Orthopedic & Muscular System: Current Research

Hong and Tan, Orthop Muscul Syst 2014, 3:1
DOI: 10.4172/2161-0533.1000144

Review Article

Open Access

Ankle Arthritis: An Evolution from Arthrodesis to Joint and Mobility Preservation

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Abstract

Ankle arthritis is a debilitating condition. It can disrupt physical function and quality of life. Non surgical treatment includes pharmacological agents and orthoses. Surgical options range from arthrodesis to joint preservation techniques. Ankle arthrodesis is a reliable and effective treatment of choice for advanced ankle arthritis but has its limitations. Total ankle arthroplasty is fast gaining renewed interest as longer term outcome studies show good results coupled with improved implant and instrumentation designs. Osteotomies and arthroscopic debridement are increasingly popular techniques that are useful for joint preservation. Joint distraction arthroplasty and osteochondral allografting are also showing some promise. This article reviews the impact of ankle arthritis and treatment strategies available from joint sacrificing surgery to joint and mobility preservation.

Introduction

Ankle arthritis is a disabling chronic condition associated with pain, deformity and dysfunction although it is not as common as osteoarthritis (OA) of the knee joint. There were 8 to 9 times as many patients with a OA of the knee seen in clinical practice than OA of the ankle [1-2]. However, a recent study has shown that patients with advanced ankle arthritis have severe pain, reduced heath related quality of life and diminished physical function that are as severe as that in patients with advanced hip arthritis [3]. Posttraumatic OA of the ankle is the commonest cause representing 70% of all patients with ankle arthritis [4-6]. Saltzman et al. reported that the 3 commonest causes of ankle OA as a result of traumatic events were due to previous rotational ankle fractures (37%), recurrent ankle instability (14.6%) and history of a single sprain with continued pain (13.7%) [6]. Stufkens and colleagues also reported in a recent study that initial cartilage damage seen arthroscopically after an ankle fracture was an independent predictor of posttraumatic ankle OA. Specifically, lesions on the anterior and lateral aspect of the talus and on the medial malleolus correlated with poor clinical outcome [7]. Other causes of ankle arthritis include inflammatory and neuropathic arthropathies, osteonecrosis of the talus and tibia plafond, primary OA and infection.

Non-surgical management of arthritic ankle usually involves a host of pharmacological agents and orthoses. Non-steroidal anti inflammatory drugs (NSAID) are the commonest analgesic option with additional use of mild to strong opioids for severe pain control. Orthoses like ankle braces, custom-moulded ankle foot orthoses (AFO), footwear modifications and walking aids can help to offload weight, correct hindfoot deformities and limit motion of the ankle joint. Intra-articular injections using corticosteroids and hyaluronic acid may help in the short term for pain relief.

Nonetheless, when non-surgical methods fail, surgical options come in useful. Ankle arthrodesis is traditionally used for the treatment of ankle arthritis and has excellent results for pain relief and improving function. However, surgical treatment of advanced ankle arthritis has evolved to joint and mobility preservation in the recent years. In keeping with this trend, total ankle arthroplasty (TAA) and several other techniques had been reported to provide a viable alternative to joint fusion. In this review article, we will describe the use of ankle arthrodesis, TAA and other joint preserving techniques in the treatment of advanced ankle OA.

Ankle Arthrodesis

Arthrodesis has long been considered the gold standard in the treatment of advanced ankle arthritis. It provides predictable results and good pain relief. Fusion rates are reported to range between 60% to 100% in several studies and the results have continued to improve with new surgical techniques [8-13]. Arthrodesis is also a reliable salvage technique for failed total ankle arthroplasty (TAA) or other joint preserving techniques.

Ankle arthrodesis is possible using a variety of approaches from open, mini-open to arthroscopic techniques. Adjacent soft tissue compromise from open techniques has been greatly reduced using mini-open and arthroscopic techniques. Studies have also shown fusion rates for both open and arthroscopic techniques are similar but arthroscopic fusion was associated with a shorter hospital stay and less blood loss [14-16]. Myerson et al. reported that patients who underwent arthroscopic arthrodesis achieved fusion at a shorter time compared to those done using an open technique [15]. Townsend and colleagues reported in a recent multicenter study that both open and arthroscopic ankle arthrodesis resulted in significantly improved pain and function but arthroscopic arthrodesis was associated with shorter hospital stay and better functional scores at 1 and 2 years [16].

