



Review Article

Achilles Tendon Injuries: Comparison of Different Conservative and Surgical Treatment and Rehabilitation

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ABSTRACT

Despite its high incidence and the great development of literature, there is still controversy about the optimal management of Achilles tendon rupture. The several techniques proposed to treat acute ruptures can essentially be classified into: conservative management (cast immobilization or functional bracing), open repair, minimally invasive technique and percutaneous repair with or without augmentation. Although chronic ruptures represent a different chapter, the ideal treatment seems to be surgical too (debridement, local tissue transfer, augmentation and synthetic grafts). In this paper we reviewed the literature on acute injuries.

INTRODUCTION

The Achilles is the strongest and the largest tendon in the body and it can normally withstand several times a subject's body weight. Achilles tendon rupture is frequent and it has been shown to cause significant morbidity and, regardless of treatment, major functional deficits persist 1 year after acute Achilles tendon rupture [1] and only 50-60% of elite athletes return to pre-injury levels following the rupture [2].

Most Achilles tendon rupture is promptly diagnosed, but at first exam physicians may miss up to 20% of these lesions [3]. The definition of an old, chronic or neglected rupture is variable: the most used timeframe is 4 to 10 weeks [4]. The diagnosis of chronic rupture can be more difficult because the gap palpable in acute ruptures is no longer present and it has been replaced by fibrous scar tissue. Typically chronic rupture occur 2 to 6 cm above the calcaneal insertion with extensive scar tissue deposition between the retracted tendon stumps [5], and the blood supply to this area is poor. In this lesion the tendon end usually has been retracted so the management must be different from the acute lesion's one.

Despite its high incidence and the great development of literature about this topic, there is still controversy about the optimal management of Achilles tendon rupture [6]. The several techniques proposed to treat acute ruptures can essentially be classified into: conservative management (cast immobilization or functional bracing), open repair, minimally invasive technique and percutaneous repair [7] with or without augmentation. Chronic ruptures represent a different chapter and the ideal treatment seems to be surgical [3]: the techniques frequently used are debridement, local tissue transfer, augmentation and synthetic grafts [8].

Conservative treatment using a short leg resting cast in an equinus position is probably justified for elderly patients who have lower functional requirements or increased risk of surgical healing, such as individuals with diabetes mellitus or in treatment with immunosuppressive drugs. In the conservative treatment, traditionally the ankle is immobilized in maximal plantar flexion, so as to re-approximate the two stumps, and a cast is worn to enable the tendon tissue to undergo biological repair. Advantages include the avoidance of surgical complications [9-11] and hospitalization, and the cost minimization. However, conservative treatment is associated with high rate of tendon re-rupture (up to 20%) [12].

Operative treatment can ensure tendon approximation and improve healing, and thus leads to a lower re-rupture rate (about 2-5%). However, complications such as wound infections, skin tethering, sural nerve damage and hypertrophic scar have been reported to range up to 34% [13]. The clinically most commonly used suture techniques for ruptured Achilles tendon are the Bunnell [14,15] and Kessler techniques [16-18].

Minimally invasive surgical techniques (using limited incisions or percutaneous techniques) are considered to reduce the risk of operative complications and appear successful in preventing re-rupture in cohort studies [19,20]. Ma and Griffith originally described the percutaneous repair, which is a closed procedure performed under local anesthesia using various surgical techniques and instruments. The advantages in this technique are reduced rate of complications such as infections, nerve lesions or re-ruptures [21]. The surgical repair of a rupture of the Achilles tendon with the Achillon™ device and immediate weight-bearing has shown fewer complications and faster rehabilitation [22].

A thoughtful, comprehensive and responsive rehabilitation program is necessary after the operative treatment of acute Achilles lesions. First of all, the purposes of the rehabilitation program are to obtain a reduction of pain and swelling; secondly, progress toward the gradual recovery of ankle motion and power; lastly, the restoration of coordinated activity and safe return to daily life and athletic activity [23]. An important point to consider is the immediate postoperative management, which includes immobilization of the ankle and limited or prohibited weight-bearing [24].

