The bright future for total ankle replacements

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Abstract Total ankle arthroplasty is an evolving method of treatment for end-stage ankle arthritis. Although historic interest did not yield favorable results, new generation total ankle implants have demonstrated comparable results with fusion with short- and intermediate-term follow-up. Comparable outcomes, in the setting of improving surgical technique and implant options, will yield increasingly superior results.

Keywords Total ankle arthroplasty · Ankle fusion · Arthritis · Deformity

A talar dome resurfacing, performed in 1962, is one of the earliest reports of arthroplasty for ankle arthritis [1]. Shortly thereafter, designs included “ball-and-socket” prostheses with variable levels of constraint and cemented polyethylene or metal components. Since that time there have been significant improvements in technique and implants that led to refined and expanding surgical indications. While mainstream interest in total ankle arthroplasty has at best been sporadic over the years, recent advances and outcome data support total ankle arthroplasty as a permanent player in ankle arthritis treatment.

There are a number of modern implants (“third” or “fourth generation”) now available in the United States that offer great promise. Most prostheses are implanted without cement and each offers unique design features. The STAR (Small Bone Innovations, Inc., Morrisville, PA), FDA approved in 2009, is the only implant in the United States with a mobile bearing design (ie, the polyethylene is not fixed to the tibial component). Proponents of the system argue this added freedom more accurately replicates the complex tibiotalar motion. The Salto Talaris (Tomier, Inc., Bloomington, MN)

is the fixed-bearing American version of the original Salto, a mobile bearing implant developed in France. The surgical technique results in minimal bone resection and the tibial keel is drilled in a coupled position with the talar implant to optimize the gliding fit between the 2 components. The INBONE (Wright Medical Group, Inc., Arlington, TN) provides a unique modular design with an advanced alignment jig and intramedullary stem. Some proponents of the INBONE advocate its use for complex deformity and revision work. The Prophecy option allows surgeons to use custom cutting guides derived from preoperative CT. The Zimmer Trabecular Metal Total Ankle (Zimmer Holdings, Inc., Warsaw, IN) is the only device that utilizes a unique trans-fibular osteotomy as opposed to the standard anterior approach. The resulting extensive lateral coverage may minimize wound complications and thus joint infections [2], a challenging postoperative complication. An alignment jig dictates accurate burring of subchondral bone to minimize bone loss and create an inherently stable surface for bony ingrowth. In all, there are a number of exciting implant options that are expanding our indications to perform TAA.

Success after TAA, however, depends heavily on surgeon experience [3–7] and it is difficult to gain expertise in each of the growing number of prostheses. Many of the best outcomes are reported by surgeons involved at least in the initial design of the implants under study. Thus, familiarity with the system and surgical volume are potentially more critical to patient outcome than implant selection.

Ankle arthrodesis has traditionally served as the gold standard for debilitating ankle arthritis. However, difficulty with ambulation on uneven ground, inclines, and driving [8, 9], as well as adjacent end stage joint arthrosis requiring fusion [10–12] have driven many towards TAA. Few high quality studies have compared fusion to TAA. A systematic review of the literature demonstrated similar intermediate outcomes when comparing fusion with arthroplasty [13], and cited the need for future comparative studies. A landmark prospective

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controlled comparative surgical trial demonstrated the STAR was not inferior to ankle fusion [14]. A statistically significant improvement in outcome scores was observed in the arthroplasty group compared with fusion. However, rates of major complications and common adverse events were likewise worse in the experimental group. The improved function, despite worse complications, resulted in equivalent patient reported satisfaction at 2 years.

Despite the excitement of improved implants, it must be noted that clinical outcomes published to date continue to be mixed and fraught with limitations. A systematic review of 13 level IV studies found a large variation in all outcomes [15]. Survivorship data ranged from 67 % at 6 years to 94 % at 12 years. Wound infections and deep infections occurred at 8 % and 0.8 %, respectively. A recent study examining a single surgeon's experience with 3 separate implant systems demonstrated no significant improvement in range of motion [16], a finding highly controversial amongst experienced arthroplasty surgeons. Clearly, further work needs to be done at centers across the United States.

As techniques and surgeon experience improve, however, relative indications are expanding. Historically, surgeons have treated coronal deformity as a relative contraindication [17]. However, recent high quality data suggests comparable outcomes in patients with preoperative moderate to severe coronal deformity when compared with patients with neutral alignment [18]. Techniques to balance the ankle with soft tissue releases, ligament repair, osteotomy, and tendon transfers continue to evolve. Absolute contra-indications are now fewer, but still include active infection, talar necrosis, and Charcot arthropathy.

Despite technical advances and increasing surgeon experience, the decision to treat with total ankle arthroplasty must be considered on a case by case basis. To define the ideal candidate it is necessary to understand the common modes of failure. Talus bone stock [19] and coronal deformity [17, 18] remain challenges. Patients with degenerative arthritis secondary to recurrent ankle instability, and therefore larger coronal plane deformity [18], continue to be more troubling cases. Therefore, healthy, lower demand patients with maintained alignment, persevered range of motion, and adequate bone stock are ideal for treatment with TAA. Despite this, it is essential that all patients understand the severity of a failed TAA and the challenges associated with salvage fusion.

