Proceeding

Supplementary Issue: Spring Conferences of Sports Science. Costa Blanca Sports Science Events, 21-22 June 2021. Alicante, Spain.

Hallux valgus deformity: Treatment options, post-operative management, and return to sport

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ABSTRACT

Hallux valgus is the commonest forefoot deformity, consisting in a deviation of the great toe. The pathophysiology is complex and multifactorial, with women being more affected than men. Hallux valgus causes symptoms in three ways: pain in the bunion, lack of space for the other toes, and metatarsalgia. Traumatic hallux valgus is an increasingly common injury in the athletic population and represents a unique variant of turf toe. Patients in whom conservative measures fail to relieve symptoms may be considered for surgery, since none of the non-surgical treatment options can permanently correct the hallux valgus deformity. Concern exists on the correct treatment approach and the most appropriate surgical technique, especially in athletes. Newest minimally invasive procedures allow to achieve good clinical and radiographic outcomes and they are associated with decreased recovery and rehabilitation times. Post-operative rehabilitation is aimed to restore physiological gait and foot function, encouraging both plantar pressure on the first ray and joint mobility, with walking immediately permitted. Further studies of higher levels of evidence should be performed to identify the correct indications for this disease. The aim of this narrative review is to give an insight about the treatment options, related post-operative rehabilitation, and return to sport.

Keywords: Hallux valgus deformity; Hallux valgus treatment; Hallux valgus surgery; Hallux valgus post-operative management; Hallux valgus return to sport.

Cite this article as:
Tarantino, D., Palermi, S., Sirico, F., & Corrado, B. (2021). Hallux valgus deformity: Treatment options, post-operative management, and return to sport. *Journal of Human Sport and Exercise, 16*(4proc), S1674-S1687. https://doi.org/10.14198/jhse.2021.16.Proc4.14

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Abstract submitted to: Spring Conferences of Sports Science. Costa Blanca Sports Science Events, 21-22 June 2021. Alicante, Spain.
JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202.

doi:10.14198/jhse.2021.16.Proc4.14

INTRODUCTION

Hallux valgus is the commonest forefoot deformity. It consists of a deviation of the great toe (hallux) towards the midline of the foot and prominence of the head of the first metatarsal, the medial eminence (Maffulli et al., 2011; Wülker and Mittag, 2012).

A recent review estimates the global prevalence of hallux valgus at up to 23% in 18- to 65-year-olds, and 35% in those over 65, although of course it is difficult to draw a line between normal and pathological positioning of the great toe (Nix et al., 2010).

Age and sex are important factor in the pathogenesis of hallux valgus deformity. Although hallux valgus is particularly frequent from the middle years of life upwards, many patients of both sexes are affected at a young age, usually in one foot but sometimes in both (Nguyen et al., 2010; Nix et al., 2010; Wülker, 1997a). Women are much more commonly affected than men, because they frequently wear narrow, high-heeled shoes and often have more flexible soft tissues (Nguyen et al., 2010).

The pathophysiology of hallux valgus is complex and multifactorial. An imbalance of the extrinsic and intrinsic foot muscles and the ligamentous structures is involved (Wülker and Mittag, 2012). When the forces between flexor and extensor tendons are unbalanced, the eventual result is valgus deformity of the great toe with spreading of the forefoot (Mann and Coughlin, 1981; Perera et al., 2011; Wülker, 1997a, 1997b). Some authors postulated that a tight Achilles tendon can predispose to hallux valgus, so a correct rehabilitation of Achilles tendinopathy could prevent this pathology (Aicale et al., 2018, 2019; Aicale et al., 2017; Aicale, Tarantino, and Maffulli, 2017; Bisaccia et al., 2019; Maffulli et al., 2017, 2020; Perera et al., 2011; Tarantino et al., 2020; Tarantino et al., 2020).

During running and jumping activities, a great amount of force is produced and imposed on the 1st metatarsophalangeal joint. Weight bearing forces applied to the first metatarsophalangeal joints can be in excess of 400% body weight, in comparison to 80% body weight during normal walking (Baxter, 1994; Saxena, 2000). It is therefore imperative to have a congruous, healthy and functional metatarsophalangeal joint to allow the demands of the athlete's sport.

