SVOA Neurology

ISSN:2753-9180

ScienceVolks Open Access

Research Article

A Prospective Cohort Study Investigating the Effects of the Combined Scarf and Akin Osteotomy, With or Without 2/3 Digital Correction, on Pain and Quality of Life 6 Months Post-Surgery

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***Received:** May11, 2021 **Published:** May 27, 2021*

Abstract

Background: Hallux valgus is a common deformity of the forefoot that affects the first ray and may lead to pain. The mainstay of treatment is operative correction and this commonly involves a combination of scarf and Akin osteotomies. The aim of the study was to investigate the effects of the combined scarf and Akin osteotomy for Hallux valgus deformity (with or without 2/3 digital correction) on pain levels and health related quality of life 6 months postoperative.

Methods: A prospective cohort study was carried out. Thirty adult participants with a clinical and radiographic diagnosis of hallux valgus were recruited, one was lost to follow-up. A combined scarf and Akin osteotomy with or without 2/3 digital correction was carried out. Participants were asked to complete the outcomes of VAS for foot pain and the health Manchester-Oxford Foot Questionnaire (MOXFQ) for quality of life before and six months post-surgery.

Results: Mean age was 59 (SD10) years with 14% males and 86% females. Median VAS pain score reduced from 6 to 0 ($p<0.0001$). The health MOXFQ domains for foot pain decreased from 60 to 5 ($p<0.0001$), walking/standing from 50 to 0 ($p<0.0001$) and social interaction from 50 to 0 ($p<0.0001$).

Conclusion: This study has international impact and contributes to current evidence that the combined scarf and Akin osteotomy with or without 2/3 digital correction is effective in the operative management of symptomatic hallux valgus foot deformity with improvements in pain and health related quality of life by 6 months post-surgery.

Keywords: *Foot Surgery; Pain; Visual Analogue Scales; MOXFQ; Hallux Valgus Surgery; Digital Surgery; Scarf and Akin osteotomy;*

Highlights

- Combined scarf and Akin osteotomy with or without 2/3 digital correction is an effective operative procedure for the management of symptomatic hallux valgus foot deformity.
- Clinical improvements in pain and health related quality of life are statistically significant by 6 months post-surgery.

Background

In general, an average of about 20 to 30% of people affected by foot pain, have decreased mobility and the ability to perform normal daily living activities (1). Hallux valgus was first described in 1870 by Hueter, with the mainstay of treatment involving operative correction with approximately 130 procedures being described (2, 3). It is one of the most common foot problems seen today in the foot and ankle and often progresses to involve the rest of the forefoot (4, 5). An audit in the United Kingdom involving 58 operative centers reported that 89% (n=3293) of patients had undergone a scarf metatarsal osteotomy for the correction of Hallux valgus over a one year period (6). Operative correction by osteotomy is the most common method of managing symptomatic Hallux valgus and has been shown to be the most desired and effective treatment (7).

The scarf osteotomy is a Z shaped osteotomy of the first metatarsal mainly by Weil and Borrelli in 1991 in USA and Barouk in France in 1993 (9, 10). The scarf osteotomy combined with Akin's closing wedge osteotomy (Akin 1925), is now widely used for the correction of painful hallux valgus (11). Research has reported high success rates of hallux valgus surgery using the scarf and Akin osteotomy (3, 5, 9-14). Improving pain outcomes for hallux valgus is the most significant indication for surgery (Kilmartin 2006) however, factors such as health related quality of life, appearance and joint range of motion are equally important (5). Furthermore, an audit of patient expectations following foot and ankle surgery in the United Kingdom found that pain relief was the dominant expectation accounting for 72.6% (n=515) (15). However, more research investigating the post-operative outcomes of pain reduction and improved health related quality of life (especially at 6 months or more) is required (5, 16). The aim of this study was to investigate the effects of the combined scarf and Akin osteotomy for hallux valgus deformity (with or without 2/3 digital correction) on pain levels and health related quality of life 6 months post-surgery.

Materials and Methods

Ethical approval was granted by Queen Margaret University Research Ethics Committee and the NHS[1] Research Ethic Committee (reference number 10/H1308/74). NHS Research and Development approval was granted by the Clinical Governance Advisory Committee of the Department of Clinical Governance of the Doncaster Bassetlaw Hospitals NHS Foundation Trust (reference number 0404/2011/NCT). All participants provided informed written consent prior to participating in the study.

