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Hallux Valgus Correction Comparing Percutaneous Chevron/Akin (PECA) and Open Scarf/Akin Osteotomies

VIDEO

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Abstract

Background: Minimally invasive surgery is being used increasingly, including for hallux valgus surgery. Despite the growing interest in minimally invasive procedures, there have been few publications on percutaneous chevron/akin (PECA) procedures, and no studies have been published comparing PECA to open scarf/akin osteotomies (SA).

Methods: This was a prospective, randomized study of 50 patients undergoing operative correction of hallux valgus using one of 2 techniques (PECA vs open SA). Data were collected preoperatively and on 1 day, 2 weeks, 6 weeks, and 6 months postoperatively. Outcome measures include the American Orthopaedic Foot & Ankle Society Hallux-Metatarsophalangeal-Interphalangeal (AOFAS-HMI) Score, visual analog pain score, hallux valgus angle (HVA), and 1-2 intermetatarsal angle (IMA). Twenty-five patients underwent PECA procedures and 25 patients received SA procedures.

Results: Both groups showed significantly improved AOFAS-HMI scores after surgery (PECA group: 61.8 to 88.9, SA group: 57.3 to 84.1, $P = .560$) with comparable final scores. HVA and IMA also presented similar outcomes at final follow-up ($P = .520$ and $P = .270$, respectively). However, the PECA group showed significantly lower pain level (VAS) in the early postoperative phase (postoperative day 1 to postoperative week 6, $P < .001$ and $P = .004$, respectively). No serious complications were observed in either group.

Conclusion: Both groups showed comparable good to excellent clinical and radiologic outcomes at final follow-up. However, the PECA group had significantly less pain in the first 6 weeks following surgery.

Level of Evidence: Level II, prospective comparative study.

Keywords: hallux valgus, scarf osteotomy, percutaneous, chevron, akin, minimally invasive

Introduction

Among 130 open procedures for hallux valgus, several techniques have shown successful outcomes if properly executed.[13] Scarf, Ludloff, and chevron are examples of some of the procedures favored by many surgeons with reliable outcomes.[6,7,10,11,35] However, despite high success rates, 15% of patients still suffer after conventional open hallux valgus operation because of pain, stiffness, slow recovery, and other complications related to the operation.[22,33,34,40] A systematic Cochrane review in 2004 concluded that no specific procedure showed superiority over other procedures for hallux valgus correction.[13] This suggests that there is potential room for improvement in hallux valgus surgery.

Percutaneous and minimally invasive operations have gained much attention in orthopedics as a result of the potential for smaller scars, less postoperative pain, quicker recovery, decreased rehabilitation times, and reduced risk of infection and wound complications.[20,23] A first-generation percutaneous technique for hallux valgus correction was described by Isham,[17] but there was no internal fixation following the osteotomy. The second-generation technique was a distal transverse osteotomy of the first metatarsal stabilized with an axial wire.[4,14,18,27,28,31,38] A third-generation

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technique with screw fixation has further increased stability.[5,33] The third-generation technique was developed by Vernois and Redfern. They incorporated the concept of percutaneous operative approach with stable internal fixation (with headless compression screws) utilizing AO principles.[33] Three recent review articles concluded there was not enough evidence to recommend minimally invasive surgery over traditional open surgery.[25,36,41] This is because there has been limited published literature on percutaneous procedures, and the majority of publications are case series without control or comparison groups. In addition, the majority of the papers in the literature report on the use of percutaneous osteotomy with K-wire fixation (second generation). The K-wire fixation does not provide rigid stable fixation, which may allow dorsal and plantar displacement of the metatarsal head. The use of wire fixation may also be associated with a higher risk of infection. This is exemplified by the prospective study by Kadakia et al.[18] In this report, the authors planned a prospective study, but they had to stop the study after 13 cases because of an unacceptable rate of complications including malunion, nonunion, recurrence, osteonecrosis, and infection.

With all new techniques, it is mandatory to evaluate the early reliability and safety of the new procedure.[18] To date, there is no published prospective, randomized trial comparing third-generation percutaneous modified chevron and akin (PECA) osteotomies and open scarf/akin (SA) osteotomies for the correction of hallux valgus. Hence, this prospective, randomized pilot study was designed to observe and compare the early outcome and complications with the PECA technique versus the SA technique.