Proper alignment for ankle arthrodesis is vital to achieve successful outcome. The ideal position of the ankle should be neutral dorsiflexion, 5 degrees of valgus, rotation equal to the contralateral side or slightly more externally rotated by 5 to 10 degrees and the anterior aspect of talar dome must be aligned to the anterior aspect of the tibia [17]. This will produce a plantigrade foot post-ankle fusion. There are multiple choices of fixation ranging from crossed or parallel screws with or without a homerun screw, anterior and lateral plating. Several papers have also described techniques using 2 or 3 screws and single or double anterior plating with good results [18,19]. External fixation can also be

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Received October 31, 2013; **Accepted** January 28, 2014; **Published** February 07, 2014

Citation: Hong CC, Tan KJ (2014) Ankle Arthritis: An Evolution from Arthrodesis to Joint and Mobility Preservation. Orthop Muscul Syst 3: 144. doi: 10.4172/2161-0533.1000144

used and is especially useful in patients with hindfoot deformities and soft tissue compromise although it is commonly complicated by pin site complications [20,21].

Common complications of ankle arthrodesis are non-union, mal-union and adjacent joint arthritis especially at the Chopart and subtalar joint [12,15,22-25]. An overall non-union rate of 22.6% (range 0-41%) was reported by Wheeler et al. in his review of 30 publications [24]. Factors associated with non-union are smoking, older age, history of neuroarthropathy and previous open fracture [11,22,23]. A recent study using CT assessment revealed that osseous bridging of greater that 25% to 49% at the fusion site is necessary to consider a hindfoot or ankle fusion clinically successful [26]. Malalignment of the ankle during fixation often produces mal-union in varus or valgus with equinus. Following that, several types of osteotomies can be applied to correct such malunited ankle arthrodesis if required but primary alignment should be observed prior to internal fixation to best avoid this complication [25].

Although ankle arthrodesis produces good results, it does have its equal share of limitations such as gait abnormalities and adjacent joint arthritis [27-29]. Adjacent joint arthritis frequently occurs over time due to abnormal gait conferred by the fused ankle joint. This abnormal gait will result in uneven loading of adjacent joints such as the Chopart and subtalar joints [27-29]. Fuentes-Sanz et al. reported recently that the commonest adjacent joints that were more degenerated were the Chopart and the subtalar joint [29]. Patients should be counselled that they may require shoe modifications to assist in the gait cycle and possibility of future surgery especially in younger patients due to adjacent joint disease to manage patient expectations. This was highlighted by Ajis et al. in his recent study comparing patient outcomes and satisfaction after ankle arthrodesis versus tibiotalocalcaneal arthrodesis whereby ankle arthrodesis patients tend to have higher postoperative activity expectations and were less likely to meet them resulting in a poorer satisfaction rate [30].

In conclusion, ankle arthrodesis is a reliable and effective means of treatment for ankle arthritis but has its limitations. It has good fusion rate and satisfactory outcomes in terms of functional scores and pain relief with low complication rates especially with newer surgical techniques [Figure 1].

Total Ankle Arthroplasty

TAA was first used in the 1970s and subsequently approved by the FDA in the mid 1980s. Earlier experiences with initial implant designs were discouraging due to high failure rates requiring revision or fusion surgery [31-35]. First generation implants were constrained, had cemented components that required extensive bony resection for implant fixation and included an all-polyethylene tibial component [31,32,34,35]. These implants were susceptible to subsidence, loosening and osteolysis due to high torsion and shear forces at the bone-implant interface [31,32,34,35]. Following that, second generation implants were designed to address these issues. These employed lesser bony resection and avoided cemented components with stem or peg fixation to increase stability. They also had less constraint between the components to reduce risks of implant loosening. However, these second generation implants were not successful yet as they resulted in subluxation or dislocation of components, symptomatic impingement and increased polyethylene wear [31,34].