All potential participants had previously been diagnosed with hallux valgus deformity and added to the day case operative load under regional ankle block. The study's inclusion criteria were over 18 years of age; no contra-indications to local anaesthetics; and correction of hallux valgus using a combined scarf and Akin's osteotomy procedure with or without 2/3 toe correction. The exclusion criteria were: history of pain syndrome which was excluded as the outcome measures may partly reflect the effects of this condition rather than only the effects of the surgery; rheumatoid arthritis which was excluded as the outcome measures may reflect disease active painful joints rather than the effects of surgery only; previous history of foot surgery which was excluded as it may partly affect outcome measures; unable to consent, these were excluded for ethical reasons; and hypermobility syndrome as the outcome measures may partly be representative of possible pain and decreased Quality of Life experience by sufferers of this condition. During the consultation, where clinical and radiographic diagnosis of hallux valgus was made, patients were screened using the study's inclusion/exclusion criteria and those eligible were invited to participate in the study. Patients who agreed to participate were provided with written advice explaining the study and introduced to the researcher. At the preoperative assessment, carried out approximately 2 weeks prior to the operative appointment, written informed consent was taken. All participants were then assigned a study number to maintain anonymity for all data collected.

Data was collected by the researcher from all participants at baseline (usually 2 weeks prior to surgery) and 6 months postoperative. At these data collection time points participants were asked to complete the outcome measures of a Visual Analogue Scale (VAS) for foot pain and the health Manchester-Oxford Foot Questionnaire (MOXFQ).

Thirty eligible participants satisfying the study's inclusion and exclusion criteria underwent a combined scarf and Akin's procedure with or without 2/3 digital correction for a hallux valgus deformity. Routine dorso-plantar, medial-oblique and lateral weight bearing x-rays were taken before and after surgery. The x-rays were used to calculate the intermetatarsal and hallux valgus angles. The intermetatarsal angle (IMA) was calculated by measuring the angle between the first and second metatarsals and the hallux valgus angle (HVA) was taken as the angle between the first metatarsal and the proximal phalanx (figure 1) (17). Some patients with symptomatic hammer toe(s) affecting the 2nd and/or 3rd digit(s) also underwent digital correction of the lesser toe(s) with fixation.

1

2

Figure 1: Weight bearing X-ray showing the hallux valgus and intermetatarsal angles measured for all participants.

Figure 2: An example of before and after surgery weight bearing X-ray for one of the participants.

Surgical Procedure

With a single dorsal-medial longitudinal incision, the medial articular capsule was released, the adductor halluces were reflected, and the sesamoid bones reduced medially. The first metatarsal was exposed from the initial incision along its medial shaft and axis, the medial eminence was resected, followed by the Z-osteotomy of the metatarsal to create a plantar and a dorsal capital fragment.

The capital fragment was translated laterally and fixed with two equidistant 2.0mm striker screws. A hallux interphalangeal closing base-wedge osteotomy was carried out and fixated with a 2.0mm fully threaded k-wire. The capsule was closed under tension and the reflected adductor halluces restored with sesamoid positioning using transosseal sutures (figure 2). If necessary, an additional procedure on the second and/or third digit(s) was carried out, either an excisional arthroplasty or arthrodesis.One surgeon carried out all the operative procedures. The surgeon was also responsible for supplying postoperative medication, normally non-steroidal anti-inflammatory drugs (NSAID) and/or compound analgesics as common practice.

Post-Operative Management

Immediately following surgery there is pain relief from the long acting anaesthetic however, to help ease post-operative pain from the second day onwards patients were advised to use combined analgesia (see above), as per normal departmental guidelines. This is essential and helps with postoperative planning and strict adherence to the operative protocols. As this is carried out on a day care center, the evaluation of postoperative results was based on subjective feelings of the patients and clinical assessment of the range of motion of the hallux, hence postoperative management was vital to avoid bias.

Post-operative patients were advised to keep their foot raised as much as possible for the first two weeks and beyond this, to reduce swelling as required. They were also informed that they could put full weight on their foot using the forefoot offloading surgical shoe for the first 6 weeks and use crutches if needed. At two weeks they were encouraged to exercise their big toe. No post-operative complications were observed and one patient was lost to follow up.