Incidence

Achilles tendon rupture is a very frequent lesion. It has been estimated an incidence of 18 per 100000 and it has been showed to be increasing in sporty and active patients. The peak incidence in men is from 30 to 39 years but in women the risk increase after the age of 60 years. After 80 years old the incidence is major in women than in men. Many studies demonstrated that most of Achilles tendon ruptures occurred during sporting-related activities. Postacchini and Puddu in 1976 showed that in 12 of 27 cases the rupture occurred during athletic activities [25]. According to a report from Finland in 2008 [26] the incidence of acute Achilles tendon ruptures increased from $8.3/10^5$ in 1987 to $14.8/10^5$ in 1999, so they thought the rate would have increased yet in the future. Achilles tendon ruptures occur most frequently in the age groups of 30-39 and 40-49, respectively in men and women [27], with a male predominance [28]. On average, women with tendon rupture are 2-3 years older than men with ruptures. Many studies report that acute Achilles tendon rupture occurs during sports activities [11,29-31], especially in racket games, football and handball [32].

Etiology and mechanism of rupture

The etiology of Achilles tendon rupture is still unclear and there is disagreement about the exact causes. However, many conditions and disorders have been associated to this problem including inflammatory conditions, autoimmunitary disorders,

hyperuricaemia, collagen abnormalities, hyperthyroidism, renal insufficiency, arteriosclerosis and high serum lipids concentration. This lesion has been associated with exposition to fluoroquinolones, steroid use, repetitive microtrauma, poor tendon vascularity with advanced age, gastrocnemius-soleus dysfunction, changes in training patterns and also footwear and exercise-induced hyperthermia [33,34]. Complete rupture of the Achilles tendon can occur as the result of either chronic degeneration of the tendon, failure of the inhibitory mechanism of the musculotendinous unit, or direct or indirect trauma [35]. Otherwise acute rupture of the Achilles tendon can also occur on top of chronic overuse phenomena such as peritendinitis and tendinosis during stress loads that would otherwise not result in any injury [36].

These injuries can be caused intrinsically by decreased vascularity, aging, or anatomic deviation, or extrinsically by a change in athletic activity or exercise conditions.

An area of decreased vascularity exists in the tendon, specifically at the region of insertion: with increasing age, blood flow at the extremities often diminishes, resulting in a weakened tendon that is apt for complete rupture. Mechanical failure can occur with either direct or indirect trauma caused by excessive loading, as might occur during the start of a sprint [37], or a sudden and violent plantarflexion or dorsiflexion of the ankle or foot during an unintentional step into a hole or a fall from a significant height [38].

About the mechanism of rupture, there are two theories: the degenerative theory and the mechanical theory. According to degenerative theory, a chronic degeneration of the tendon leads to the rupture, in absence of trauma. The events that cause the rupture are not clear. In 1976 Puddu et al. [39] classified the Achilles tendon disease in 3 categories: 1) pure peritendinitis or inflammation of peritendinous tissue with normal tendon 2) peritendinitis with tendinosis or inflamed peritendinous tissue and degenerative changes of the tendon 3) tendinosis or normal peritendinous tissue with degenerative changes of the tendon. All “spontaneous ruptures” (patients without any history of previous problem to the Achilles tendon) have shown evidence of degenerative lesions in the tendon tissue and no evidence of peritenon alterations [11].

A more recent classification was provided in 2011 by Amlang M.H. et al [120] using ultrasonographic analysis. They organized this classification according to the location of the rupture, the contact of the tendon ends, and the structure of the interposition between the tendon ends in 5 types (with the add of 2 subtypes for the types 2 and 3): 1) High contact 2a) Partial contact with hyperechoic interposed structure 2b) Partial contact without hyperechoic interposed structure 3a) Dehiscence with hyperechoic interposed structure 3b) Dehiscence without hyperechoic interposed structure (Organized hematoma) 4) Proximal rupture (Rupture at the intersection of muscle and tendon) 5) Distal rupture (Near insertion, often in cases with insertional tendinopathy) [40].