Methods

This study was a prospective, randomized, controlled, single-center study conducted between April 2012 and May 2015. The study was designed and conducted in accordance with the Declaration of Helsinki and the Guidelines on Good Clinical Practice.[29] The institutional review board of North Shore Private Hospital (Sydney, Australia) approved the study protocol, and written informed consent was obtained from all patients prior to the study.

After evaluating pain level using a visual analog scale[43] (VAS) during follow-up as the primary outcome, the sample size calculation was performed. Based on previous studies, a total of 48 cases (24 cases in each group) generated a power of 90% to detect a mean difference of 1 point (10%) on the 10-point pain level of the VAS scale between groups ($\alpha = 0.05$).[32,34]

Inclusion criteria for the study were (1) older than 20 years with painful bunion; (2) failure of more than 3 months of conservative treatment, including shoe modification, pad, and oral medications; (3) moderate to severe hallux valgus deformity on standard radiography according to Coughlin classification (hallux valgus angle [HVA] ≥ 20, intermetatarsal angle [IMA] ≥ 12); and (4) signing written consent form after full description of the study. Patients were excluded from the study if they had any systemic disease affecting the musculoskeletal system (eg, rheumatoid arthritis, gout, ankylosing spondylitis, seronegative rheumatoid arthritis, and systemic lupus erythematosus), first metatarsophalangeal (MTP) joint arthritis, first metatarsocuneiform joint instability, infection, need for simultaneous lesser toe procedure, and/or history of prior surgery on the foot and ankle. A total of 50 eligible patients were identified based on history, physical examination, standardized weightbearing foot radiographs, and review of medical records. The patients were enrolled and randomized into the 2 groups. A biostatistician who was blinded to the purpose of the study conducted a stratified permuted block randomization. Patients in the study group received the PECA procedure, while patients in the control group received the open SA procedure. Figure 1 shows a general summary of the study design.

Demographics

The study enrolled 50 patients who met the inclusion criteria. After randomization, 25 patients were allocated to the PECA group and 25 to the open SA group. All demographic characteristics were comparable between groups. In the PECA group, there were 2 males and 23 females, with an average age of 52.6 (range, 20-76) years while the open SA group included 3 males and 22 females with an average age of 53.4 (range, 25-75) years ($P = .799$ and $P = .759$, respectively). The average BMI was 26.3 for the PECA group and 26.4 for the open SA group ($P = .452$).

Clinical and Radiographic Evaluation

For the clinical outcome assessment, VAS and the American Orthopaedic Foot & Ankle Society Hallux-Metatarsophalangeal-Interphalangeal Score (AOFAS HMI score)[21] were adopted to determine the level of pain and function throughout the follow-up period. The VAS score was assessed preoperatively and on 1 day, 2 weeks, 6 weeks, and 6 months postoperatively. The AOFAS HMI score also was assessed preoperatively and at 6 months postoperation. Additionally, subjective patient satisfaction was evaluated using the criteria by Bonney and Macnab.[2] Patient satisfaction was graded as excellent, good, fair, or poor.

For the radiographic evaluation, standard foot anteroposterior and lateral weightbearing radiographs were performed. The HVA and IMA were measured by an independent orthopedic fellow who was blinded to the purpose of the study. The HVA was defined as the angle formed by the longitudinal axis of the first metatarsal bone (a line connecting the center of the metatarsal head and the center