Subsequent review of previous implant failures and biomechanical studies on the ankle joint kinetics had shed some light on the development of new and improved implants. The new prostheses consist of two- or three components with either fixed or mobile bearings. A fixed bearing system refers to a two component system whereby the polyethylene is attached to the tibial component. A mobile bearing system, also known as meniscal-bearing system, refers to a three piece component where the polyethylene is interposed between the tibial and talar components. Both implants are semi-constrained and allow far more motion between the bearing surfaces and the talar component compared to previous generations. Newer designs utilize components with non-bearing surfaces that contain bony ingrowth potential for fixation stability. These third generation implants have improved the outcome of TAA.

TAA is usually indicated for patients with painful and advanced ankle arthritis that have failed nonoperative treatment. Patient selection is of utmost importance to ensure successful TAA. General consensus for selection criteria includes patients that are older, thinner and low demand with minimal or no lower tibial malalignment [31,32]. It is however contraindicated to perform TAA in patients with active infection, severe osteoporosis, extensive talar avascular necrosis, inadequate soft tissue envelope around the ankle joint, peripheral vascular disease and neuroarthropathy [31,32]. Common complications after TAA are aseptic implant loosening and subsidence, superficial or deep infection, gutter impingement and residual ankle pain [31-33]. These should be conveyed to the patients prior to surgery.

Multiple studies have been reported on the outcomes of TAA with various types of implants [33,36-38] There were extensive variations in the methodology, indications, implants used and outcome measures [33,36-38]. In view of significant differences in these studies, we would like to remind readers to take caution in interpreting the reported results. In 2007, Haddad et al. [13] reported a systematic review of TAA and ankle arthrodesis. They reported that meta-analytic mean results of 10 studies which evaluated TAA in 852 patients showed excellent outcome in 38% of the patients. The 5-year survival rate was 78% (95% CI: 69-87.6%) and the 10-year survival rate was 77% (95% CI: 63.3-90.8%). Revision rate following TAA was 7% (95% CI: 3.5-10.9%) with the most common reason being implant loosening and subsidence (28%).

In a recent study, Gougoulias et al. [33] performed a systematic review on 13 studies with 1105 TAAs with a minimum of 2 years follow up. Survivorship analysis data ranged from 67% at 6 years to 95.4% at 12 years. They reported 108 failure cases (9.8%; 95% CI: 3.1-16.5%) that required subsequent revision (62%), arthrodesis (36%), amputation (1%) and OC allograft (1%). They also reported that superficial wound complications including superficial infection, delayed healing, skin necrosis were found in 66 (8%) of 827 patients ranging from 0-14.7% in individual studies. Deep infections occurred in 7(0.8%) of 827 patients ranging from 0-4.6%. Nine studies were showed to report ankle range of motion (ROM) as an outcome measure and they found that the mean postoperative ROM was either equal to preoperative ranges or improved by 4-14 degrees. Residual pain in the hindfoot after TAA was reported in 7 studies ranging from 23% to 60%.

The preservation of ankle joint ROM after TAA should ideally prevent the development of adjacent joint arthritis. However, we note the paucity of literature on adjacent joint arthritis after TAA. Hence, there are still more room for research to be performed in this area.

In conclusion, we feel that TAA implants and instrumentation has significantly improved over the last few decades. Current third generation implants are more bone preserving and user-friendly. Results have been shown to be at least satisfactory in multiple studies.

