The Journal of Arthroplasty 29 (2014) 122–126

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Treatment of Large Bone Defects With Trabecular Metal Cones in Revision Total Knee Arthroplasty
Short Term Clinical and Radiographic Outcomes

Pascale Derome, MD [a], Amir Sternheim, MD [b], David Backstein, MD, FRCSC [b], Michel Malo, MD, FRCSC [a]

[a] Department of Orthopedic Surgery, Hôpital du Sacré-Coeur, Université de Montréal, Montréal, QC, Canada H4J 1C5
[b] Department or Orthopedic Surgery, Mount Sinai Hospital, University of Toronto, Toronto, ON, Canada M5G 1X5

ARTICLE INFO

Article history:
Received 27 January 2013
Accepted 17 April 2013

Keywords:
trabecular metal cone
revision total knee arthroplasty
bone deficit

ABSTRACT

The early term results of 29 cases of revision total knee arthroplasty using highly porous trabecular metal cone implants for femoral and tibial major bone deficit reconstruction (Anderson Orthopedic Research Institute classification type 2B and 3) have been prospectively analyzed. Indications for revision surgery included: aseptic loosening/wear, staged reimplantation after infection, as well as periprosthetic fracture. At an average follow-up of 33 months (range, 13–73 months) the mean Knee Society Score and functional score statistically improved. Radiological follow-up revealed no evidence of loosening or migration of the constructs. No evidence of complications was noted in correlation with the use of trabecular metal cones. This study supports evidence that trabecular metal cones are an efficient and effective option for dealing with significant bone deficits and obtaining stable biological fixation in revision total knee arthroplasty.

As the number of knee replacement surgeries increase, the demand for revision total knee arthroplasty (TKA) is expected to grow significantly in the coming years [1]. Revision TKA surgery possesses numerous challenges, including the management of bone defects, which is a critical step in the achievement of a stable construct and successful results. The AORI (Anderson Orthopaedic Research Institute) classification of bone defects [2] is a useful system to guide orthopedic surgeons through the different treatment strategies (Table 1). AORI type I minor bone deficits are commonly managed using cement or morselized allograft. Metal augments may be required to correct larger deficits (AORI type IIA) [3]. Major bone defects of the femoral and/or tibia (AORI type IIB/III) have been reconstructed using impaction grafting [4–7], structural allografts [8–13] or tumor prosthesis [14]. The major concerns with structural allograft are graft resorption, mechanical failure, availability, disease transmission, considerable surgical skill required and prolonged operative time. Porous tantalum metaphyseal cones are an exciting alternative treatment method.

Tantalum has unique characteristics including high porosity, which make it particularly well suited for bone ingrowth. Its mechanical properties include a high friction coefficient, high porosity and stiffness similar to that of trabecular bone which enable an improved interface with bone in order to achieve biological fixation [15–17]. While no consensus has been established on the method of choice to correct large bone defects, some recent studies [18–21] suggest promising results with the use of these porous tantalum cones.

The purpose of this study was to assess the early-term results of porous tantalum metaphyseal cones for the reconstruction of major bone deficit in TKA revision surgery.

Materials and Methods

Thirty-one patients underwent revision total knee arthroplasty at two academic referral centres, using porous tantalum cones (Trabecular Metal; Zimmer, Warsaw, Indiana) for femoral and/or tibial bone defects, between June 2006 and October 2011. All surgical procedures were performed by the two senior authors (M.M. and D.B.). The study protocol was approved by the institutional review board of both institutions. This retrospective study is based on our prospectively collected databases. Patients were excluded from this study if they did not meet the twelve months minimal follow-up period. Two patients died of unrelated causes prior to the minimum twelve months follow-up duration and were therefore excluded. Consequently, twenty-nine patients formed our study group. Twelve patients had a femoral cone implanted, thirteen had a tibial cone and four patients had both. The mean clinical and radiologic follow-up was 33 months (range, 13–73 months).

The primary outcome of interest was defined as reoperation surgery for any cause and functional outcome. Secondary outcomes were defined as radiographic findings indicative of loosening.

The Conflict of Interest statement associated with this article can be found at http://dx.doi.org/10.1016/j.arth.2013.04.033.

Reprint requests: Michel Malo, MD, FRCSC, Department of Orthopedic Surgery, Hôpital du Sacré-Coeur, 5400, boul. Gouin Ouest, Montréal, QC, Canada H4J 1C5.

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http://dx.doi.org/10.1016/j.arth.2013.04.033

Table 1
Anderson Orthopedic Research Institute Classification of Bone Defects.

Type	Definition
Type I	Minor femoral or tibial defects with intact metaphyseal bone
Type II	Damaged metaphyseal bone
IIa	Bone defects limited to one femoral or tibial condyle
IIb	Bone defects affecting both femoral or tibial condyles
Type III	Deficient metaphyseal segment that compromises a major portion of either femoral condyles or tibial plateau

Demographic data, preoperative and postoperative function, indication for surgery, type of implant, and complications were recorded from the patient chart and database. The study group was composed of 19 men and 10 women with a mean age of 70 years old (range 36–84). Indications for revision included aseptic loosening/wear (20), second-stage revision after deep infection (7) and periprosthetic fracture (2) (Fig. 1A, B). Trabecular metal cones use was anticipated upon preoperative radiographic assessment. Final decision was made intraoperatively after implant removal and debridement. Intraoperative assessment revealed a significant femoral and/or tibial bone defect, defined as AORI type IIB or III, in all twenty-nine cases.

