The Journal of Foot & Ankle Surgery xxx (2017) 1–8

Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Review Article

Percutaneous Osteotomies in Hallux Valgus: A Systematic Review

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ARTICLE INFO

Level of Clinical Evidence: 3

Keywords:
hallux valgus
minimally invasive
osteotomy
percutaneous
Reverdin-Isham

ABSTRACT

Percutaneous and minimally invasive surgery is one of the greatest advances in the operating field of orthopedic since the late 1990s. The potential advantages include a shorter operative time, quicker recovery, and reduced hospital stay compared with traditional open surgery. However, scientific validation of the safety and efficacy of hallux valgus (HV) percutaneous surgery remains inconclusive. The objective of the present study was to systematically review the published data and clinical evidence for percutaneous HV surgery, evaluate the scientific method of the reports, and clarify the indications, safety, efficacy, and potential risks of these surgical techniques. Two reviewers independently identified the studies using a PubMed search, with the keywords "hallux valgus," "osteotomy," "minimally invasive," and "percutaneous." Quality assessment was performed using the Coleman methodology scale, and each study was assigned a level of evidence and grade of recommendation. Eighteen studies were included and reported a total of 1534 procedures for percutaneous HV surgery on 1397 patients. Of the 18 studies, 14 (77.8%) were level IV, 2 (11.1%) were level III, and 2 (11.1%) were level II. Overall, the average angle correction of the HV deformity improved postoperatively. Regarding the complications, although some investigators revealed no major complications, others described deformity recurrence in 7.8%, stiffness of the first metatarsophalangeal joint in 9.8%, malunion in 4% to 8.7%, and infection rates ranging from 1.9% to 14.3%. The main indication for percutaneous HV surgery is the correction of mild deformities. The complication rate was elevated even in experienced surgeons. In conclusion, future research in percutaneous techniques should include adequately sized randomized control trials, standardization of treatment protocols, and the use of validated tools for the measurement of clinical outcomes.

Hallux valgus (HV) is a common condition and affects a reported 28.4% of adults aged > 40 years (1). It is characterized by progressive abduction and pronation of the first phalanx, adduction, pronation, and elevation of the first metatarsal, and lateral capsular retraction of the first metatarsophalangeal joint (MTPJ). Pain and discomfort are experienced because of inflammation of the bursa overlying the medial eminence and irritation of the dorsal cutaneous nerve (2).

More than 150 procedures have been described for conventional surgical treatment of HV (3). Surgical correction has been performed using many techniques that are often conceptually very different (4). Therefore, the surgical option is not unique and the variety of choices has been dictated by the multiplicity of causal factors and the surgeon's personal preference (5).

Minimally invasive surgery has increased in popularity in all fields of orthopedic and trauma surgery. The advantages include potentially decreased recovery and rehabilitation times, reduced operative times, and less stress to the patient. It has been referred to by several

Financial Disclosure: None reported.
Conflict of Interest: None reported.

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http://dx.doi.org/10.1053/j.jfas.2017.06.027

Table 1
Levels of evidence for therapeutic studies

Level	Description
I	High-quality randomized trials with statistically significant differences or no statistically significant differences but narrow confidence intervals; systematic reviews of level I randomized controlled trials (with homogeneous study results)
II	Lesser quality randomized controls trials (<80% follow-up, no blinding, or improper randomization); prospective comparative studies; systematic reviews of level II studies or level I studies with inconsistent results
III	Case-control studies; retrospective comparative studies; systematic reviews of level III studies
IV	Case series
V	Expert opinion

Data from Wright et al (14).

different names, including minimally invasive surgery, percutaneous surgery, and microsurgery. The concepts should not be used interchangeably. Percutaneous forefoot surgery (PFS) is performed through the smallest possible working incision without direct visualization of the underlying target structures, and minimally invasive surgery is performed through the smallest incision necessary to perform the procedure (6). In practice, PFS is performed through millimetric incisions (1 to 3 mm long) using the surgeon's tactile senses and a mini-blade for soft tissue dissection and power rotary burr for osseous procedures, most commonly under intraoperative fluoroscopic guidance.