Hallux valgus causes symptoms in three ways. First and foremost is pain in the bunion, the pressure-sensitive prominence on the medial side of the head of the first metatarsal. It hurts to wear a shoe. Furthermore, the valgus deviation of the great toe often results in a lack of space for the other toes, which become displaced, usually going upwards and leading to pressure against the shoe, with a hammer toe or claw toe deformity. Finally, normal function of the forefoot relies heavily on the great toe pressing down on the ground during gait. Since the valgus deformity stops this happening to a sufficient degree, the metatarsal heads II–V are overloaded. The resulting pain is referred to as transfer metatarsalgia (Wülker and Mittag, 2012).

The clinical picture of hallux valgus in the athletic population ranges from simple pain in shoe gear to loss of propulsion, transfer lesions from abnormal weight bearing distribution, to overall decrease in athletic performance (Baxter, 1994; Saxena, 2000). Hallux valgus deformity in the athlete is no different than the non-athlete and should be evaluated similarly. The diagnosis is made with both clinical examination and radiographs.

Conservative management should be started first, and may include footwear modification, training modification, bunion shield, padding and orthotics (Baxter, 1994; Facfas and Miller, 2001; Saxena, 2000).

However, its value has been questioned (Maffulli et al., 2011; Torkki et al., 2001). Patients in whom conservative measures fail to relieve symptoms, so the pain continues and activities and sports are impaired given the progressive nature of this condition, may be candidates for surgery (Klosok et al., 1993). Despite being a common forefoot pathology, the most appropriate surgical approach is still to be decided, particularly in the athletic population, since athletes usually have higher functional demands (Fournier et al., 2019).

Regardless of whether the patient is active or not, the goals of hallux valgus correction are the same: correcting an increased intermetatarsal angle, re-establishing a congruent joint, and repositioning the sesamoid apparatus (Fournier et al., 2019).

CLINICAL EXAMINATION

The lateral deviation of the great toe is obvious when the patient stands barefoot (Wülker and Mittag, 2012). Examination of a hallux valgus deformity involves inspection of foot both standing, weightbearing and non-weightbearing. The position of the great toe is inspected in both the transverse and frontal planes.

The angle between the longitudinal axes of the first metatarsal and the proximal phalanx of the great toe, with the vertex at the head of the first metatarsal (hallux valgus angle), can be measured: if the angle is greater than 15-18°, it is considered abnormal, although there is considerable interindividual variation (Wülker, 1997a).

In the majority of cases the metatarsus is splayed, increasing the prominence of the metatarsophalangeal joint. Moreover, the great toe is often somewhat pronated, so that the nail faces medially (Wülker and Mittag, 2012).

The examiner should also establish whether the deformity is flexible, i.e., whether it can be corrected by manipulation, and whether motion of the metatarsophalangeal joint is limited by pain, which would point to osteoarthritis. Furthermore, the stability and mobility of the first tarsometatarsal joint should be determined at the first tarsometatarsal joint. The tarsus and hindfoot must also be investigated to exclude accompanying deformities, such as flatfoot or cavus deformity, metatarsus adductus, and associated lesser toe pathology, such as hammertoes and cross-over toe deformities. Investigation of peripheral vascular perfusion and motor and sensory functions is obligatory (Wülker and Mittag, 2012).

IMAGING

Weightbearing dorsoplantar (antero-posterior), lateral and oblique radiographs are required. Lateral or oblique views may help to depict deformities of the smaller toes and instability of neighbouring joints. Only under loading can the angle between the first and second metatarsals (intermetatarsal angle) be determined accurately. The radiograph will show the congruence of the metatarso - phalangeal joint, i.e., whether a subluxation exists, and should also be inspected for any signs of osteoarthritis (joint space narrowing, subchondral sclerosis) (Wülker and Mittag, 2012).

Several angles can be evaluated using the dorsoplantar radiograph: intermetatarsal angle, metatarsus adductus angle, hallux abductus angle, proximal articular set angle, and hallux abductus interphalangeus, as well as the first metatarsal length, sesamoid position, first metatarsophalangeal joint condition, bone stock, first metatarsal base, hallux rotation, and medial metatarsal head enlargement (Hallux Valgus Workup: Laboratory Studies, Imaging Studies, Staging).

The angular measurements made on weightbearing radiographs with the AutoCAD software in patients with hallux valgus deformities were more reliable than those made manually with a goniometer (Piqué-Vidal et al., 2006).

