Total Ankle Joint Replacement as an Alternative to Ankle Joint Arthrodesis

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Background

Ankle joint arthrodesis was first described in 1878 for treatment of the severely arthritic ankle joint (1). Since that time, over 30 procedures have been described for the fusion of the ankle joint (2). Variations in the procedure include the amount and location of bone resection, the use of bone graft, and the use of various internal and external fixation techniques. In 1923, Steindler reported his results of pantalar fusion (3). In 1943, Blair reported his results of the "Blair" fusion for AVN of the talus (4). In 1948, Adams recommended a transfibular approach to ankle joint fusion (5). Charnley described his compression arthrodesis of the ankle in 1959 (6). Many of these procedures or variations of these procedures are still used today. Over the last 100+ years, arthrodesis has been the treatment of choice for severe ankle joint arthritis. While arthrodesis has been shown to reduce pain and restore ambulation, there are many complicating factors to this technique. A variable fusion rate has been well documented in the ankle joint (7,8). Post-operatively, an extended period of immobilization is necessary to allow fusion to take place. Functional deficits and compensatory joint changes are also inherent to this procedure (9).

Total Ankle Joint Replacement

In the early 1970's many authors developed and reported on their results of total ankle joint replacement (10-19). The purpose of ankle joint replacement was to preserve ankle joint function and stability, as well as preserving surrounding joints. There are three main distinctions of the ankle joint endoprostheses: unconstrained or multi-axis design, constrained or single axis design, and semi-constrained design. This refers to the planes of motion allowed by the implant. The first unconstrained implants includes those described by Smith, Waugh, and Newton (10-12). Early constrained implants include the St. George-Buchholz, New Jersey, Oregon, ICLH (Imperial College, London Hospital), Mayo, TPR (Thomson-Parkridge-Richards) and Conaxial (Beck-Steffee) implants (13-19). Many of the early ankle implants were cemented in place using polymethylmethacrylate. Component loosening has been reported as one of the most common complications in many of the early ankle endoprosthetic designs (20). In response to implant loosening, many designs have changed to a bead coating rather than using cement. The New Jersey low contact stress total ankle replacement was designed with a metallic, sintered bead porous coating on both implant surfaces in 1981 and later modified to the Buechel-Pappas Ultra total ankle replacement (13). In 1987, Scholz described the Scholz-PCA ankle implant, which is a semi-constrained ankle replacement with a porous beaded surface on both the tibial and talar components (16). In 1990, Takakura, et al. reported on results of 30 cemented metal vs. 30 uncemented ceramic prostheses and concluded that patients undergoing ankle arthroplasty without osteoporosis should be implanted without cement (21) . In 1988, McGuire et al. compared 23 patients with ankle joint arthroplasty and 18 patients with ankle joint arthrodesis. After an average of 3.8 years, 70% of arthroplasty patients had good or excellent results, and after 3.3 years, 94% of arthrodesis patients had excellent or good results (22). Many procedures have also been described for arthrodesis of failed ankle joint implant arthroplasty (23).

Agility Ankle Implant

In 1991, Frank Alvine described what is now referred to as the "Agility" ankle implant (24). This is a semi-constrained, non cemented implant, with a titanium tibial component, a cobalt-chromium talar component, and a polyethylene liner which is seated within the tibial component. Modifications were made for the insertion of this new implant, including a more anatomical valgus position, fusion of the tibiofibular syndesmosis to broaden the bony base for the tibial component, the use of a cutting jig to avoid malpositioning, and the use of distraction of the ankle to bring the ankle back to its original length, minimize bone removal, and rigidly hold the joint implant in position. In 1998, Pyevich et al. reported on results of 100 Agility ankle replacements in 95 patients (25). At the time of reporting, 83 patients (86 ankles) were alive, and 1 implant had been removed and went on to arthrodesis. Five ankles had been revised after the initial surgery. Of the remaining 85 ankles, at an average of 4.8 years follow-up, 47 ankles were not painful, and 24 ankles were mildly painful. Range of motion averaged 36 degrees and 93 percent of the ankles were satisfactory to the patients.

Indications

Patients who have shown to have the best results are those with rheumatoid arthritis or elderly patients with a reduced activity level, although the implant has shown success in young patients suffering from post-traumatic arthritis as well. In Alvines's 1991 article, patients aged 38 to 76 years with an average of 54.4 years were included. In

Pyevich's 1998 article, patients aged 27 to 81 years were included, with an average age of 63 years.

Procedure

The procedure for insertion of the implant begins with distraction of the ankle joint. An Orthofix external fixator is applied by inserting pins into the talus, calcaneus, and two pins in the tibia (Fig.1). A distractor is then attached to the fixator, and the joint is distracted 1cm. A thigh tourniquet is then inflated to 350mm Hg. The anterior incision is placed between the Tibialis Anterior tendon and the Extensor Hallucis Longus tendon at the anterior aspect of the ankle joint (Fig 2). A lateral incision is made over the fibula for fusion of the syndesmosis. The alignment jig is then placed over the anterior aspect of the ankle joint, and the C-arm is used to check placement and in order to choose the correct size jig (Fig. 3). Three pins are used to secure the alignment jig in place, and the sagittal saw is used to make the cuts outlined on the jig (Fig.4). After removal of the alignment jig, a separate jig for the slot on the dorsum of the talus is aligned parallel to the second metatarsal shaft, and a reciprocating saw is used to make the cut in the talus. Any excessive bony proliferation around the ankle joint is resected at this time. A trial implant is then used to confirm the fit of the implant, and the actual implant is then inserted. Through the lateral incision, the tibiofibular syndesmosis is identified, packed with autogenous bone graft from the original cuts, and fixated using two 4.5mm titanium cancellous screws (Fig. 5-7). The external fixator is then removed, and motion is evaluated. If an equinus is present, a tendo-achilles legthening is performed at this time. All incisions are closed with absorbable deep closure and non-absorbable skin closure.