Priori sample size calculation

For a 5% one sided paired t-test with α=0.05 and power 80% and a moderate effect size of 0.5 (Cohen 1988), it was estimated that a total of 27 participants would be required. The study was overpowered by 10% to an estimated 30 participants to allow for dropouts during the 6 months data collection period.

Statistical analysis

The health MOXFQ is a validated questionnaire that contains 16 items on a Likert Scale (each with five possible responses) and these are divided into 3 domains: pain (contains 5 items); walking/standing (contains 7 items); and social interaction (contains 4 items). Each item was scored with a value between 0 and 4. For each domain the items were then added up and converted to a metric score ranging from 0 to 100 with 100 being most severe (18-20).

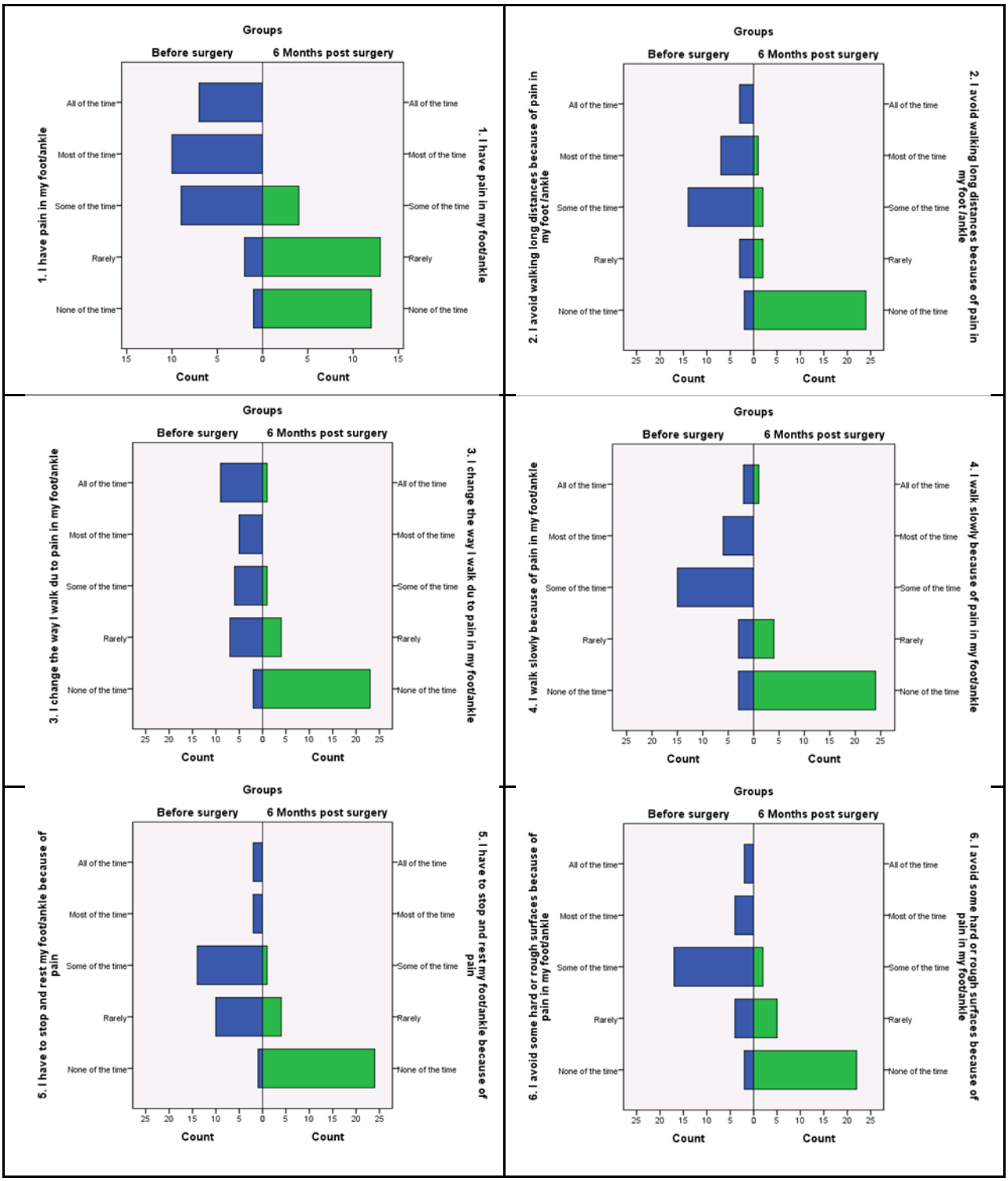
Data was analysed using the statistical program SPSS (version 17) (SPSS Chicago, Illinois). Data for Pain and health MOXFQ domains was tested for normality using histograms and a Shapiro-Wilk's test (data was assumed parametric if $p>0.05$). Where data was assumed parametric, a paired t-test was used to test for statistical significance and where data was assumed non-parametric, a Wilcoxon's test was used. Means and standard deviation are reported for parametric data, and medians and inter-quartile range for non-parametric data. Statistically significant differences for VAS and heath MOXFQ was set at $p<0.05$.