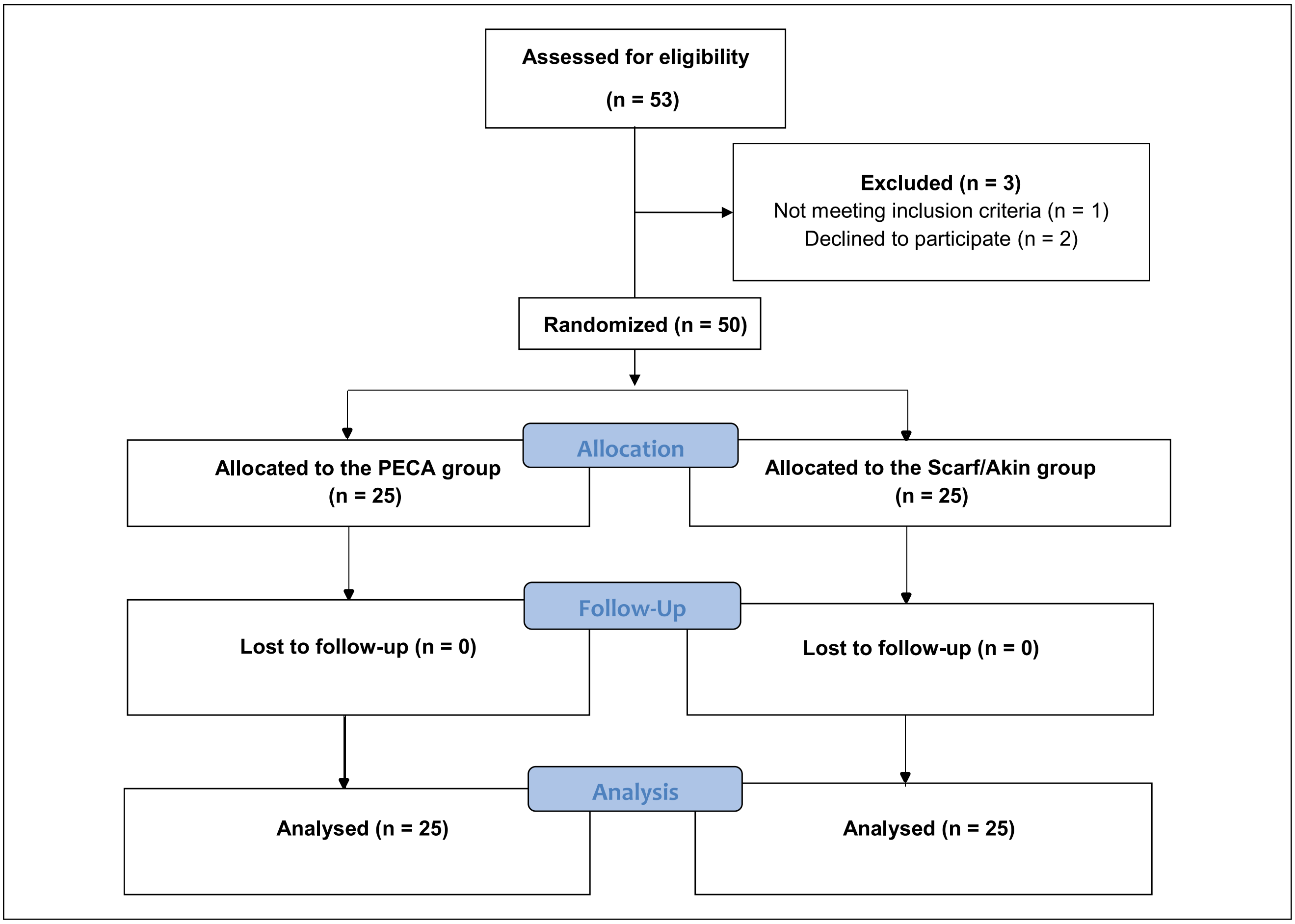

Figure 1. CONSORT diagram illustrating the flow of patients participating in the study.

of the metatarsal base) and the longitudinal axis of the proximal phalanx of the great toe (a line connecting the midpoints of the proximal and distal articular surfaces of the proximal phalanx).[39] The IMA was defined as the angle formed by the longitudinal axis of the first metatarsal bone and the longitudinal axis of the second metatarsal bone. Radiographic evaluation was performed preoperatively and postoperatively at 6 weeks and 6 months.

Operative Technique for PECA

Under general anesthesia in a supine position with the feet sitting over the end of the operating table (video of operative technique available in the online version of the journal), the senior author preferred to use a pneumatic tourniquet on the proximal thigh even though some surgeons do not recommend tourniquet use in order to allow a cooling effect from blood flow (verbal communication, Joel Vernois, MD, David J. Redfern, FRCS(Tr&Orth), August 2013). The dorsal and plantar outline of the first metatarsal was drawn (Figure 2). Using a beaver blade, 3-mm incisions were made over the

Figure 2. Clinical photo showing outline of the first metatarsal and the initial stab incisions (marked in A, B, and C).

midpoint (dorsoplantar of the first metatarsal head) at the medial aspect of the first metatarsophalangeal joint (Figure 2, marked as A) and midpoint (dorsoplantar of the first metatarsal) at the base of the flare of the medial eminence (distal diaphyseal-metaphyseal junction) (Figure 2, marked B), and

Figure 3. (A) Dorsal and plantar cut of the chevron osteotomy using the Shannon burr. (B) Corresponding radiography.