DIAGNOSIS

Clinical

The diagnosis of Achilles tendon rupture is usually clear and built on a detailed patient history and an appropriate clinical examination. Patients present pain and swelling in the posterior part of the ankle and describe a traumatic event or a feeling of being kicked at the back of the heel [15]. Patients may hear an audible popping sound [41] and may have difficulty in deambulation, walking uphill or climbing stairs [42-44]. On examination there is often swelling of the calf [45], loss of Achilles tendon congruity or palpable gap [46], weakness of ankle joint plantar flexion and inability to do heel raises [47].

Many signs and tests are described to diagnose Achilles tendon rupture. The most commonly used clinical test is the calf-squeeze test, also described as Thompson's or Simmonds' test [48], the patient lies prone on the examination couch with ankles out of the couch. The examiner squeezes the proximal muscular half of the soleus muscle, avoiding direct pressure on the tendon. If the tendon is intact, plantar flexion of the foot is evoked during the squeezing test. If there is a rupture, no movement of the foot is noted. Another simple and no touch test is the Matles' test [49], the patient lies prone on the examination couch and is invited from the examiner to flex both knees carrying tibiae perpendicular to the floor. On the affected side, the angle between the anterior aspect of the shin and the dorsal aspect of the foot is more acute than on the uninjured side. A mini-invasive test is O'Brien test [50] which uses a hypodermic 25-gauge needle inserted through the skin of the calf, approximately 0.5 cm off the midline and approximately 10 cm proximal to the insertion of the tendon. The needle should be inserted until its tip is just within the substance of the tendon. Then, the ankle is alternately plantarflexed and dorsiflexed. During dorsiflexion, if the needle points distally, probably the tendon is intact in the portion distal to the needle. If the needle points proximally or remains relatively still, probably there is a loss of continuity between the needle and the side of insertion of the tendon. In the Copeland's test [51], a sphygmomanometer cuff is wrapped around the middle of the calf while the patient lying prone. The cuff is inflated to 100 mmHg with the foot in plantar flexion. The foot is then dorsiflexed. If the pressure rises to around 140 mmHg, the musculotendinous unit is supposedly intact. If the pressure remains at or around 100 mmHg, an Achilles tendon rupture may be diagnosed. If at least two of the aforementioned tests are positive, the diagnosis of Achilles tendon rupture is certain [52]. Maffulli [39], evaluated the sensitivity, specificity and predictive values of the calf squeeze test, palpable gap, Matles' test, O'Brien needle test and Copeland sphygmomanometer test in 174 complete Achilles tendon tears. All tests showed a high positive predictive value. However, Thompson's test and Matles' test had significantly more sensitive (0.96 and 0.88, respectively) than the other tests.

Imaging

Diagnostic modalities include radiographs, ultrasonography and magnetic resonance imaging (MRI). Standard radiography is usually not indicated, even if it is useful to diagnose some conditions. Particularly, lateral radiographs of the ankle it is used to diagnose an Achilles tendon rupture: in this case, the Kager's triangle [39], (a triangular fat-filled space between the anterior aspect of Achilles tendon, the posterior aspect of the tibia and the superior aspect of the calcaneus) loses his configuration and can be distorted. Furthermore, Arner et al. [53], found that the radiographic changes most likely associated with Achilles tendon rupture was the deformation of the contours of the distal segment of the tendon, resulting from loss of tone. . Radiographs assist by ruling out a calcaneal avulsion and other bone pathologies [54].

Real-time high-resolution ultrasonography is an inexpensive, rapid and dynamic diagnostic aid [55] and it is used as primary imaging method, even if it is operator dependent [56,57]. Linear ultrasonography of the Achilles tendon produces a dynamic and panoramic image of the tendon: its appearance varies with the type of transducer used and the angle of the ultrasound beam with respect of the tendon [58]. High frequency probes of 7.5 to 10 MHz provide the best resolution, but have a short focusing distance [59]. The Achilles tendon is composed by longitudinally arranged collagen bundles, which reflect the ultrasound beam. The probe should be held at right angles to the tendon to ensure that an optimal amount of ultrasonic energy is returned to the transducer avoiding artifacts. Linear array transducers are therefore better suited than sector-type transducers, which produce excess obliquity of the ultrasound beam at the edges. Also, it may be necessary to use a synthetic gel spacer or stand-off pad, increasing the definition of the surface echoes and allowing a suitable support [60,61].