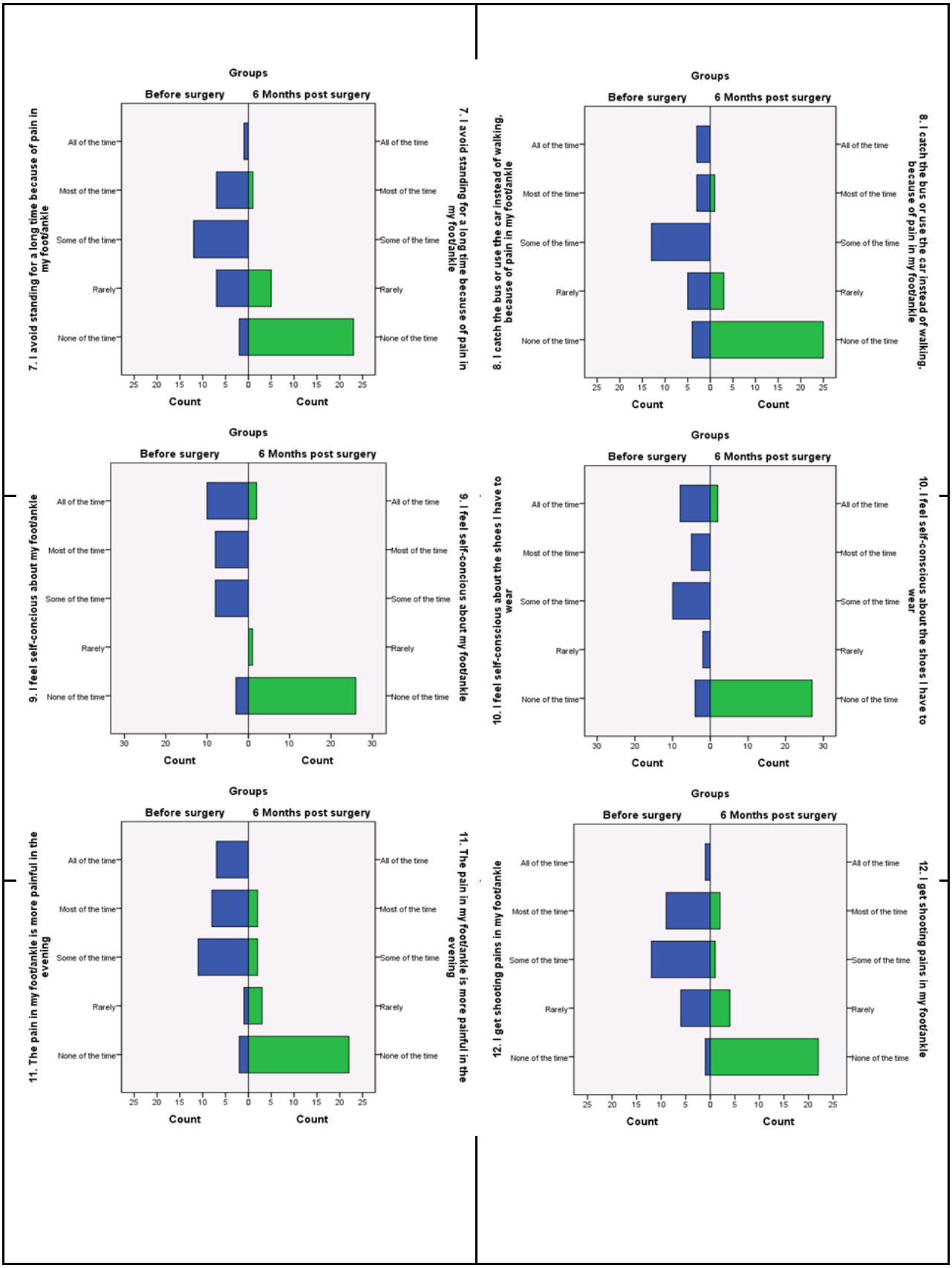
Results

Thirty participants were recruited into the study however one participant was lost to follow-up and their data was not included in the analysis. Data for 29 participants was used for the analysis, 14% (n=4) were males and 86% (n=25) were females (table 1). The mean age was 59 years (SD²10) with a minimum age of 37 and a maximum age of 81. The intermetatarsal angle had a mean of 17 degrees (SD 3) before surgery with a mean of 10 degrees (SD 3) after surgery. The hallux valgus angle had means of 33 degrees (SD 6) before surgery and 15 degrees (SD 5) after surgery.

Individual health MOXFQ items responses are shown in figure 3. Only one patient failed to complete question 8, part of the walking/standing domain, at baseline. Since the respective patient completed all questions at 6 months, their baseline data was entered as missing for that respective question only and taken into account when conducting the walking/standing domain calculations at baseline for this patient only. Overall, at baseline there is a pattern of scoring across the range of the responses for most questions with no particular trends shown. At 6 months post-surgery, there is an overall pattern of improved symptoms scoring within the range of responses for most questions.

Table 2 summarizes the health MOXFQ outcome scores for the investigated cohort with all domain scores showing a significant reduction in scores by 6 months post hallux valgus surgery. All data for VAS and health MOXFQ was non-parametric therefore the Wilcoxon's test, medians and interquartile ranges (IQR) are reported. For the health MOXFQ pain