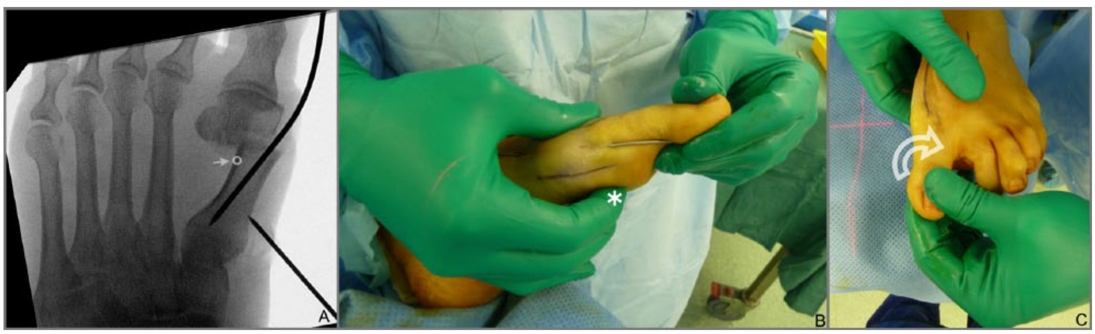

Figure 4. (A) Applying varus force with 2-mm K-wire for translation of distal fragment (arrow depicts the targeted far cortex for the initial guide pin, which enables 3-point screw fixation). (B) Corresponding clinical photo (asterisk depicts index finger supporting metatarsal head to maintain alignment). (C) Clinical photo showing the correction maneuver of the great toe pronation deformity (supination force applied as demonstrated with arrow).

a 5-mm incision was made at the medial aspect of the first tarsometatarsal joint (Figure 2, marked C). The chevron osteotomy was made using a 2 × 20 mm Shannon burr. The burr was introduced through incision B in Figure 2. The burr removed approximately 2 to 3 mm of bone. If the burr was directed perpendicular to the axis of the second metatarsal (Figure 3), then as the metatarsal head was displaced laterally, it displaced the head fragment distally by approximately 3 mm. This counteracted the effect of the burr shortening and thus prevented any significant overall shortening of the first metatarsal. The burr was also directed in a plantar direction. In patients with a long first metatarsal, it may be desirable to direct the burr more proximally to allow shortening of the first metatarsal. The dorsal limb of the osteotomy was performed in a vertical fashion. For the plantar cut, the burr was directed along an imaginary line toward the skin of the heel to provide a short plantar limb. After the osteotomy was completed, a 1.6-mm Kirschner wire (K-wire) was introduced from the medial base of the first metatarsal proximally (through the incision marked C in Figure 2), in the mid axis of the metatarsal bone, to perforate the far cortex of the distal first metatarsal so that the wire exited the bone approximately 1 cm proximal to the osteotomy (Figure 4A). The 1.6-mm K-wire was then withdrawn and a 1-mm guide wire was inserted through the holes made by the 1.6-mm K-wire. This technique was used because the currently available 1-mm guide wire was too flexible to allow easily reproducible placement of the wire for the proximal screw. The placement of the proximal screw with 3-point fixation was extremely important, as this allowed stable fixation of the osteotomy. A 2-mm-diameter guide wire was inserted through incision A as shown in Figure 2, through the osteotomy into the shaft of the first metatarsal to allow lateral displacement of the metatarsal head. The reduction maneuver was important. The first step was to use the right hand to make sure the head was in alignment in the lateral plane (Figure 4B, asterisk). This prevented plantar or dorsal displacement/tilt of the first metatarsal head. The second step