Imaging techniques can be also used during the post-operative follow-up. Recurrence of hallux valgus after a proximal chevron osteotomy can be reliably predicted from immediate postoperative non-weightbearing radiographs. An immediate postoperative hallux valgus angle of ≥8°, an immediate postoperative sesamoid position of grade 4 or greater, a preoperative metatarsus adductus angle of ≥23°, and a preoperative hallux valgus angle of ≥40° are significantly associated with recurrence (Park and Lee, 2017).

CONSERVATIVE TREATMENT

Conservative therapy can address only symptom relief, because none of the non-surgical treatment options will permanently correct the hallux valgus deformity, and it is not possible to change the irreversible cartilage, bony, and soft-tissue adaptations of the deformity (Hallux Valgus).

Pain in the smaller toes can be alleviated with pads and toe straighteners. Wide, soft shoes with deeper toe boxes are helpful if they give the toes enough space.

Nonsteroidal anti-inflammatory drugs and physical therapy can be offered to relieve acute, episodic inflammatory processes. Corticosteroid injections can also be useful for acute inflammatory conditions in the first metatarsophalangeal joint. No evidence supports prolonged physical therapy for hallux valgus (Hallux Valgus Treatment & Management: Approach Considerations, Medical Therapy, Surgical Options).

Functional orthotic therapy may be implemented to control foot biomechanics (Karabicak et al., 2015). This approach can relieve symptomatic bunions, though the foot and first MTP joint must maintain some degree of flexibility (Hawke et al., 2008).

However, once hammer toes or claw toes have developed, however, surgery is necessary (Wülker and Mittag, 2012).

SURGICAL TREATMENT

For surgical treatment to be indicated, the patient must have pain that is not alleviated by a simple change of shoes or by other, conservative treatments. Moreover, the pain must regularly occur and must noticeably impair the function of the affected foot (Wülker and Mittag, 2012).

Surgical correction of hallux valgus rebalances the first ray, correcting the various features of the deformity (Klosok et al., 1993). It is important to keep in mind the greater demands placed on the 1st metatarsophalangeal joint of an athlete, in excess of 4 times body weight during running and jumping activities. An increase in range of motion is also required for certain sports such a ballet dancing. It is therefore critical that not only the deformity must be corrected, but its function must be restored.

Distal metatarsal osteotomies, with the Chevron technique and its modification being the most widely performed, have classically been indicated in patients with mild or moderate deformity with an intermetatarsal angle up to 15° (Chang, 2001).

The osteotomy offers several advantages including an early return to activities, which is appealing to athletes. Saxena et al. (Saxena, 2000) reported that, after a distal Chevron osteotomy, an average of 8.9 weeks are needed to return to a training session. They also stated that this procedure is technically easy to perform, leads to minimal shortening of the first metatarsal, and therefore reduces potential risks of transfer lesions and overload of the lesser metatarsals, which can be harmful to athletes.

In a recent prospective analysis, Giotis et al. (Giotis et al., 2016) measured both subjective and objective outcomes of the modified Chevron osteotomy fixated with a percutaneous Kirschner-wire (removed at 6 weeks post operatively) without adductor halluces brevis tendon release) for the treatment of mild to moderate hallux valgus deformity in the female athlete (intermetatarsal angle <16 degrees). Objective results showed that all patient osteotomies were healed at the 2-year follow up, with a reduction of the intermetatarsal angle from 14.2 degrees to 8.1 degrees post-operatively. In addition, first metatarsophalangeal joint range of motion was maintained post operatively, and 40 out of 42 feet were completely pain free at the time of follow up. The mean American Orthopedic Foot and Ankle Society (AOFAS) score, which consists of nine questions and covers three categories (pain, function and alignment) all scored together for a total of 100 points, improved from 47.4 preoperatively to 96.3 at 2 years post-surgery. Regarding cosmesis, 95% of patients reported good to excellent results.

Other techniques, such as the Lapidus procedure and its modification, and the Ludloff procedure, allow correction of intermetatarsal angles as large as 20° (Mizuno et al., 1992).

Arthrodesis of the first tarsal-metatarsal joint (i.e., Lapidus procedure) offers correction of a severe deformity especially in the presence of hypermobility of the first ray. However, concerns exist about its indication in the athletic population given the potential stiffness that results from the loss of the first tarsal-metatarsal joint. Some authors question its indication in athletes (Baxter, 1994). The Lapidus procedure is regarded as technically demanding, with a high rate of complications such as non-union, malunion, shortening, elevation, progression of midfoot arthrosis, transfer metatarsalgia, neuro-vascular compromise, hematoma, and hardware issues (MacMahon et al., 2016; McInnes and Bouché, 2001; Saxena, 2000).