Ultrasonography in an uninjured Achilles tendon demonstrates hypoechogenic bands of parallel fibrillar lines contained between 2 hyperechogenic bands in the longitudinal plane and round or oval shape in the transverse plane [13,62,63]. Tendon fascicles appear as alternate hypoechogenic and hyperechogenic bands separated when the tendon is relaxed and more compact when it is strained. Ultrasonographic images of ruptured tendon demonstrate discontinuity of normal fibrillar pattern, gap between torn ends and acoustic vacuum [47,64]. Hartgerink et al. [52] evaluated 26 suspected Achilles tendon ruptures with ultrasonography and compared the results of this test with surgical results. They demonstrated that ultrasonography is accurate in distinguishing full-thickness tears from partial-thickness tears or tendinopathy with a sensitivity of 100%, a specificity of 83%, an accuracy of 92%, a positive predictive value of 88% and a negative predictive value of 100%.

The multiplanar imaging capabilities of MRI combined with its excellent soft tissue contrast characteristic make it ideally suited for imaging of the rupture of the Achilles tendon. In the evaluation of the Achilles tendon, sagittal and axial planes, using combination of T1- and T2-weighted imaging sequences, are most useful. MRI allows determination of the extent and nature of the condition of the tendon ends in complete Achilles tendon tears [65]. It provides extensive informations on the internal morphology of the tendon and the surrounding structures. It is useful for the evaluation of acute ruptures as well as various stages of chronic degeneration. MRI has a sensitivity of 95% and a specificity of 50% in evaluating Achilles tendon pathology [66,67]. Subtle thickness changes are detected in the axial plane and the longitudinal extent of the tear on sagittal images. A normal Achilles tendon is seen as an area of low signal intensity on all sequences. The tendon tapers smoothly and shows no focal defects. The dark band of the tendon is well contrasted from the high signal intensity of the pre-Achilles fat pad [53]. Any high signal intratendinous intensity is seen as abnormal (58). For a T1-weighted image, a complete rupture is visualized as disruption of the signal within the tendon, mixed with hemorrhage and edema localized in the pre-Achilles fat pad. Older complete tears display hemorrhage as low signal intensity on T1-weighted images. A T2 image will show generalized increased signal intensity representing the edema and hemorrhage within and around the ruptured tendon [51].

Unlike ultrasonography, it is not operator-dependent and it allows multiplanar imaging. Also MRI allows adequate evaluation of the size of partial and intrasubstance tears, potential gapping of ruptured ends and the amount of tendon degeneration/scar tissue [68].

Literature research strategies

In literature there are many studies regarding the treatment of Achilles tendon ruptures and comparing operative with non-operative interventions.

An analysis of the literature was conducted with keywords: “Achilles tendon lesion” [Queries (therapy, broad)], “Achilles tendon injury” [Queries (therapy, narrow)], “Achilles Tendon / injuries” [Majr] AND “Achilles Tendon / surgery [Majr]. All articles had to document the choice or the comparison between operative or non-operative techniques.

The results of database extrapolate 163 articles which were assessed according to the use of following limits: full text, last 5 years, English / Italian, human, adults 19 + years. Sixty-one articles were excluded based upon title and abstract informations. Eventually 38 articles were found to be of significant level and screened for eligibility.

CONSERVATIVE TREATMENT

There is no agreement in treatment of Achilles tendon lesions and so there are many studies that try to compare the different approaches.