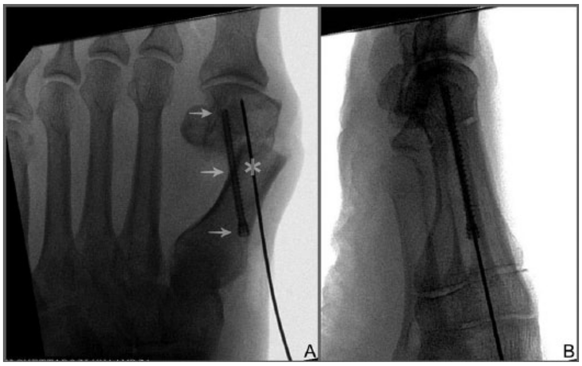

Figure 5. (A) Three-point fixation of the first proximal screw (marked with arrows) and the guide pin for the second screw (marked with asterisk). (B) Lateral radiography showing maintained alignment with screw fixation.

was to use the left hand with the aid of the 2-mm wire to displace the head laterally (Figure 4A and B). The third step was to correct the pronation of the metatarsal head (Figure 4C). Once this was achieved, the 1-mm guide wire was advanced into the displaced first metatarsal head. The screw (3.0-mm headless cannulated screw) was then inserted. A second metatarsal screw was inserted to provide rotational stability and strength to the construct (Figure 5). It was important to obtain internal oblique views of the foot to confirm that the head of the screws were completely engaged in the bone. This was because the screw head may appear completely engaged on the anterior-posterior view but may still be protuberant. If this occurred, the prominent screw may cause irritation and possibly require removal at a later date. The akin osteotomy was performed with a 2- × 12-mm Shannon burr, and this osteotomy was fixed with a cannulated screw (3.0-mm headless cannulated screw) introduced from the medial base of the distal phalanx (Figure 6). A distal soft tissue release was performed with insertion of a beaver blade from the dorsum of the first metatarsophalangeal joint just lateral to the extensor hallucis longus tendon (Figure 7). The blade divided the lateral plantar plate and the lateral sesamoid phalangeal ligament when a varus force was applied to the big toe. Through incision B (Figure 2), a curved periosteal elevator was used to puncture the medial capsule just distal to the capsular attachment on the medial eminence. A 3.1-mm-wedge burr was used to remove the medial prominence. The adequacy of the removal was confirmed on the image intensifier. The 3.1-mm-wedge burr was used to remove any medial prominence of the proximal first metatarsal at the site of the osteotomy. Image intensifier control was used with each step to confirm satisfactory correction and fixation of the osteotomies. Postoperative dressing included nonadherent dressing (such as Adaptic), dry gauze, softband, and crepe bandage.

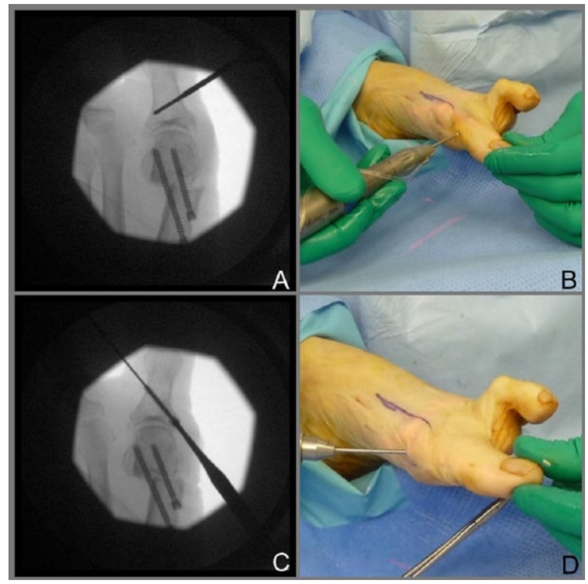

Figure 6. (A) Radiography showing initial placement of the Shannon burr for the apex of the akin osteotomy. (B) Corresponding clinical photo. (C) Radiography showing placement of the screw percutaneously after akin osteotomy. (D) Corresponding clinical photo.