The tourniquet is deflated, and a dressing and posterior mold is applied. The patient is seen in the office after the first week, and fitted with a removable cast. The patient continues to use crutches for the first 6 weeks, while performing range of motion and strengthening exercises for the ankle four times a day. After 6-8 weeks, the patient is allowed to bear weight with the use of the removable cast, while continuing physical therapy. After 10-12 weeks, the patient is returned to a shoe.

Case Report

Patient #2 presented to the office after a pilon fracture of the left ankle in 1993, which was treated by surgical open reduction with internal fixation. The patient complained of a painful, stiff ankle joint following the fracture. He was treated conservatively with orthotics, AFO bracing, and multiple ankle joint injections with cortisone. The patient's pain and deformity were progressive, and the patient's ankle joint was left in a state of equinus with a negative amount of dorsiflexion present. He exhibited muscle wasting of the left calf due to his inability to ambulate on the left ankle. He also related inability to perform his job due to the manual labor required, and had changed to a sitting job. X-ray examination showed severe ankle joint narrowing, joint position changes, subchondral sclerosis, osteophytic lipping around the ankle, and fusion of the tibiofibular syndesmosis due to the previous fracture. At this point, ankle arthrodesis or ankle joint replacement were presented to the patient. It was recommended that the patient undergo total joint replacement. Implantation of the Agility ankle joint replacement was performed. The patient was splinted for 3 weeks following surgery, and then physical therapy was begun. The patient returned to work 2.5 months following surgery, and he has returned to his job that includes manual labor with minimal disability. At eight months post-operatively, he had 10 degrees of dorsiflexion present in the ankle with muscle strength approximately equal to the contralateral limb, and no limp was present.

Results

The author has implanted the agility ankle in 8 patients, aged 23 to 73, with a mean of 51 years (Table 1). The etiology of the patients' degenerative joint disease was post-traumatic in five of the eight patients, psoriatic arthritis in one patient, osteoarthritis in one patient, and one patient had previously undergone ankle fusion for osteoarthritis which had failed. Follow-up time ranged from 1.5 months to 13.5 months, with an average of 5.7 months. Pre-operative and post-operative pain was rated on a scale of 0-10, where 0 is no pain, 1-3 are mild pain, 4-7 are moderate pain, and 8-10 are severe pain. Pre-operative pain ranged from 5/10 to 9/10, and averaged 8/10. Post-operative pain ranged from 0/10 to 3/10, and averaged 1.5/10. Range of motion was measured pre- and post-operatively as well. Pre-operative dorsiflexion ranged from –8 to 4 degrees, with an average of –1 degrees. Pre-operative plantarflexion ranged from 0 to 20 degrees, with an average of 8 degrees. Post-operative dorsiflexion ranged from 0 to 10 degrees, with an average of 7.8 degrees. Post-operative plantarflexion ranged from 10 to 30 degrees, with an average of 20.6 degrees. Several complications occurred, most of which were visualized on x-ray and did not affect the outcome of the ankle implant thus far. Patient #1 had a lateral malleolus fracture immediately after surgery. This patient also developed some exogenous bone growth around the implant, which was removed surgically. Patient

#3 had a medial malleolar fracture which was asymtomatic and healed uneventfully. Patient #4 had a superficial wound dehiscence, a medial malleolar fracture, and slight opening of the tibio-fibular syndesmosis. The wound dehiscence healed completely and the medial malleolar fractue and diastasis were asymptomatic to the patient and have not affected the outcome. Patient # 6 developed a lack of dorsiflexion with a rigid end range of motion, however no bony block was visualized on x-ray. Patient # 7 was non-compliant post-operatively and did not return for his scheduled post-operative visits. This patient developed a varus rotation of the talar component as well as a medial malleolar fracture.

Discussion

These results show a significant decrease in the pain rating, as well as a significant increase in range of motion of the implanted ankle endoprosthetics as compared with the patients' own joints. While the procedure is slightly more complicated than fusion, the results seem to validate the cost and work involved in total joint replacement. In addition, in the case of failure of the implant, the joint can be subsequently fused if necessary. It has yet to be seen how the Agility ankle will perform with long-term follow-up in comparison to ankle arthrodesis, however at the early follow-up stages, it appears to out perform arthrodesis in terms of patient function.

Conclusions

The early results of the use of the Agility Ankle presented in the literature and seen clinically are encouraging. This procedure is presented as a viable alternative to ankle joint fusion with the added benefits of preserving ankle joint function and preserving the integrity of surrounding joints.

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Figure Legends

Figure 1
Placement of the external fixator, used for distraction of the ankle joint

Figure 2
Marking of anatomical structures for placement of the anterior and lateral incisions

Figure 3
Alignment jig being positioned into place

Figure 4
Sagittal saw making cuts for placement of the tibial component

Figure 5
Lateral incision for fusion of the tibio-fibular syndesmosis

Figure 6A & 6B
Pre-op X-rays showing severe ankle joint degeneration and arthrosis

Figure 7A & 7B
Post-op X-rays showing position of Agility ankle joint.