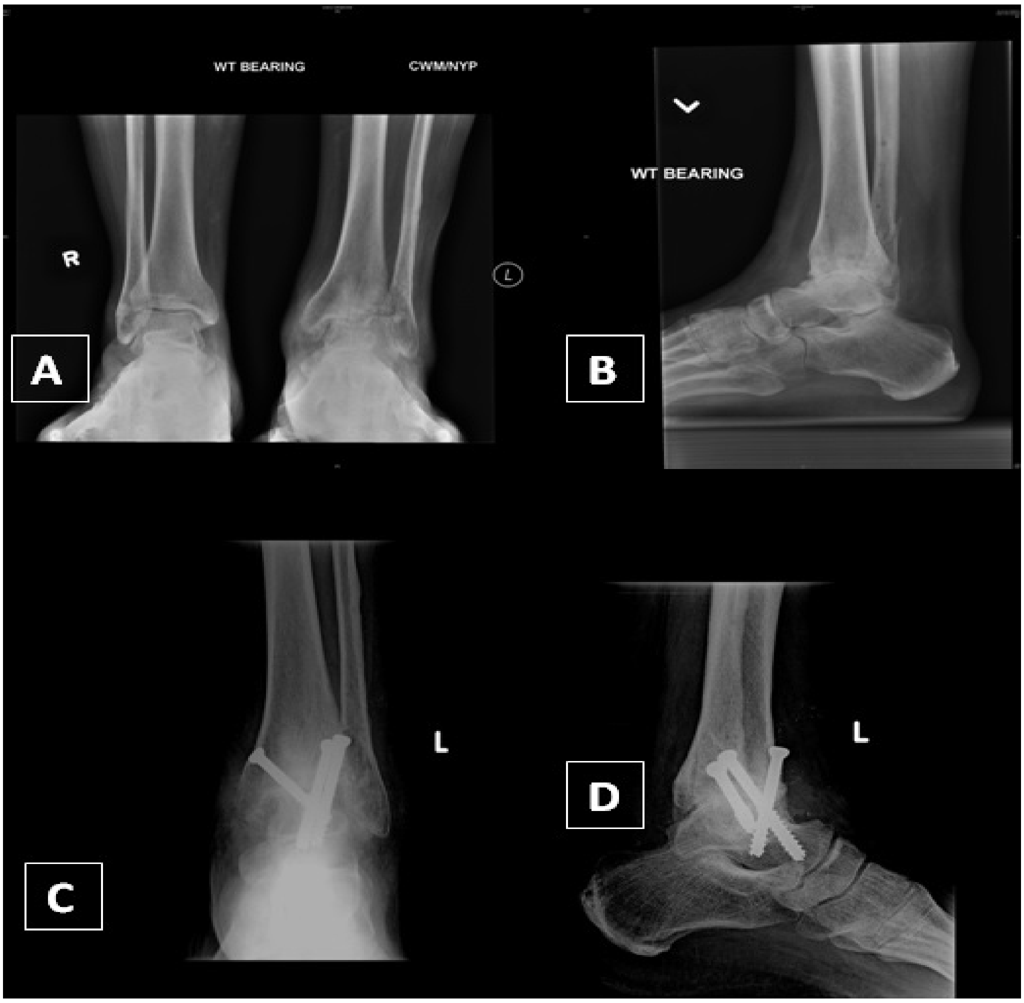

Figure 1: A and B show advanced ankle arthritis from a prior open ankle fracture in a 40 year old man. C and D show a successful ankle fusion at 3months post surgery using a mini-arthrotomy technique with 3 screw fixation.

TAA has a definite role in the management of ankle arthritis and allows preservation of mobility in the ankle joint [Figure 2].

Ankle Joint and Mobility Preservation Techniques

Arthroscopic ankle debridement

Arthroscopic ankle debridement for soft tissue or bony impingement, osteophyte excision and osteochondral (OC) lesions under 15 mm in diameter has been shown to be successful in relieving pain, improving function and patient satisfaction [39].

Several studies reporting on arthroscopic debridement of anterior soft tissue or bony impingement showed excellent improvement in pain and function at their final follow up [39-44]. van Dijk et al. compared results of arthroscopic debridement in 2 groups of patients post-ankle fracture. They found that the group with anterior soft tissue or bony impingement symptoms fared better after intervention compared to the group with diffuse ankle pain without impingement symptoms. This study concluded that ankle arthroscopic debridement is successful in treating patients with anterior impingement and minimal signs of arthritis while is not beneficial in treating patients with diffuse ankle pain with arthritis [42]. Baums and colleagues reported the results of arthroscopic debridement for anterior impingement in 2 groups comparing between soft tissue (12 patients) and bony (14 patients) anterior impingement. They found success of treatment without significant difference between both groups [43].