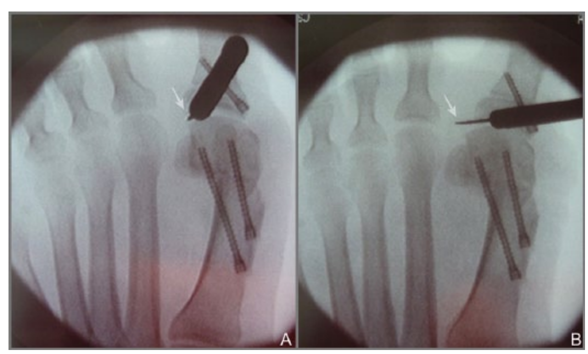

Figure 7. (A) For the distal soft tissue procedure, a beaver blade is introduced from the dorsum of the first metatarsophalangeal joint just lateral to the EHL tendon. (B) While applying a varus force to the great toe, the blade divides the lateral plantar plate and the lateral sesamoid phalangeal ligament.

For patients who received the open scarf/akin procedure, the conventional open scarf and akin operative technique was performed. This was described in a previous article.[1]

Postoperative Care

Postoperatively, the patient was allowed to fully bear weight as tolerated in a flat postoperative shoe for 2 weeks. Patients were encouraged to walk with their foot flat on the ground rather than on the lateral border of the foot. They were advised to walk with the aid of crutches for up to 2 weeks postoperatively. The patients were advised to elevate the foot/feet as much as possible in the first 10 days after surgery to reduce the degree of foot swelling. They were examined 10 to 14 days postoperatively. Gentle plantar flexion stretching exercises of the first metatarsophalangeal joint were commenced after 2 weeks to help regain joint motion, and scar massage was used to desensitize the scars. Patients were allowed to wear a pair of sneakers with a straight medial last after 2 weeks. Standard weightbearing radiographs were performed at 6 weeks and 6 months postoperation.

Statistical Analysis

All continuous variables are reported as means ± standard deviations. Normal distribution in continuous variable was verified with the Kolmogorov-Smirnov test. Student *t* test or Mann-Whitney *U* test was performed for continuous variables, depending on the normality of the data distribution. Additionally, the paired *t* test was performed to identify any significant differences in pre- and postoperative clinical outcomes. Differences in proportion of categorical variables were evaluated by Pearson chi-square test or Fisher exact test. An alpha level less than .05 was considered significant. Statistical analyses were carried out by an independent biomedical statistician using Stata statistical software (version 13, StataCorp, College Station, TX).

Results

Radiologic Outcomes

Compared with preoperative radiography, both groups showed significant improvements in the HVA and the first-second IMA at final follow-up ($P < .05$). When comparing groups, both HVA and IMA showed similar end results at final follow-up ($P = .520$ and $P = .270$, respectively). Table 1 summarizes radiographic outcomes.

Clinical Outcomes

The mean VAS and AOFAS HMI score improved significantly in both the PECA and open SA groups postoperatively ($P < .001$, Table 1). Although the initial and final clinical outcomes between groups were comparable regarding VAS and AOFAS HMI, the PECA group showed statistically significant superiority regarding pain level in the early postoperative phase (postoperative 1 day to postoperative 6 weeks, $P < .001$, $P < .001$, and $P = .004$, respectively, Table 1). Regarding patient satisfaction, there were 21 patients with excellent (84%) and 4 with good (16%) satisfaction in the PECA group and 18 with excellent (72%) and 7 with good (28%) satisfaction in the open SA group.

Table 1. Summary of Outcomes: Clinical Outcome, Radiological Outcome, and Complications.[α]

	PECA Group (n = 25)	Scarf/Akin Group (n = 25)	*P*
Clinical outcomes			
VAS, mean ± SD			
Preoperative	7.1 ± 1.5	6.9 ± 1.7	.179
POD 1 day	2.2 ± 1.2	3.9 ± 1.9	**<.001**
POD 2 weeks	1.0 ± 1.4	2.4 ± 1.7	**<.001**
POD 6 weeks	0.6 ± 1.8	2.1 ± 2.0	**.004**
POD 6 months	0.3 ± 0.9	0.5 ± 1.1	.160
AOFAS score, mean ± SD			
Preoperative	61.3 ± 3.2	58.5 ± 4.3	.220
Last follow-up	88.7 ± 2.1	83.0 ± 3.5	.560
Satisfaction			.340
Excellent	21	18	
Good	4	7	
Fair	0	0	
Poor	0	0	
Radiologic outcomes			
Hallux valgus angle			
Preoperative	31.4 ± 2.1	31.2 ± 4.1	.890
Last follow-up	7.6 ± 1.2	10.1 ± 1.9	.520
Intermetatarsal angle			
Preoperative	15.6 ± 1.0	15.7 ± 1.4	.960
Last follow-up	6.4 ± 0.8	7.6 ± 0.9	.270
Complications	6 screw removals	2 metatarsalgia	

Abbreviations: AOFAS, American Orthopaedic Foot & Ankle Society; PECA, percutaneous chevron akin; POD, postoperative day; SD, standard deviation; VAS, visual analog scale.