domain, the median pre to postoperative scores, was also reduced from 60 (IQR 22) to 5 (IQR 15) with a score change of -55 (IQR 27) ($P<0.0001$). In addition, the health MOXFQ walking and standing domain median scores, between pre and postoperative, was reduced from 50 (IQR 21) to 0 (IQR 7) with a score change of -50 (IQR 28) ($P<0.0001$). Similarly, the health MOXFQ social interaction domain median scores, comparing pre and postoperative scores, was also reduced from 50 (IQR 22) to 0 (IQR 0) with a score change of -50 (IQR 25) ($P<0.0001$). Finally, the VAS scale also showed a reduction for pre to postoperative median scores from 6 (IQR 4) to 0 (IQR 0) with a reduction of -6 (IQR 3) ($P<0.0001$).


Groups
Before surgery
6 Months post surgery
1. I have pain in my foot/ankle
All of the time
Most of the time
Some of the time
Rarely
None of the time
Count
2. I avoid walking long distances because of pain in my foot/ankle
3. I change the way I walk du to pain in my foot/ankle
4. I walk slowly because of pain in my foot/ankle
5. I have to stop and rest my foot/ankle because of pain
6. I avoid some hard or rough surfaces because of pain in my foot/ankle


Groups
Before surgery
6 Months post surgery
7. I avoid standing for a long time because of pain in my foot/ankle
All of the time
Most of the time
Some of the time
Rarely
None of the time
Count
8. I catch the bus or use the car instead of walking, because of pain in my foot/ankle
9. I feel self-concious about my foot/ankle
10. I feel self-conscious about the shoes I have to wear
11. The pain in my foot/ankle is more painful in the evening
12. I get shooting pains in my foot/ankle