In 2011, Keating JF et al. conducted a randomised prospective study [31], on 80

patients with an acute rupture of Achilles tendon randomised to operative repair with open technique or to non-operative treatment in cast. After open repair the limb was immobilised in a full equinus cast during four weeks; then it was changed to a semi-equinus cast for further two weeks. The weight-bearing was allowed after removing the cast. Patients treated in non-operative way were immobilised in a below-knee cast in full equinus for four weeks, semi-equinus for others four weeks and in neutral position for two weeks. Weight-bearing was not allowed for eight weeks from the trauma. As results of this study they obtained no significant differences in re-rupture rate, an infection rate of 8.1% in operative group and none in the conservative. Pain score, range of movement and muscle recovery showed similar patterns. The return to sport rate was higher and faster in the operative group, while time to return to work was similar in the both groups. The main difference in the both groups was the higher re-rupture rate: even if it was not significant, it was consistent with previously published literature [69].

Wallace RGH et al. [70], conducted the largest study of non-operative functional management of rupture of Achilles tendon reporting the outcome of 945 consecutive patients. All the patients with Achilles tendon lesion were treated non-operatively when tendon ends were found to be well approximate on palpation with the foot in plantar flexion. Patients with delayed presentation were treated surgically if tendon ends did not approximate on plantar flexion. The treatment functional protocol involved equinus cast without weight-bearing until four weeks from trauma, then it was positioned a pneumatic walker heel raise that it was reduced every fortnightly. At eight weeks, for almost four weeks, the orthoses were removed and patients started physiotherapy for gait training, strength and mobility training. Follow up was conducted and each patients completed a questionnaire about pre and post-injury work and activity levels, time to return to work, medical and drugs history, history of Achilles tendon injury, diagnosis, treatment, physiotherapy and complications. The re-ruptured rate of this study was about 2.8% and it was considered similar or also better than published with operatively treatment. Re-ruptures occurred within three months of diagnosis; the distribution did not evidence statistically clinical difference in the mean age of the patients, between sporting and non-sporting patients and between those with an acute and delayed presentations. This study showed that treatment with a functional orthoses and physiotherapy protocol can provide dependable results in a context of a non-operative management.

The Cochrane collaboration performed a meta-analysis [13], to summarize the outcome of different management in patients with tendon Achilles lesion: the studies analysed showed improving functional outcome and lower rates of re-ruptures when treatment involved functional orthoses and early mobilisation.

Open repair of acute achilles tendon rupture [71]

There are several suture techniques, several suture and graft materials that can be used. The goal is always to restore the anatomic length of the triceps surae. It is very important wait for the preoperative soft tissue normalization to prevent complications and repair the lesion within the first 30 days of rupture to obtain good results.

The first surgical technique developed the open end-to-end repair which involves a longitudinal incision of 6-8 cm that follows the medial edge of the Achilles tendon. The ankle must be plantar flexed to expose the tendon ends. The suture can be done with Krackow technique, Bunnell technique or Kessler technique. The Bunnell technique is an interlacing suture that provides high stability by interlacing the tendon with a large contact area between the tendon and the thread surface. This technique has two major disadvantages: possibility to compromise microcirculation and to damage the paratenon. However, it is one of the most used techniques for open Achilles tendon repair. The Kessler technique is a typical grasping suture in which a suture

surrounds the tendon with one loop. In comparison with the Bunnell technique, the Kessler one is less complex and less invasive for the tendon and the connecting tissue. In a biomechanical study [72], the Krackow technique is proven stronger than the Bunnell and Kessler sutures measuring the mean load to failure, but it has not been demonstrated to have clinical significance.

The open end-to-end repair modified by Mandelbaum is characterized by a posteromedial incision (about 1 cm medial to the tendon) long approximately 10 cm; the ruptured ends of the tendon are sutured using a Krackow configuration. In the end-to-end repair the suture can be reinforced with the plantaris tendon if the surgery is performed within the first two weeks after lesion. Another way to reinforce the suture is using living fascia that can also prevent adhesions of the repaired tendon to the overlying skin (fascial turn-down augmentation). A single strip of gastrocnemius fascia or two flaps are used to cover the rupture site.