[α]Values are presented as mean ± standard deviation for the continuous variables. The categorical variables are presented as the number (%) of patients. Boldface indicates statistical significance ($P < .05$).

Secondary Outcomes and Complications

The combined scar length was 107.1 mm in the open SA group and 25.3 mm in the PECA group ($P < .001$). The average radiation screen time was 31.8 seconds in the PECA group and 1.2 seconds in the open SA group ($P < .001$). There were no wound complications in either group. There were 2 cases of second metatarsalgia in the open SA group. Six patients in the PECA group required removal of the screws because of prominence of the screws under the skin.

Discussion

This randomized, controlled study prospectively compared the outcomes between the open SA procedure and the PECA procedure. The PECA technique is the third-generation technique of percutaneous hallux valgus correction in that it utilizes the principle of stable internal fixation. This study showed comparable satisfaction rate, clinical results, and radiologic results between the 2 groups. However, during the early postoperative phase, the PECA group showed a significantly superior result in terms of lower pain level. Additionally, the secondary outcome analysis showed significantly shorter scar length in the PECA group.

The primary goal of hallux valgus surgery is to re-establish a painless first MTP joint with normal alignment.[37] In order to achieve this goal, a combination of soft tissue and bony procedures is necessary. The adequacy of the operative correction was determined by the radiologic parameters of HVA and IMA. Conventional open hallux valgus surgery requires extensive soft tissue dissection. This can result in increased pain, swelling, stiffness, and wound complications that can result in delayed recovery.

Several surgeons have tried to overcome this limitation by implementing minimally invasive/percutaneous surgery concepts, similar to other fields of orthopedic surgery (eg, shoulder, knee, fracture, and spine surgery). In the 1980s, first-generation percutaneous hallux valgus surgery was popularized by Stephen Isham.[17] This technique involved a percutaneous oblique medial closing wedge osteotomy of the first metatarsal head with the percutaneous adductor hallucis release. Despite concerns regarding shortening and instability because of the absence of internal fixation, the author claimed a marked improvement at short- to mid-term follow-up. The second-generation percutaneous hallux valgus surgery was based on Hohmann osteotomy and modified by Bosch in Austria.[3] For this technique, a short vertical osteotomy was placed at the level of the metatarsal neck and supported with a single K-wire in the medullary canal.

During the late 1990s to early 2000s, successful outcomes after this technique were reported by a few surgeons.[14,26,28] Satisfactory results were achieved even at 10-year follow-up.[12] However, like the Reverdin-Isham technique, inherent instability at the osteotomy site still raised concerns for possible complications. Indeed, subsequent studies failed to reproduce favorable results even after application of a second transfixion Kirschner wire at the osteotomy site.[15,16] In a prospective study by Kadakia et al,[18] poor outcomes and an unacceptable complication rate were observed at short-term follow-up. Complications including dorsal malunion (70%), recurrence (40%), osteonecrosis, and wound complications eventually lead the authors to stop the study and the technique.[18]

The major pitfall of the first- and second-generation percutaneous techniques is the lack of stable internal fixation. In order to overcome this limitation, while preserving benefits of percutaneous hallux valgus surgery, Vernois and Redfern[42] developed the minimally invasive chevron and akin (MICA) technique. The use of headless compression screws allowed stable internal fixation, which in turned allowed more reliable and reproducible results.