Hassouna et al. reported in a prospective study of 80 consecutive patients (80 ankles) that consisted of 55 (69%) patients with soft tissue impingement and 25 (31%) patients with arthritic changes. They found that none of the patients with impingement symptoms required further major surgery within 5 years of follow up while the 28% of the patients with arthritic changes required major ankle surgery. This study suggests that arthroscopic debridement for ankle arthritis may be less favourable [44].

In terms of OC lesions, Donnenwerth and colleagues recently reported in their systematic review on outcome of arthroscopic debridement and microfracture for OC lesions of the talar dome and found that good to excellent results can be consistently reached in greater than 80% of patients with arthroscopic debridement and microfracture [45]. On top of that, Glazebrook et al. demonstrated in their systematic review of evidence based indications for ankle arthroscopy that there is fair evidence to support the use of ankle arthroscopy for the treatment of anterior impingement and OC lesions. However, treatment of ankle

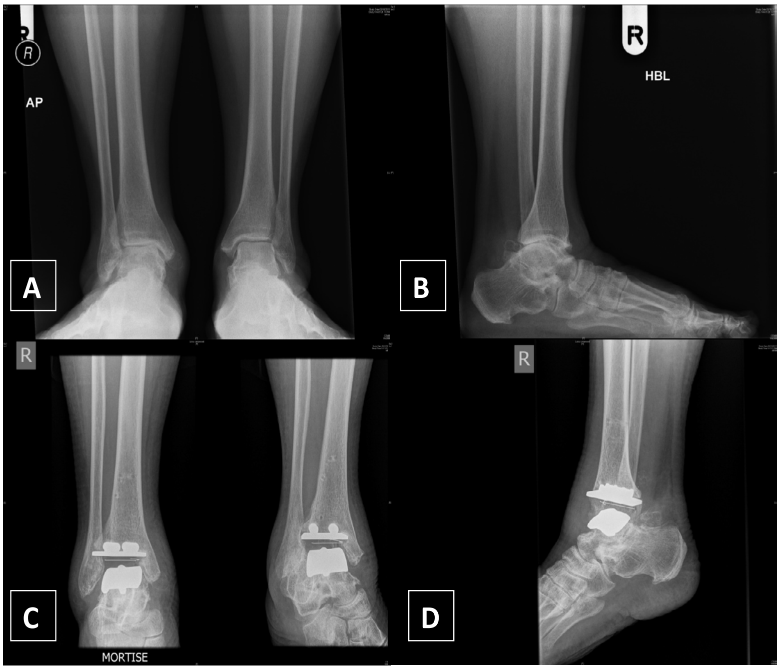

Figure 2: A and B show right ankle arthritis with a subtalar bony coalition in a 68 year-old lady. The bony subtalar coalition was confirmed on a CT scan and she had no subtalar motion. She is a slim and active lady who declined the option of ankle arthrodesis as she wants to continue wearing high heels for ballroom dancing. C and D shows total ankle arthroplasty performed using the Scandinavian Total Ankle Replacement (STAR) implant. She was ambulating independently at 6 weeks post-surgery with good range of motion.

arthritis with arthroscopy is not recommended due to lack of evidence [39]. We feel that the use of arthroscopic debridement for anterior impingement and osteophyte formation in patients with early signs of ankle arthritis may be beneficial in preventing progression of arthritic changes although those with advanced arthritic changes may have less benefit.

Realignment procedures

Surgical realignment procedures can help restore joint function and prevent further progression of asymmetric ankle arthritis [46-52]. It allows redistribution of the abnormal weight bearing axis on the ankle joint to unload the diseased joint area. Supramalleolar osteotomy (SMO) has been used to realign normal joint anatomy in event of distal tibial deformity for both primary as well as posttraumatic ankle arthritis with good results [46-52]. SMO has been shown in several studies to correct existing ankle joint malalignment, provide good pain relief, improve functional scores and halt progression of arthritic changes [46-52]. In 2003, Stamatis et al. reported the use of SMO to correct distal tibial malalignment of at least 10 degrees with or without radiographic evidence of arthritic changes in 13 ankles. All ankles reported significant improvement in AOFAS and Takakura scores [48]. Tanaka and colleagues reported in 2006 the use of distal tibia valgus osteotomy for 26 ankles with primary arthritis of the ankle secondary to varus deformity with an average follow up of 8 years. They concluded that SMO provided excellent outcomes in terms of improvement in clinical scores for pain, walking and activities of daily living via correction of distal tibia varus deformity. They also showed that SMO is indicated in varus type ankle arthritis of Takakura ankle grade 2 or 3a as it allowed significant restoration of the joint space and improvement to grade 1 ankle [49].