Patients were routinely followed in clinic at 6, 12, 24 weeks, one year and yearly thereafter. This included a standard questionnaire, an SF-12 questionnaire, physical examination of the knee including mechanical alignment, range of motion, stability and extension lag. Preoperative and postoperative functional scores were assessed with the Knee Society Score. Serial radiographic exams were reviewed to assess for osseointegration and signs of migration and fracture. These included an anteroposterior standing, lateral and merchant views of the knee.

Surgical Technique

All revision TKA procedures were performed by following the three-step technique as originally described by Vince [22]. The surgical technique used for implantation of the femoral and tibial trabecular metal cones has previously been described by Howard et al [19] and Meneghini et al [21]. First an intraoperative assessment of the bone defect using the AORI classification system was conducted after implant removal and thorough debridement of bone surfaces. All cases assessed as femoral or tibial types IIb or III were selected for TM cones use, which otherwise would have required the use of structural bone allograft and could not have been effectively addressed with modular augments. Then a cone trial was selected based on optimal fit. The cavitary bone defect was contoured with a high-speed burr to improve seating. A trial reduction included the cone and the femoral and tibial components. If a gap existed between the cone and the implants, a block augment was inserted. Finally, the porous tantalum cone was tapped into place in order to achieve a press-fit. Rotational and axial stability was confirmed by means of the application of manual force to the cone implant. Voids between the cone and host bone were filled with morselized cancellous bone allograft.

The Zimmer NexGen LCCK revision system was used in conjunction with the trabecular metal cones in all cases. In eleven (11) knees standard posterior stabilized (LPS) polyethylene inserts were used and in eighteen (18) LCCK constrained articulating surfaces were utilized. The implants were cemented up to the metaphyseal region with the remainder of the diaphyseal-engaging femoral and tibial stems inserted in a press-fit manner. Antibiotic-loaded bone cement was routinely used in all cases (Simplex P Tobramycin-Howmedica Stryker Osteonics, Mahwah, NJ, and Palacos R+G, Zimmer Orthopaedics, Warsaw, IN). Postoperative rehabilitation protocol included unrestricted range of motion exercises and full weight bearing as tolerated.

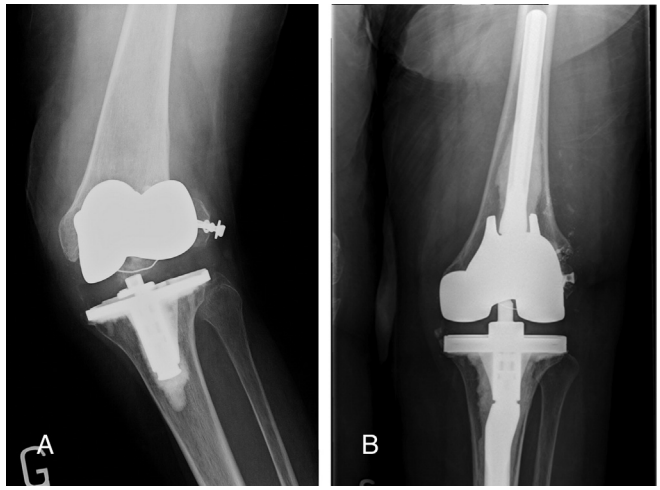

Fig. 1. A 65-year-old woman who had an intraoperative TKA periprosthetic lateral femoral condyle fracture treated with ORIF and a postoperative brace that failed. She underwent a TKA revision with use of a femoral cone, on which was fixed the lateral epicondyle with a washer and screw. (A) Preoperative AP radiograph. (B) Postoperative AP radiograph at the latest follow-up.

Results

Clinical Outcomes

Preoperatively, the range of motion consisted of a mean flexion contracture of 5° (range, 0–40°) and a mean flexion of 88° (range, 0°–125°). At the time of the latest follow-up, the range of motion had improved to a mean flexion contracture of 3° (range, 0°–20°) and a mean flexion of 112° (range, 90°–125°). Mediolateral stability in flexion and extension was achieved in all patients, with appropriate patella tracking based on clinical assessment. The average Knee Society Score was 42 points (range 0–80 points) preoperatively and improved to 82 points (range, 26–99 points) postoperatively, the average function score was 34 points (range, 0–85 points) preoperatively and improved to 65 points (range, 35–100 points) postoperatively ($P < 0.0001$).

Radiographic Outcomes

Review of serial postoperative radiographs of all cases shows a stable construct, with sign of osseointegration (Fig. 2A, B, C, D) and no evidence of loosening or migration of implants and/or cones. The radiographic follow-up of one patient, for whom a fixation of the patellar tendon to the tibial cone was performed during surgery using a washer and screw, showed a progressive patella alta (Fig. 3). Clinically, this patient had a 20° extension lag. This is reflected functionally by a slight impact, with a fair functional score of 65 points postoperatively. No lucent lines were noted around any of the trabecular metal implants. There was no change in trabecular metal implant position or alignment on latest radiographic assessment.

Complications/Reoperations

No significant complications related to the use of trabecular metal cones were identified in this cohort. One minor intraoperative fracture in the distal femur occurred during the impaction of one trabecular metal cone and was treated successfully with a cerclage wire. Radiographic follow-up showed no evidence of migration. This