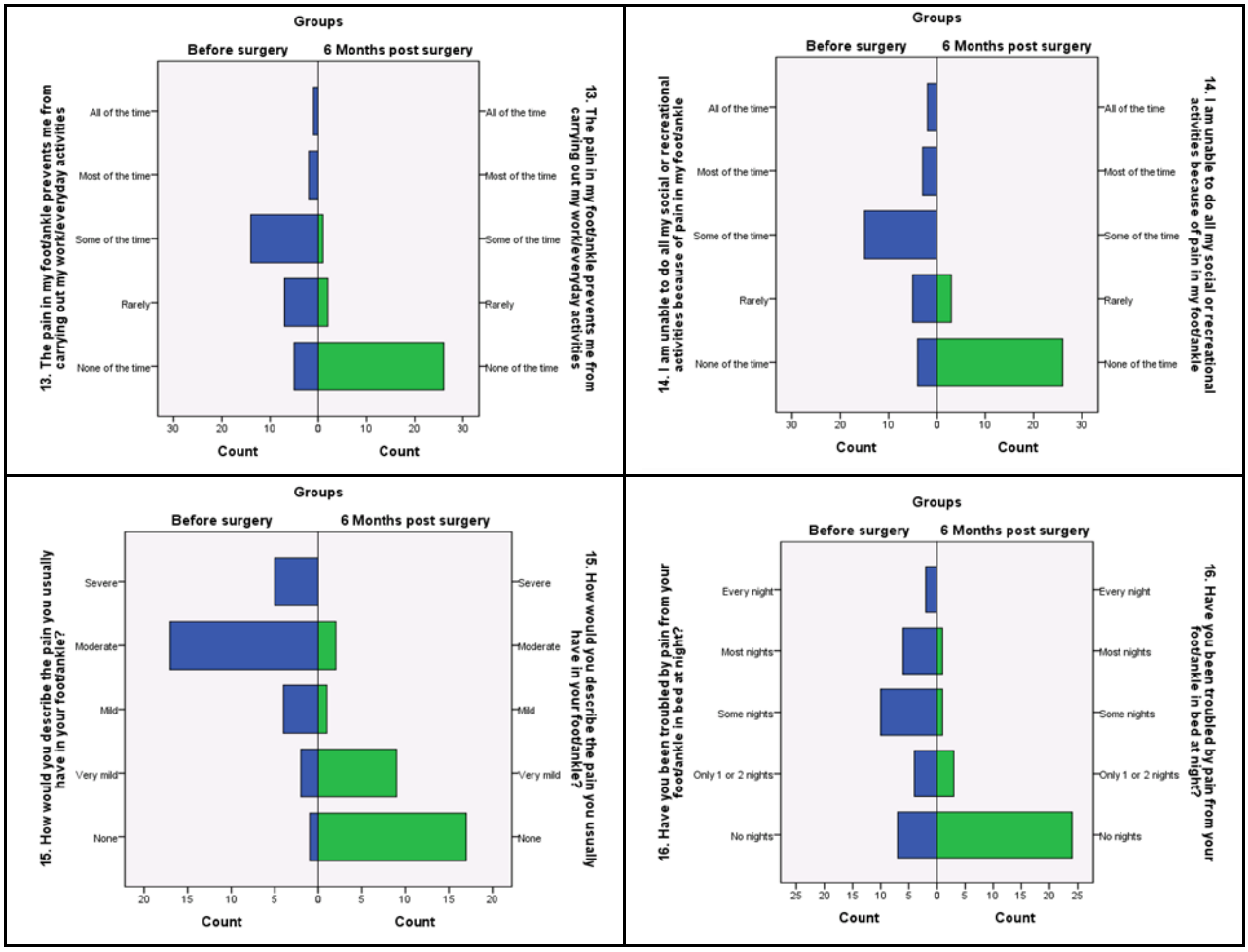


Figure 3a-p Patient's responses to individual MOXFQ items (N=29) representing the pre and post-operative scores across the three fundamental domains. For most questions there is no pattern to the scoring before surgery but an overall pattern of improved symptoms within the range of responses for most questions is apparent 6 months post- surgery

Table 1: Demographic distribution and clinical radiographic examination data for the study's cohort before and after surgery (min – minimum value; max – maximum value; SD – standard deviation).

Demographics and clinical radiographic examination			
Gender	Male 14% (n=4)	Female 86% (n=25)	
Age (years)	Min 37 Max 81	Mean 59 (SD10)	(n=29)
Inter-metatarsal angle BEFORE surgery (degrees)	Min 12 Max 24	Mean 17 (SD 3)	(n=29)
Inter-metatarsal angle AFTER surgery (degrees)	Min 4 Max 16	Mean 10 (SD 3)	(n=29)
Hallux valgus angle BE-FORE surgery (degrees)	Min 19 Max 42	Mean 33 (SD 6)	(n=29)
Hallux valgus angle AFTER surgery (degrees)	Min 4 Max 26	Mean 15 (SD 5)	(n=29)

Table 2: The median and interquartile ranges (IQR) for the pre and post-surgical scores for the VAS and MOXFQ domains of Pain, Walking/Standing, and Social Interaction. The score change for pre and post-surgical scores is also shown. The p values for the Wilcoxon's tests comparing pre and post-surgical scores outcomes is shown (* denotes statistically significant results).