In 2011, Lee et al. reported the use of SMO in 16 ankles with primary moderate medial ankle arthritis with an average follow up of 2 years. They showed significant improvement in AOFAS and Takakura scores especially in those with lower postoperative talar tilt (<4 degrees). All ankles showed improvement in Takakura grading of at least 1 stage and that preoperative talar tilt of 7.3 degrees was the optimal threshold predictive of high postoperative talar tilt [50].

In a recent study, Schmid et al. reported the effect of SMO and lateralizing calcaneal osteotomy (LCO) in a fixed cadaveric cavovarus foot deformity on the lateralization of the center of force and reduction of peak pressure in the ankle joint. They found that SMO and LCO both significantly reduced the anteromedial ankle joint contact stresses with equivalent unloading effect in a cavovarus foot model. Hence, they concluded that in patients with fixed cavovarus foot, both SMO and LCO provided good redistribution of elevated ankle joint contact forces and the site of osteotomy could therefore be chosen on the basis of surgeon's preference, simplicity or local factors [51]. In keeping with this, Labib et al. in their recent review article also reported that based on the limited level IV studies, a grade I treatment recommendation can be made for performing SMO as treatment for mild to moderate ankle arthritis associated with lower tibial malalignment [52].

Osteotomies above or below the ankle joint have been demonstrated to be a very useful joint preserving technique in asymmetric ankle arthritis associated with deformity.

Ankle joint distraction arthroplasty

Joint distraction arthroplasty for ankle arthritis had been shown to produce good pain relief and functional scores [53-58] This process also known as arthrodiastasis has been proposed for use in joint preserving techniques in ankle joint as studies suggest that the mechanical distraction and unloading of the ankle joint allows for pressure relief and intermittent flow of intra-articular synovial fluid to allow articular cartilage self repair [53]. An external fixator is required to maintain distraction and unloading of the joint. It is typically over 2 to 3 months and patients are allowed to weight bear as tolerated. The distraction can be done with or without articulation at the ankle joint. Paley et al. reported that 78% of 32 patients in their study had maintained their ankle range of motion and had no pain to occasional moderate pain that could be managed generally by nonsteroidal anti-inflammatory drugs alone. One of their patients required ankle fusion and another had undergone ankle replacement [56]. In addition, Amendola and colleagues presented their findings of a prospective randomized trial on motion versus fixed distraction arthroplasty for ankle arthritis with a 104 month follow up. They reported both methods provided good improvement in symptoms but the motion group had higher improvement in the Ankle Osteoarthritis Scale compared to the static distraction group [57].

Tellisi et al. retrospectively reviewed 25 patients who had distraction arthroplasty performed for ankle arthritis and reported significant improvement in pain for 91% of their patients. Their average AOFAS score also improved significantly after the procedure. Only two patients required ankle fusion following distraction [58]. However, this cohort of patients had adjunctive procedures performed together with the distraction arthroplasty such as ankle arthrotomy, Achilles tendon lengthening, ankle arthroscopy and osteotomies to correct distal tibia deformity which can confound the outcome of the distraction arthroplasty alone. In a recent review article, Labib et al. reported that 6 level IV studies have shown beneficial short-term and intermediate-term good results in patients undergoing isolated ankle distraction for treatment of ankle arthritis but some of the studies included combined adjunctive procedures. Therefore, it not possible to filter the potential benefits of joint distraction from the adjunctive procedures. Furthermore, based on relatively small number of studies and with level IV evidence only looking at isolated ankle distraction, they were unable to recommend for or against the use of ankle distraction arthroplasty for treating ankle arthritis [52]. We feel that the evidence for the use of distraction arthroplasty is limited and do not recommend it as a routine procedure for ankle OA.