The percutaneous procedure has evolved from the traditional Kramer open technique (7). The technique included a distal lateral translational osteotomy that was secured with a Kirschner wire placed in the medial soft tissue of the proximal phalanx and passed across the MTPJ into the intramedullary canal, simultaneously pushing the metatarsal head laterally. In the 1990s, Bösch et al (8,9) developed the percutaneous technique, performing a "Kramer-like" osteotomy by perforating the subcapital cortex of the metatarsal and manually breaking it. Magnan et al (10) used the micromotorized Lindermann® bone cutter (Aesculap, Tuttlingen, Germany) for the same osteotomy.

In the United States, Stephen Isham modified the Reverdin osteotomy by performing a medial wedge osteotomy in the head of the first metatarsal at an angle from dorsally and distally, just proximal to the articular surface on the dorsal aspect of the head, to plantarly and proximally to a point just proximal to the articular surface on the plantar aspect of the first metatarsal head, to align the first ray by medial rotation of the first metatarsal head and distal metatarsal articular angle (DMMA) correction (11). This technique experienced few modifications and was highly diffused in Europe.

The current question is whether it is justifiable to use percutaneous HV surgery from the actual medical data. Despite all the available percutaneous techniques on the correction of HV, scientific validation of the safety and efficacy of these techniques remains inconclusive. Some systematic reviews on the topic have been reported (6,12,13); however, its use remains highly controversial owing to the limited evidence.

The aim of the present systematic review was to establish the safety and efficacy of PFS for correction of HV deformity, evaluating the scientific methods of recent reports, to provide a clear choice of the best technique for every case.

Table 2
Grades of recommendation for summaries or reviews of orthopedic surgical studies

Grade	Evidence
A	Good evidence (level I studies with consistent findings) for or against recommending intervention
B	Fair evidence (level II or III studies with consistent findings) for or against recommending intervention
C	Poor-quality evidence (level IV or V studies with consistent findings) for or against recommending intervention
I	Insufficient or conflicting evidence not allowing a recommendation for or against intervention

Data from Wright et al (14).

Table 3
Coleman methodology scale

Item No.	Item and Answer	Score
Part A*		
1	Study size: procedures (n)	
	<30	0
	30 to 50	4
	51 to 100	7
	>100	10
2	Mean follow-up (mo)	
	<12	0
	12 to 36	4
	37 to 60	7
	>60	10
3	Surgical approach	
	Different approach used; outcomes not reported separately	0
	Different approaches used; outcomes separately reported	7
	Single approach used	10
4	Study type	
	Case series (level IV)	0
	Case-control study (level III)	5
	Retrospective comparative study (level III)	5
	Prospective comparative study (level II)	10
	Randomized control trial (level I)	20
5	Surgical technique description	
	Inadequate (not stated, unclear)	0
	Fair (technique only stated)	5
	Adequate (technique stated, surgical procedure details given)	10
6	Postoperative rehabilitation description	
	Described	5
	Not described	0
Part B†		
1	Outcome criteria	
	Outcome measures clearly defined	2
	Outcome assessment timing clearly stated	2
	Use of outcome criteria with reported reliability	3
	General health measure included	3
2	Procedure of assessing outcomes	
	Subjects recruited	5
	Investigator independent of surgeon	4
	Written assessment	3
	Completion of assessment by patients with minimal investigator assistance	3
3	Description of subject selection process	
	Selection criteria reported and unbiased	
	Recruitment rate reported	
	>90%	5
	<90%	0

Data from Altman et al (17).
* Only 1 score allowed for each section (n = 6).
† Scores allowed for each option in each section (n = 3), if applicable.

Materials and Methods

Two of us (A.B., F.G.P.) independently identified studies written in English, French, Portuguese, or Spanish using a systematic search of PubMed with a combination of the following key words: "hallux valgus" and "osteotomy" and "minimally invasive" or "percutaneous." All studies relevant to the subjects were retrieved, and their reference lists were carefully reviewed to find additional references of this subject. Eligible studies were required to report the treatment results of patients with HV treated by PFS. Only studies reported in peer-reviewed journals were included in the present systematic review.

The exclusion criteria were systematic and theme reviews, open and minimally invasive surgery techniques, infant patients, cadaveric and biomechanical studies, other forefoot pathologic features, commentaries, technique descriptions, case series with <5 patients, and studies for which the full text could not be retrieved.