Another approach is the peroneus brevis weave technique in which a posterolateral longitudinal incision exposes the Achilles tendon and the tuberosity of the calcaneus. The peroneus brevis tendon is detached from its insertion and is passed through a hole in the calcaneus and back beside the Achilles tendon reinforcing the site of rupture; then it is sutured to the peroneus brevis itself producing a dynamic loop [54]. Although this technique was originally used for acute injuries, nowadays it is preferably used for chronic or neglected lesions, with good results in terms of return to pre-injury sports and daily activities [73,74].

In 1997 Fernandez-Fairen and Gimeno [75], conducted a study with 29 athletes using suture augmented with a polyethylene terephthalate mesh synthetic graft and no immobilization after surgery. All patients were able to resume their sport activities in the same level; no re-ruptures occurred, even if there were two problems with scarring and problems with healing because this repair is voluminous.

Percutaneous and mini-open repair

The percutaneous and the mini-open repair are recognized treatments for acute rupture of the Achilles tendon. Delayed presentations are considered a contraindication to fixation by percutaneous method because soon after rupture the space between tendon ends fills with hematoma and developing scar tissue.

The first percutaneous technique has been described by Ma and Griffith [76], in 1977 with the aim to reduce the complications associated with open surgery; in their series they obtained only two minor skin complications and no sural nerve damage, although another study found out a high rate of sural nerve damage (13%) [77]. During the years, the incidence of sural nerve complications in percutaneous Achilles tendon repair appeared to be related to operative procedures in which the nerve is not isolated to protect it from damage or entrapment [78,79], to avoid this risk Webb and Bannister developed a percutaneous technique which involves three skin incisions in the midline away from the lateral side of the tendon to avoid the risk of iatrogenic injury.

Exposure of the sural nerve during percutaneous repair has been shown to reduce the incidence of nerve injury. In 1995 Kakiuchi [74], published a report about patients treated with a limited open and percutaneous technique to allow visualization of the tendon stumps by a small incision over the palpable gap. Assal et al. [22], basing on the principles of Kakiuchi's technique, developed a guiding instrument called Achillon. Theoretically, the Achillon device allows avoiding sural nerve lesions because the sutures are retrieved by the inner arm of the device. Many studies tried to compare the different therapeutic approaches to Achilles rupture but the optimal method remains controversial. In 2011, in their review, Carmon et al. [55], compared open



repair and minimally invasive repair they found similar function outcomes, but in the first group they recorded a higher risk of infections, adhesions and disturbed skin sensibility, while in the second group a slightly higher rates of re-rupture and sural nerve damage. Hospital stay, wound complications and time to return to work were lower in the minimally invasive group [80].

More recently, Muezzinoglu et al. [81], described a new technique called “Internal Splinting” (SIIS) that utilizes bridging the rupture site enabling to hold the tendon ends together with strong sutures without opening the site of injury, allowing to combine the best features of both open and percutaneous techniques. Sarman et al. [82] demonstrated that SIIS method for Achilles tendon ruptures performed better in terms of both functional and objective outcomes compared with open surgery.

Functional rehab

For complete ruptures of Achilles tendon the mainstay of postoperative management is traditionally initial rigid immobilization in an equinus cast. However immobilization in dorsiflexed position reduces the tendency to lose dorsiflexion during post-operative immobilization. Traditionally, 6 to 8 weeks have been the accepted length of immobilization. [83]. The aim of rehabilitation is to avoid the detrimental effects of joint immobilization, such as joint stiffness, muscle atrophy, tendocutaneous adhesions, deep vein thrombosis and ulceration of the joint cartilage.

In different studies the definition of “functional rehabilitation” has been applied using a variety of orthotics and rehabilitation regimes; however, the key concept is weight-bearing mobilization. Usually, mobilization is possible within an orthotic device and early limited range of motion is permitted. About the orthoses, we can use rigid rocker bottom style or the more flexible carbon-fibre dorsal orthosis: there is not agreement about degrees of plantarflexion that should be maintained: some authors prefer ankle in neutral position while other ones use three hell-wedge insert. Finally, there is not a consensus about of when weight-bearing should be permitted and how long the orthosis should be worn [84], but the new trend is immediate fully weight-bearing and early removal of the orthoses (average eight weeks) [85].