Allograft ankle arthroplasty

Allograft ankle arthroplasty is also known by many other names; OC ankle arthroplasty, allograft resurfacing and total ankle shell allograft reconstruction. It involves replacing all or part of the arthritic ankle joint with a cadaveric OC allograft. This is a technically demanding procedure that requires an anatomically matching allograft in terms of side and size to host bone [59-63]. It is usually indicated for young active patients that are not suitable for total ankle arthroplasty.

Kim et al. published the first report on OC allograft ankle arthroplasty in 2002 in 7 patients. There were improved functional scores, health related outcomes and satisfaction level in all patients. They suggest that resurfacing of the arthritic ankle joint with fresh OC shell allograft provided an excellent biological alternative to fusion surgery and total ankle arthroplasty based on 2 principles; 1) fresh cartilage contains viable chondrocytes that can survive transplantation and support intact cartilage matrix and 2) transplanted bone is incorporated and replaced by host bone through creeping substitution. They analysed the failed cases and attributed that poor graft fixation and fit was the cause of failure and the use of total ankle arthroplasty cutting jigs may improve precision and fit. Although their series had 3 (42%) patients with failure and subsequent conversion to arthrodesis, it provided evidence that the use of OC allograft for advanced ankle arthritis is a viable option [60].

In 2005, Meehan et al. reported in their study of 11 patients of which 9 underwent bipolar OC allografting while 2 had unipolar allograft with an average follow up of 33 months that the pain, gait, walking surface and AOFAS scores improved significantly. These patients had their graft cut and fitted using the Agility (Depuy, Warsaw IN) ankle arthroplasty jigs. Of the 5 (45.5%) patients with failure, 3 of them had repeat allografting with success, 1 was revised to total ankle arthroplasty while the other has had no further surgery. They concluded that poor results occurred in ankles with mismatch of size and graft thickness (<7mm) [61].

Jeng and colleagues published their results of fresh OC allografting using the Agility arthroplasty jigs in 29 patients with a mean follow up of 2 years in 2008. They reported only 31% success rate. Fourteen (48%) out of 29 patients had failed allografting. Of the 14 failure cases, 5 required repeat allografting, 5 had ankle arthrodesis with interpositional femoral head allograft, 3 underwent total ankle arthroplasty and the last patient developed deep infection which eventually resolved following successful fusion with external fixator after removal of allograft and repeated debridements. They concluded that this procedure had high failure rate and factors like younger age, higher body mass index and preoperative angular deformity are predictive of failure. They also suggested that this procedure be considered only in patients who are too young for ankle replacement, have excellent range of motion, low body mass index, normal alignment and who refuse arthrodesis [62].

In the most recent study on OC allografting and perhaps the largest series with the best results to date, Giannini et al. reported in 2010 on their cohort of 32 patients with bipolar fresh OC allografting for severe posttraumatic ankle arthritis using a lateral transfibular approach and a custom made jig. The average follow up was 31 months. They reported 26 (81%) patients with fair to excellent results. There were 6 failure cases of which 4 cases underwent ankle fusion, 1 case had arthroscopic ankle debridement, removal of detached cartilage and osteophytes and the last case had ankle fusion after resolution of infection by antibiotic therapy. The authors concluded that precise allograft sizing, correct fitting, stable fixation and delayed weight bearing are the key factors to a successful outcome [63].

We feel that OC allografting is currently still experimental and due to resource limitation is not ready to be a routine procedure for ankle arthritis.

Conclusion

Advanced ankle OA is debilitating. Traditionally, ankle arthrodesis has been the gold standard for treatment of advanced ankle OA. However, the treatment modalities for ankle arthritis are progressively evolving toward joint and mobility preservation. TAA has been shown to improve functional scores, quality of life and provide pain relief with relatively low to moderate failure rates. Osteotomies are good options in the treatment of asymmetric ankle arthritis particularly when there is associated deformity. As for joint distraction arthroplasty and OC allografting, time will tell if they become accepted as a routine option.

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