MacMahon et al. (MacMahon et al., 2016) suggested that the modified Lapidus procedure (described as first metatarsal-cuneiform arthrodesis without first and second metatarsal base arthrodesis, as originally described) is a feasible option in athletes. Their study reported subjective findings only, with 81% of the patients being satisfied with their return to activities, and 80% being able to participate in their previous sports. Fifteen percent of patients experienced complications, ranging from hematoma (requiring surgical evacuation) to transfer metatarsalgia.

McInnes et al. (McInnes and Bouché, 2001) published a retrospective study on the outcomes of the modified Lapidus arthrodesis, and reported on both subjective and objective findings. The procedure was performed for the management of moderate to severe hallux valgus in the presence of first ray hypermobility. Subjective evaluation revealed that 78% of the patients rated the surgery as "*completely*" or "*very*" effective, yet athletes demonstrated a lower return to activity (30%) than with the MacMahon et al's study of 80%. Their objective findings reported shortening of the first metatarsal on an average of 3.4mm. Complications included five non-unions and two delayed unions. No significant differences in outcome were seen amongst athletes, active patients and sedentary patients (McInnes and Bouché, 2001).

Saxena et al. (Saxena and McCammon, 1997), in a retrospective study, reported on the Ludloff osteotomy, (i.e. oblique osteotomy of the first metatarsal shaft oriented from dorsal-proximal to distal-plantar) as a means

to correct a moderate increase in intermetatarsal angle in the athletic population. This osteotomy prevents excessive shortening on the first ray, allowing for plantarflexion of the capital fragment if necessary. The study demonstrated an average reduction of intermetatarsal angle from 15.9 degrees to 9.4 degrees. The average first metatarsal shortening was 1.4 mm, and no transfer lesions were noted to the lesser metatarsal. The average AOFAS score was of 92.3. One delayed union was reported.

A more recent study performed by Saxena et al. (Saxena and Louis, 2013) showed a return to sport at 3.6 months in the athletic population . All the athletes in this study on the Ludloff procedure returned to their desired sport. The authors consider the Ludloff osteotomy to be more suitable for competitive athletes with hallux valgus by allowing early weight bearing, avoiding the surrounding joints and therefore potential capsular adhesions, while being able to correct length and large intermetatarsal angle (Saxena and Louis, 2013).

While several well-established surgical methods are available for hallux valgus (more than 130 different operative methods) (Klosok et al., 1993), consensus regarding the best management has yet to be established (Ferrari et al., 2004; Saro et al., 2007).

A recent study by Ciechanowicz et al. (Ciechanowicz et al., 2020) assessed the return to physical activities after Scarf osteotomy (i.e. a kind of "Z" osteotomy whose considerable potential lies in its ability to provide three-dimensional correction) for hallux valgus. The authors found out that after this surgical procedure, the frequency of undertaking physical activity increased by about 21%, and the time spent by patients during the week on sports (minutes per week) increased by about 19%. They also stated that the result of the UCLA – Activity Score after surgery increased by an average of about 4.7%. The average satisfaction with the result of the surgery was 8.2 (on a 1-10 scale) with most of patients (67%) being able to maintain the amount of physical activity after the surgery, while few patients (24%) were even able to increase this amount.

A Cochrane review by a group of podiatrists in London, originally published in 2004 (Ferrari et al., 2004) and updated in 2009 (Ferrari et al., 2009), analysed a total of 21 randomized or "*quasi-randomized*" clinical trials (Wülker and Mittag, 2012). No recommendations were given with regard to operative techniques. Trials of operative techniques have yielded inconsistent results; no one technique was superior to all others (Wülker and Mittag, 2012).

The actual choice of procedure over the whole spectrum of hallux valgus deformities thus depends essentially on the surgeon's expertise and experience (Wülker and Mittag, 2012).

The basic distinction is between operations that restore the normal anatomy of the forefoot, and thus come into question particularly in younger patients, and interventions where the joint is sacrificed (resected or fused), which are considered especially in older patients and in the case of osteoarthritis of the metatarsophalangeal joint (Wülker, 2011; Wülker et al., 2007; Wülker and Suckel, 2005).

In the face of the high number of different operations described and the mostly low level of evidence of the investigations published, it is extremely difficult to give treatment recommendations based on high-level evidence (Wülker and Mittag, 2012).