We have to consider the biology that governs tendon healing during treatment decision process: there are both preliminary clinical evidence and underlying basic science research to support early loading and movement. The biomechanical inferiority of the newly formed scar tissue is due to its increased stiffness: animal model demonstrated that early loaded movement increased the properties of scar tissue, decrease excessive adhesion formation and enhances the gliding function of the tendon [86].

In 2006 two different randomised controlled trials [87] were developed in order to assess the potential benefits of immediate weight-bearing mobilisation after rupture of the Achilles tendon. The first trial was conducted on operatively treated patients: after surgery were randomised either to the treatment group for immediate mobilisation in a carbon-fibre orthosis with three 1,5 cm heel raises or to the control group who had traditional plaster cast immobilisation. Both the plaster cast than the orthoses was removed at eight weeks and equinus position was reduced every two weeks. Patients were evaluated at three months, six months and 1 year: there was a significant difference in the time taken to return to normal walking and stair climbing. Two re-rupture occurred in the treatment group: this fact suggests that patients mobilized fully weight-bearing should be selected carefully and need structured rehabilitation.

The second trail was conducted on non-operative patients. Patients in the control group wore equinus cast while the other patients wore a carbon-fibre orthosis with three 1,5cm heel raises and then they were mobilized fully weight-bearing and

encourage to move the ankle. In the follow up the equinus position was not changed for the first six weeks, then it was reduced and at the end the cast and the orthoses were removed after 12 weeks. It was no offered formal physiotherapy but a written exercise programme with a series of exercises was given to all patients. In this trial the primary outcome was similar in the both groups but also the complications were similar.

Adam C Strome et al. [23], proposed a rehabilitation protocol for the repair of the acute Achilles tendon. The aims of this rehabilitation program are: 1) to address residual pain and swelling with ice and massage; 2) to recover motion while preserving the integrity of the repair with stretching to recover dorsiflexion; 3) to consider the strengthen the gastrocnemius soleus Achilles motor unit with a program using elastic bands and closed chain exercises; 4) to improve the strength and coordination of the entire lower extremity (the rehabilitation is facilitated by swimming, water, jogging and exercise cycling); 5) to provide a safe and competitive return to athletic activity. The protocol must be modified in case of complications, for example superficial infections.

In 2005 Calder et Al published a study [88] on 46 patients who had sustained a spontaneous rupture of the Achilles tendon and who underwent operative repair using the Achillon suture system. After the surgery the ankle was positioned in 20° equinus for two weeks: actually, a previous publication demonstrated that skin perfusion over the Achilles tendon was maximal in this position [89]. At two weeks the brace was adjusted to allow movement of the ankle up to plantigrade and an active physiotherapy rehabilitation started. There were no re-ruptures in these patients and only one superficial wound infection: the mini-open incision and the early postoperative rehabilitation program observed in this study do not appear to be associated with an increased risk of re-rupture or wound breakdown.

In 2002 a randomized clinical study [90], on 50 patients with Achilles tendon rupture was published. All the patients were managed with Kessler suture technique and a central gastrocnemius aponeurosis flap was turned down over the suture line. At the end of the surgery a below-knee rigid plaster splint was applied with the ankle in neutral position. After surgery patients were randomized into two groups: the early motion group, which maintained a below-knee dorsal cast for 6 weeks that allowed active free plantar flexion and restricted dorsiflexion to neutral, or the immobilization group, which maintained a below-knee plaster cast with the ankle in neutral position for six week. Weight-bearing was allowed after three weeks in both groups. Almost all the outcome results (range of motion, stiffness, footwear restriction, and subjective result) and the complications obtained in the both groups of patients were very similar. The major finding was that the isokinetic calf muscle strength results were better in the early motion group.