MOXFQ and VAS scores Pre and post-surgery								
		Pre-Surgical Scores		**Post-Surgical Scores**		**Score Change**		**P value**
		Median	**IQR**	**Median**	**IQR**	**Median**	**IQR**	
MOXFQ	**Foot pain**	60	22	5	15	-55	27	P<0.0001*
MOXFQ	**Walking/Standing**	50	21	0	7	-50	28	P<0.0001*
MOXFQ	**Social Interaction**	50	22	0	0	-50	25	P<0.0001*
Foot Pain Scale	**VAS**	6	4	0	0	-6	3	P<0.0001*

Discussion

Hallux valgus is a common forefoot painful condition, it can be very disabling, and at present metatarsal osteotomies are common procedures used for pain relief and deformity correction for this condition. The studied cohort had a higher female to male ratio. Possible reasons for this gender variation in the prevalence of hallux valgus could be related to social and cultural factors with women more likely to wear constrictive and inappropriate footwear as a consequence of shoe fashion (2, 4, 5, 21). However, other factors relating to differences in anthropological foot characteristics between males and females and their consequence in foot pathomechanics may also explain the differences; for example, women may have a narrower and smaller foot size than males (21, 22). A meta-analysis investigating the prevalence of hallux valgus in the general population also reported a higher prevalence of females with this condition (23).

Age also appears to be related to the development of hallux valgus. Saro et al. (2008) in a study investigating operative management of hallux valgus found that those undergoing surgery peaked in the fifth decade regardless of gender (24). Furthermore, current trends in the number of musculoskeletal foot and ankle consultations (including hallux valgus) in the UK also shows a trend with increasing age with the highest proportion in the 45-64 years age group and peaking in the 65-74 age group (25). Similarly, the age distribution for the current study reflects the trends mentioned above and that of other studies with the prevalence of hallux valgus increasing with age (23).

Pique-Vida et al. (2009) in a geometric analysis of hallux valgus classified the hallux valgus angle as normal (less than 15°), mild (15-20°), moderate (21-39°) and severe (equal or greater than 40°). The authors also classified the intermetatarsal angle as normal (less than 9°), mild (9- 11°), moderate (12-17°) and severe (equal or greater than 18°) (26). Before surgery, the measurements taken from the weight bearing x-rays suggest that, on average, participants presented with a moderate deformity as assessed by the intermetatarsal and hallux valgus measurements. Following surgery, intermetatarsal and hallux valgus angles, were both corrected to within mild to normal ranges (see above classification for angles) (26). This improvement in deformity and joint alignment may have contributed to better foot function with a reduced width of the forefoot and better footwear fitting; and may account for the observed statistical reductions in pain and improved quality of life of the self-reported post-surgery outcomes.

The scarf osteotomy (8-10, 27, 27) combined with Akin's closing wedge osteotomy (11), is now widely used for the correction of painful hallux valgus.

The combined scarf and Akin's osteotomy is a diaphyseal osteotomy of the first metatarsal as well as a closing wedge osteotomy of the proximal phalanx of the hallux in order to correct a moderate to severe hallux valgus foot deformity, that is, a 1st to 2nd intermetatarsal angle of 12 degrees or more (9, 13, 26, 28-30). It is a very versatile osteotomy and can be modified to deal with many common problems (3, 9, 10, 30, 31). The combined scarf and Akin osteotomy in addition allows for early weight bearing and avoids excessive shortening of the first metatarsal but permits its elongation and plantar displacement by oblique osteotomy (27). Advantages of this procedure include internal stability and correction of first ray with early recovery and ambulation, a favorable fact that can relate to the benefits of surgery if health related quality of life and reduction of foot pain can be achieved (27).