The principal contraindication to surgery is arterial occlusive disease (Williams et al., 2006). Because it is the part of the body most distant from the heart, the foot is the first place where decreased perfusion will make itself noticed. If the pedal pulse is not distinct, the vascular status must be determined. Only if sufficient

perfusion is assured can surgery take place. Diabetes, even with early polyneuropathy, does not represent a contraindication. Hallux valgus can also be treated surgically in the presence of chronic polyarthritis or other rheumatic diseases, although care must be taken to select an appropriate procedure (Wülker and Mittag, 2012).

The aim is uncomplicated wound healing in at least 99% of patients, and particular care must therefore be taken when operating on the great toe. The duration of ischemia must be as short as possible. The incision should grant direct access to the operation site without undue dissection of soft tissues. Excessive retraction should be avoided. Care must be taken to ensure proper compression by the bandage applied postoperatively. The suture for wound closure should be left in place until 14 days after surgery. Although functional rehabilitation under full loading is generally possible, the foot must be elevated to avoid excessive swelling (Wülker and Mittag, 2012).

MINIMALLY INVASIVE HALLUX VALGUS TECHNIQUES

Minimally invasive hallux valgus techniques, such as arthroscopy, percutaneous and minimum incision osteotomies, have the theoretical advantage of decreasing recovery and rehabilitation times, because surgical exposure and deep soft tissue dissection are less extensive and possibly gentler (Maffulli et al., 2005, 2011).

With the advance of foot and ankle arthroscopy, distal soft tissue procedures (lateral soft tissue release and medial capsular placation) have been performed endoscopically (Lui, 2007, 2008; Lui et al., 2005, 2008).

The advantages of arthroscopic procedures are better assessment of sesamoid reduction and the potential to minimize the risk of overcorrection. However, arthroscopic hallux valgus correction is technically demanding, is time-intensive and carries the potential risk of digital nerve injury (Lui, 2007, 2008; Lui et al., 2005, 2008).

Percutaneous and minimum incision osteotomies for the management of patients with hallux valgus have received increasing recognition because of the perceived efficacy comparable to traditional open approaches but with purported less cost and higher patient satisfaction (Roukis, 2009).

Percutaneous and minimum incision techniques seem to be indicated in high-risk patients who have ulceration or recurrent ulceration as a means of performing limb preservation/salvage without extensive soft tissue and osseous trauma (Roukis, 2005a, 2005b; Roukis and Schade, 2008; Weitzel et al., 2007).

Special instruments (Bösch et al., 2000; Portaluri, 2000) and, in some percutaneous techniques, fluoroscopy are needed (Magnan et al., 2006).

Percutaneous surgery is performed through the smallest possible working incision (usually 1–3 mm long) without direct visualization of the underlying target structures, using a mini-blade for soft tissue incision, and a power rotatory bur for bony procedures under intra-operative fluoroscopy (Roukis, 2005a, 2009; Roukis and Schade, 2008).

A percutaneous subcapital distal osteotomy as described by Maffulli et al. (Maffulli et al., 2005), performed with a 2 cm medial incision made just proximal to the bunion, using a small osteotome, and with the insertion of a 2 mm Kirschner wire, allows the orthopaedic surgeon to reliably achieve good correction of most hallux

valgus deformities without removal of the bunion and without open lateral release, performing only a manipulation of the big toe.

Minimally incision surgery is performed through the smallest incision necessary to perform the procedure (usually 1–3 cm long) using a traditional scalpel blade for soft tissue incision and power saw blades for bony procedures under direct visualization of the structures, and may or may not require intra-operative fluoroscopy (Roukis, 2009).

The most common complication following minimally invasive foot procedures is recurrence of the deformity, a consequence of incorrect selection of the procedure, incorrect surgical technique, and underestimated healing time of the osteotomy (de Prado et al., n.d.; Kadakia et al., 2007; Leemrijse et al., 2008).

POST-OPERATIVE MANAGEMENT

Regardless of the type of surgical procedure chosen, an appropriate post-operative protocol must be followed (Fournier et al., 2019). Post-operative rehabilitation should help to restore physiological gait and foot function, encouraging both plantar pressure on the first ray and joint mobility. Consultation between orthopaedic surgeon and physiotherapist about the surgical technique used is advisable before starting rehabilitation (Polastri, 2011).