Even though there are only 3 publications regarding the MICA technique because of its short history, early experience with this surgery has been promising. In 2013, Vernois et al[42] first reported his early experience of 408 cases (67 bilateral) using the MICA technique. After 1- to 3-year follow-up, 95% of patients reported good to excellent satisfaction . The study randomly picked 100 cases for radiologic evaluation. After the operation, HVA improved from 33.7° to 7.3° and IMA improved from 14.5° to 5.5°. The author reported no major complications, including dorsal or plantar malunion. However, no outcome measurement tool was used in the study. Karry et al[19] analyzed their initial 23 cases. Final radiologic outcome significantly improved, with HVA improving from 33.7° to 7.3° and IMA from 14.5° to 5.5°. Clinical outcomes also showed significant improvement, with the AOFAS HMI score improving from 59.3 to 88.4. Like the previous study, there were no significant major complications such as avascular necrosis, malunion, or wound infection. More recently, midterm results after the MICA technique were published by Hernandez et al[24] with satisfactory outcomes. At 59.1 months postoperation, HVA and IMA were corrected from 26.2° to 9.6° and 11.8° to 7.9°, respectively. In addition, the AOFAS HMI score improved from 62.5 to 97.1. There were 4 cases of screw removal due to irritation, 1 case of delayed wound healing, and 1 case of fixation failure.

When a new procedure is described, surgeons need to consider its safety and reliability as compared to the established techniques for the treatment of the condition. The first and second generations of percutaneous hallux valgus surgery have failed to fulfill the basic requirements. Safety and complications were of significant concern, since the procedures were performed without direct visualization for the target structures. Reported wound problems from burning of the skin with the burr (introduced through 3-mm skin incisions) after percutaneous hallux valgus surgery varied from 0% in experts to 13% in beginners during the learning curve.[8,9] However, with additional guidance from experts and instructional courses, this problem could be avoided even during the learning curve.[19] Other than minor complications (edema, phlebitis) that could be treated conservatively, major complications such as avascular necrosis, nonunion, and malunion are unacceptable if they occur frequently. For this reason, a previous prospective study evaluating second-generation percutaneous hallux valgus surgery was abandoned after 3 months because of a high number of major complications during early follow-up.[18]

There are only a few reports on the third-generation percutaneous hallux valgus surgery technique. They all lack comparison with a control group to prove safety and reliability of the new technique. Hence, the current analysis is the first study to objectively assess the safety and outcomes of the PECA technique during short-term follow-up

Figure 8. (A) Radiography showing moderate hallux valgus deformity with pronation of the great toe. (B) Corresponding clinical photo. (C) Radiography showing the correction of hallux valgus deformity after percutaneous chevron/akin procedure. (D) Corresponding clinical photo.

compared to one of the well-established procedures (scarf/akin) for the treatment of hallux valgus.

The current study found similar radiologic and clinical outcomes compared to previous studies (Figure 8). Both HVA and IMA were significantly improved from 31° to 7.6° and 15.6° to 6.4°, respectively, in the PECA group. Comparable improvements of AOFAS HMI scores were also observed in the PECA group (61 to 89). These radiologic and clinical outcomes were comparable to those in the open SA group during follow-up. Most importantly, other than 6 cases of screw removal due to irritation, no major complication was observed, unlike second-generation percutaneous hallux valgus surgery.

There are several limitations of the present study. First, because of limited resources, only a statistically necessary sample was recruited in a limited time period, leading to a small number of participants for each group. However, with a proper statistical method and comparable baseline characteristics, the data were sufficient to accomplish the goal of the study. Second, the outcome measurement that was used for this study was not validated. Even though the AOFAS scoring system is the most widely used tool in foot and ankle literature, some authors point out a lack of validation, and the development of supplementary or new assessment tools has been recommended. However, because the majority of studies evaluating outcomes after hallux valgus surgery have used the AOFAS HMI score, the results of the study could be compared with previous data. Currently, a follow-up study has begun using a validated outcome tool. Lastly, the procedure for the control group was only one of the popular procedures among many techniques. It would be ideal to compare this treatment method with several other well-known procedures for more reliable data.

In conclusion, there should be a prudent approach when introducing a new procedure. The first step should be to evaluate the safety and reliability of early outcome, because according to a recent systematic review, there were insufficient data to recommend percutaneous/minimally invasive hallux valgus surgery over conventional open procedures.[30] The current study is the first to objectively demonstrate comparable outcomes of the new technique by a nondeveloper group. Considering various clinical presentations of hallux valgus, treatment should be tailored to the individual patient, and no single perfect operation exists. More studies should be done to further validate percutaneous surgery for the treatment of hallux valgus.

Declaration of Conflicting Interests

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Supplemental Material

Supplementary video is available online with this article.

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