Research has reported high success rates of hallux valgus surgery using the scarf and Akin osteotomy (3, 5, 9-13). The alleviation of painful hallux valgus is usually the primary indication for operative intervention (5) with clinicians usually using pain reduction as a primary outcome measure however, factors such as the health-related quality of life, appearance and joint range of motion are equally as important to the patient. The health MOXFQ is a measure of foot health related quality of life developed and validated specifically to measure the outcomes of foot surgery (18, 19, 32, 33). Although the VAS scale is designed to assess pain purely based on its singular entity, the health MOXFQ questionnaire is validated to assess quality of life and is divided into walking/standing, foot pain and social interaction dimensions. These scores have also been shown to reflect both clinical improvements in symptoms as well as statistically significant differences (18, 32, 33).

Dawson et al. (2007) reported minimal clinical important differences for health MOXFQ of 12.8 for the walking/standing domain, 4.6 for pain domain and 20.3 for social interaction domain (19). The results of this prospective cohort study have supported the findings that, by 6 months, an operative intervention for painful hallux valgus can achieve a reduction in pain ($p<0.0001$) and improve the health related quality of life through improvement across all 3 domains of health MOXFQ namely; pain, walking and standing, and social interaction ($p<0.0001$) with the findings not only statistically significant but also clinically significant. The findings of this study are consistent with previous reports, which has shown that the minimal clinical important difference for each of the health MOXFQ domains can be exceeded following reconstructive hallux valgus surgery with or without 2/3 toes correction (19, 20). Furthermore, the results of this study also compare favorably with other studies that have considered the significance of patient related outcome measures and health status following foot and ankle surgery using the health MOXFQ (18-20, 32-34).

Other studies have compared the outcomes of the combined scarf and Akin osteotomy to chevron osteotomy. From a surgical perspective the scarf and Akin procedure is a more extensive procedure with a longer learning curve than a distal chevron osteotomy (35). However, studies have found comparable clinical and radiological outcomes of chevron and Akin versus scarf and Akin osteotomies (36, 37, 38, 39, 41, 42, 43). Lai et al. (2018) found that at 24 months follow-up the clinical and radiological outcomes of chevron and Akin verses scarf and Akin osteotomies are comparable, however from a surgical perspective the chevron and Akin had a shorter surgical length of time with less perioperative pain, probably due to the chevron and Akin procedure being less invasive (36). In contrast, Vopat et al. (2013) found that the 2 surgical procedures produced comparable outcomes for pain and satisfaction scores as well as for correction of the HVA and IMA for moderate to severe hallux valgus (37). Similarly, other authors have reported no statistical differences between the 2 procedures with similar AOFAS scores, HVA and IMA (38, 39, 42, 43). However, for correction of the IMA, a systematic review found that the scarf osteotomy was superior to the chevron osteotomy, however the authors reported that the articles included were of low quality (40). At 14 years follow-up Jeuken et al. (2016) reported no significant difference for the two procedures for preventing recurrence of the condition (41). Although this article methodologically did not make a direct comparison between chevron and scarf osteotomies the findings reported in this paper for scarf and Akin osteotomy support the findings for the scarf procedures reported in the comparative articles. Overall, with regards to clinical and radiological outcomes and recurrence rates, the two procedures are comparable although some surgeons prefer the chevron osteotomy because its less invasive and the scarf osteotomy appears to achieve marginally better IMA correction.

Conclusions

This study found that a combined Scarf and Akin osteotomy with or without 2/3 digital correction is an effective procedure for the operative management of symptomatic hallux valgus foot deformity with statistical and clinical improvements found in pain reduction and health related quality of life by 6 months post-surgery. It is however, recommended that future studies consider whether combining Scarf Akin with lesser digit correction versus Scarf Akin only will affect outcomes. The inclusion of lesser digit surgery in future should stipulate the number of patients who actually undergo concomitant lesser digit surgery and indeed indicate if it is the 2nd or 3rd digit or both.

A longer term outcomes study which includes other secondary biomechanical outcomes to explain if the improvements found have a biomechanics basis would be an excellent suggestion to consider for a future study.

Conflict of interest

There were no conflicts of interests.

Role of the funding sources

This study received no sources of funding.

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Citation: Nake I, Adekunle T, Wilkinson T, Babi F, Coda A, Santos D. "A Prospective Cohort Study Investigating the Effects of the Combined Scarf and Akin Osteotomy, With or Without 2/3 Digital Correction, on Pain and Quality of Life 6 Months Post-Surgery". SVOA Neurology 2:3 (2021) Pages 60-71.