A 2011 review [91], tried to systematically identify the individual components that define immediate weight-bearing protocols. They concluded that immediate weight-bearing is safe; the type of orthotic that should be worn, the degree of plantarflexion and the timing of removal have not been fully evaluated and require further research.

DISCUSSION

In literature, there is disagreement about the best treatment to use in acute Achilles tendon rupture. We have to consider that individual patients have different needs according to age, comorbidity, functional requirements and activities. Surgical treatment has several associated complications, including inherent complications from surgery (scar adhesions, superficial infections and sensibility disturbances), anesthesia and wound problems. Some studies have demonstrated that non-operative approaches present similar results to operative procedures and they are indicated especially in high-risk patients [11,92]. On the contrary, athletes are generally younger and healthier with less comorbidities. Furthermore, they need a faster return to daily

activities. Several studies demonstrated that overall operative repair provides earlier return to sporting activities and less rate of re-rupture [93-96]. However, non-surgical management of acute Achilles tendon rupture have an increased risk of re-rupture because, without surgical suture, the once-ruptured tendon do not bear the intensity of pre-injury activities. Moreover, Carden et al [92] found an increased risk of re-rupture if non-surgical management was not started within the first 48 hours after injury.

The main problem in the non-operative management is the high re-rupture rate ranging from 10-20% [97]. Cetti et al. [22], in a prospective study of 111 patients found a re-rupture rate of 13% in patients treated non-operatively and a lower rate (4%) in those ones who underwent surgery.

Wallace et al. [98], described similar or even lower rate of re-rupture in patients undergoing non-operative functional management compared to patients undergoing surgery. Hufner et al. emphasised the decisive advantages and better results of conservative functional therapy [99].

Conservative options include serial casting with gradual decrease in gravity equinus position and splinting devices. Another important key-component is weight-bearing mobilization, usually within an orthotic device with early, but limited, range of movement permitted. Furthermore, multiple rehabilitation protocols are available and they are surgeon dependent. With regard to the orthoses, there are two basic designs: rigid rocker bottom style [100] or the more flexible carbon-fibre dorsal orthoses [87]. The flexible orthoses generally facilitates a greater range of movement than the more rigid ones. In addition, there is disagreement about the degrees of plantarflexion that should be maintained within the orthoses. Some studies have advocated that the ankle should be positioned in neutral (plantar-grade) but with restricted dorsiflexion, while others have used three heel-wedge inserts such that the ankle joint is initially maintained at near full plantarflexion [101]. Finally, it is important to decide when weight-bearing should be permitted (day one or within 2 weeks), how long the orthoses should be worn and whether or not to allow active range of movement exercises throughout the period when the orthosis is worn [29,102,103]. An accepted conservative regimen uses either an above-the-knee cast or a below-the-knee cast, with the ankle in plantarflexion for approximately 4 weeks. Then they begin gradually to reduce the equinus position for the next 4-8 weeks and eventually transitioning to a walking boot with a heel lift while starting ROM exercises and a rehabilitation program. It is important to implement physical therapy with passive and active ROM exercises. Some studies argue for early ROM to enhance tendon healing process and to reduce side effects due to immobilization. Some studies advocate early ROM with splint devices argue that this technique provides a speedier recovery and early ambulation [93].

CONCLUSIONS

Despite the frequency of Achilles tendon ruptures, the indication for operative or non-operative management remains controversial. In the past, conservative treatment was widely accepted but with the increasing functional demands resulting from a greater number of people playing sports, operative treatment must be considered. The problem with the non-operative management is the high re-rupture rate. Moreover, the return to previous sport was lower in the conservative group, although the patients treated with surgery more often present deep infections.

Operative treatment is indicated in patients who wish to resume their activity so the age of the patients is not a contraindication. It is important to consider the risk factors such as diabetes, tobacco and steroid use that increase the complications rate following surgical repair. Regarding to operative repair, there are a variety of techniques that can be divided into different groups: the open repair, the percutaneous repair and the mini-open repair.

Finally, despite the chosen treatment, the rehabilitation plays a fundamental role in the return to pre-injured level of sport and activity.

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