Ankle arthritis is a debilitating condition with outcome scores comparable with CAD, hemodialysis and hip arthritis [20]. Historically treated with ankle fusion, these patients are now treated with ankle arthroplasty at increasing rates. As implant design and surgeon experience continue to improve, we anticipate long term outcomes superior to fusion for appropriately selected patient populations. In addition, as necessary criteria for successful outcomes become more apparent, we will expand our indications just as we have seen recent success with instability induced arthritis. Total ankle

arthroplasty offers an important alternative to fusion, such that when used in the appropriate patient, can provide important long lasting preservation of function with significant pain relief. Our patients having undergone TAA, at least in the relative short term, are some of the happiest we know.

Compliance with Ethics Guidelines

Conflict of Interest Stephen Greenfield and Scott Ellis declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

References

1. Muir DC, Amendola A, Saltzman CL. Forty-year outcome of ankle "cup" arthroplasty for post-traumatic arthritis. *Iowa Orthop J*. 2002;22:99–102.
2. Kessler B, Sendi P, Graber P, et al. Risk factors for periprosthetic ankle joint infection: a case-control study. *J Bone Joint Surg Am*. 2012;94:1871–6.
3. Myerson MS, Mroczek K. Perioperative complications of total ankle arthroplasty. *Foot Ankle Int*. 2003;24:17–21.
4. Saltzman CL, Amendola A, Anderson R, et al. Surgeon training and complications in total ankle arthroplasty. *Foot Ankle Int*. 2003;24:514–8.
5. Lee KB, Cho SG, Hur CI, Yoon TR. Perioperative complications of HINTEGRA total ankle replacement: our initial 50 cases. *Foot Ankle Int*. 2008;29:978–84.
6. Lee KT, Lee YK, Young KW, et al. Perioperative complications of the MOBILITY total ankle system: comparison with the HINTEGRA total ankle system. *J Orthop Sci*. 2010;15:317–22.
7. Reuver JM, Dayerizadeh N, Burger B, Elmans L, Hoelen M, Tulp N. Total ankle replacement outcome in low volume centers: short-term follow-up. *Foot Ankle Int*. 2010;31:1064–8.
8. Muir DC, Amendola A, Saltzman CL. Long-term outcome of ankle arthrodesis. *Foot Ankle Clin*. 2002;7:703–8.
9. Mazur JM, Schwartz E, Simon SR. Ankle arthrodesis. Long-term follow-up with gait analysis. *J Bone Joint Surg Am*. 1979;61:964–75.
10. Coester LM, Saltzman CL, Leupold J, Pontarelli W. Long-term results following ankle arthrodesis for post-traumatic arthritis. *J Bone Joint Surg Am*. 2001;83-A:219–28.
11. Fuchs S, Sandmann C, Skwara A, Chylarecki C. Quality of life 20 years after arthrodesis of the ankle. A study of adjacent joints. *J Bone Joint Surg Br*. 2003;85:994–8.
12. Jackson A, Glasgow M. Tarsal hypermobility after ankle fusion—fact or fiction? *J Bone Joint Surg Br*. 1979;61-B:470–3.
13. Haddad SL, Coetzee JC, Estok R, Fahrback K, Banel D, Nalysnyk L. Intermediate and long-term outcomes of total ankle arthroplasty and ankle arthrodesis. A systematic review of the literature. *J Bone Joint Surg Am*. 2007;89:1899–905.
14. Saltzman CL, Mann RA, Ahrens JE, et al. Prospective controlled trial of STAR total ankle replacement vs ankle fusion: initial results. *Foot Ankle Int*. 2009;30:579–96.
15. Gougoulas N, Khanna A, Maffulli N. How successful are current ankle replacements?: a systematic review of the literature. *Clin Orthop Relat Res*. 2010;468:199–208.
16. Ajis A, Henriquez H, Myerson M. Postoperative range of motion trends following total ankle arthroplasty. *Foot Ankle Int*. 2013;34:645–56.

17. Haskell A, Mann RA. Ankle arthroplasty with preoperative coronal plane deformity: short-term results. *Clin Orthop Relat Res*. 2004;424: 98–103.
18. Trajkovski T, Pinsker E, Cadden A, Daniels T. Outcomes of ankle arthroplasty with preoperative coronal-plane varus deformity of 10 degrees or greater. *J Bone Joint Surg Am*. 2013;95:1382–8.
19. Berkowitz MJ, Sanders RW, Walling AK. Salvage arthrodesis after failed ankle replacement: surgical decision making. *Foot Ankle Clin*. 2012;17:725–40.
20. Glazebrook M, Daniels T, Younger A, et al. Comparison of health-related quality of life between patients with end-stage ankle and hip arthrosis. *J Bone Joint Surg Am*. 2008;90:499–505.