rather than to change the axis of the phalanx (Figure 3).

Foot width: Toe distance (Dist T)

The preoperative average foot width at the level of the toe for all patients in this study is 83.06 mm. For the Akin group, the average toe level foot width is 80.73 mm and 84.85 mm for the TOC group. There appears to be an increase in forefoot width from surgery in both groups, with an average increment of 1.33 mm. This increment is observed in both groups (1.92 mm in Akin group, 0.87 mm in TOC group), with no statistical significance in the level of increment between the two groups (p=0.14) (Figure 4).



Figure 3: Hallux valgus interphalangeus Angle



Figure 4: Foot Width: Toe distance

Foot width: MT distance (Dist MT)

The preoperative foot width at the level of metatarsal for all patients averaged 92.28 mm. The Akin group has generally narrower preoperative foot width (89.86 mm) compared to the TOC group (94.14 mm), however this is not statistically significant ($p = 0.08$). Both groups had reduced foot width from surgery, with TOC group observing a more substantial reduction (-8.58 mm) compared to the

Akin group (-4.67 mm). There is no statistical significance between the two groups in changes to the foot width ($p=0.30$) (Figures 5 and 6).



Figure 5: Distal metatarsal articular angle



Figure 6: Foot Width: Metatarsal distance

1st web space distance (1WD)

Increased postoperative first web space distance is observed in all patients, with an average increment of 6.4 mm. In the Akin group, the average increment is 4.11 mm, whereas in the TOC group the average increment is found to be 8.16 mm (Table 3). There is statistical significance ($p=0.02$) between the Akin and TOC group in terms of

changes to the first web space from their respective operations, with a more marked change observed in the TOC group (Figure 7).



Figure 7: First web space distance

Discussion

Various procedures can be used in addition to first metatarsal osteotomy to correct hallux valgus [1,2,4,9,11,12]. From this study, there appears to be no significant difference in the majority of radiological outcomes between Akin osteotomy and transosseous capsulorrhaphy, with exception to the changes to the first web space distance. There is a theoretical risk of recurrence of hallux valgus deformity due to stretching of the capsular repair with transosseous capsulorrhaphy. The advantages and disadvantages of Akin's procedure however has been the subject of much discussion.

Akin osteotomy should be considered in the correction of hallux valgus with associated hallux valgus interphalangeus. It should be considered as an adjunct to first metatarsal osteotomy, rather than as a primary procedure in the correction of hallux valgus [6,12]. Goldberg reviewed outcomes of patients who underwent Akin osteotomy for hallux valgus correction has found generally poor outcomes as the procedure did not address the underlying biomechanical factors causing the deformity.

Overcorrection from both Akin osteotomy and first metatarsal osteotomy can cause hallux varus, leading to patient dissatisfaction. Whilst considered a relatively rare complication of corrective hallux valgus surgery, if left untreated can lead to stiffness, pain and degenerative arthritis [10]. Management of hallux varus requires a comprehensive assessment that focuses on joint flexibility, joint integrity, soft tissue balance, and bony deformity [13]. Additional osteotomies to the proximal phalanx exposes the bone to risk of non-union and need for further metal work, thus incurring additional surgical costs. Shortening of the hallux was observed in all cases secondary to the closing wedge osteotomy [9,10]. Whilst Akin osteotomy is indicated in those with hallux valgus interphalangeus, the indiscriminate use of the Akin osteotomy with little regard for

preoperative criteria may result in disappointing results for both the practitioner and patient.

Preoperative Measurements							
	HVA	HVI	IMA	DMAA	Dist. (T)	Dist. (MT)	1WD
Akin (n = 10)	31.45	5.86	14.32	34.68	80.73	89.86	17.71
TOC (n = 13)	31.68	5.14	14.28	29.38	84.85	94.14	22.13
Total (n = 23)	31.58	5.45	14.30	31.68	83.06	92.28	20.21
Postoperative Measurements							
Akin (n = 10)	18.24	6.33	6.93	18.09	82.65	85.19	21.82
TOC (n = 13)	16.58	6.67	8.89	14.17	85.72	85.56	30.29
Total (n = 23)	17.30	6.52	8.04	15.87	84.38	85.40	26.61
Difference							
Akin (n = 10)	- 13.21	0.47	- 7.39	- 16.59	1.92	- 4.67	4.11
TOC (n = 13)	- 15.11	1.53	- 5.39	- 15.21	0.87	- 8.58	8.16
Total (n = 23)	- 14.28	1.07	- 6.26	- 15.81	1.33	- 6.88	6.40

Table 3: Preoperative and Postoperative Patient Radiographic Measurements

The primary outcome of this study was the radiological measurements of different surgical techniques, and therefore prolonged follow up was not considered to be necessary. However, the lack of subsequent follow up has prevented the study in identifying late recurrences of hallux valgus deformity.

It is noted that this study is limited by relatively low number of study subjects, as well as a lack of patient randomisation. While the majority of pre and post-operative radiographs of the foot have been taken whilst weight bearing, some post-operative radiographs are taken off-load as patient were unable to tolerate weight bearing due to pain. This inconsistency may be contributing as a source of error in radiological measurements.

As the study is a retrospective clinical analysis, patient selection and follow up protocol were not in place – this potentially affects the overall reliability of the results. As this study was designed to be a pilot study, future efforts should concentrate on standardization in patient selection, operative procedures, follow up and rehabilitation protocols.

Conclusion

Akin osteotomy may offer additional improvement in the correction of hallux valgus in cases where hallux valgus interphalangeus is present. However, there appears to be no significant advantage in the routine use of Akin osteotomy in addition to first metatarsal osteotomy when compared to a safer and cheaper alternative such as transosseous capsulorrhaphy.

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