In the literature review performed by Polastri (Polastri, 2011), the results suggest that the post-operative rehabilitation timeframe may vary depending on the surgical technique and can be performed in an outpatient setting.

The use of appropriate footwear that allows safe walking and does not compromise the surgical result is important immediately after surgery. Indeed, the post-operative protocols advocated by both Wülker et al. (Wülker and Mittag, 2012) and Fraissler et al. (Fraissler et al., 2016) consist of full weightbearing mobilization in a post-operative shoe with a flat, stiff sole that is worn for six weeks. Patients are told to wear comfortable normal shoes for 3 to 6 months, gradually returning to former footwear (Maffulli et al., 2005).

Walking is allowed immediately with the patient advised to walk on his or her heel (Maffulli et al., 2005), and it is generally safe to allow the athlete on a stationary bicycle with a cast or cast boot early post-operatively to maintain cardiovascular fitness (Saxena, 2000; Saxena and Louis, 2013).

Weightbearing recommendations after hallux valgus correction remain controversial because no evidence-based published guidelines exist (Hester and Pedowitz, 2020). Some surgeons allow immediate weightbearing in a postoperative shoe, while other surgeons make patients non–weightbearing for 2 weeks and then allow weightbearing in a forefoot unloading shoe or a regular stiff-soled post-operative shoe until the eighth week (Hester and Pedowitz, 2020).

A recent randomized controlled trial by Ling et al. (Ling et al., 2020) showed that an early post-operative weightbearing (i.e. at 2 weeks after surgery) did not lead to premature implant failures or increased recurrence rates, and also resulted in fewer symptoms like stiffness, lessened pain, better performance in daily activities and a better quality of life. Patients can usually walk normally after 8 to 12 weeks (Wülker and Mittag, 2012).

Management of edema and pain must be also achieved. Because of the frequent tendency to swelling, patients are advised to keep the affected foot raised for much of the time during the first 2 weeks (Wülker and Mittag, 2012). Maffulli et al. (Maffulli et al., 2005) suggest foot elevation when at rest.

Post-operative pain management could be achieved with a multimodal approach using regional blocks, minimal narcotics, nonsteroidal anti-inflammatory drugs, and other modalities as necessary (Hester and Pedowitz, 2020).

A compressive bandage is applied, and control radiographs (anteroposterior and oblique views) are routinely obtained at regular intervals every six weeks until osseous healing is achieved (Fraissler et al., 2016; Maffulli et al., 2005).

Kirschner wire fixation (as described earlier) produces stable elastic stabilization, favouring early healing of the osteotomy combined with early weightbearing. After 6 weeks, the dressing and the Kirschner wire are removed (Maffulli et al., 2005).

Physical therapy may help to regain full metatarsophalangeal joint range of motion (Fournier et al., 2019). A post-operative regimen consisting of a multimodal rehabilitation program including mobilization, manual therapy, strengthening exercises and gait training may lead to improved function and weightbearing of the first ray after hallux valgus surgery (Schuh et al., 2008, 2009, 2010).

CONCLUSIONS

Despite the common occurrence of these deformities, concern exists on the correct treatment approach and the most appropriate surgical technique, especially in athletes. The literature contains practically no well-controlled prospective trials; in particular, no comparison of different treatment procedures, especially in athletes, together with an appropriate concern from the treating physician that a non-perfect surgical approach may compromise athletes' careers. When dealing with hallux valgus deformity in athletes, it is crucial to conduct a thorough evaluation, assess patients' goals and activity level, and then properly counsel them regarding possible outcomes of the surgery (Fournier et al., 2019).

Minimally invasive procedures allow to achieve good clinical and radiographic outcomes comparable to those obtained with open surgical techniques in the management of mild to severe hallux valgus deformity, and they are associated with decreased recovery and rehabilitation times (Chiang et al., 2012; Maffulli et al., 2005, 2009; Magnan et al., 2006). However, no definitive guidelines regarding the systematic use of minimally invasive surgery for hallux valgus correction have been drawn, so it is not possible to determine clear recommendations regarding the systematic use of minimally invasive surgery for hallux valgus correction, even though preliminary results are encouraging (Maffulli et al., 2011, 2013).

Further studies of higher levels of evidence, including large, randomized trials should be performed to identify the correct indications for this technique. Future trials should use validated functional and clinical outcomes, adequate methodology, and be sufficiently powered (Maffulli et al., 2011).

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