



Use of tantalum cones in primary arthroplasty of acute proximal tibial fractures

Harish SIVASUBRAMANIAN, Sunil Gurpur KINI, Kai Yun ANG, S. S. SATHAPPAN

From the Department of Orthopaedic Surgery, Tan Tock Seng Hospital, Singapore

Metaphyseal tantalum cones in primary total knee arthroplasty and their functional outcome is described using 3 case reports over 6 years. 3 knees in 3 elderly individuals (mean age of 70.4 years), with pre-existing osteoarthritis and complex proximal tibial fractures, were operated on. Ambulation with walking frame was achieved from post-operation day 1, with weight-bearing as tolerated. Mean range of motion was 122° and Mean Knee Society Score was 88. All showed improvement in pre-operative limb alignment. Radiological fracture union was achieved on an average of 3 months. All were independent ambulators and pain-free at the latest follow-up. Our case series shows that tantalum cones are associated with significant improvements in clinical scores, patient symptoms, range of movement, early weight-bearing and low rates of complications in complex proximal tibial fractures with poor bone stock.

Keywords : primary knee arthroplasty ; proximal tibial fractures ; tantalum cone.

INTRODUCTION

The use of tantalum cones in revision arthroplasty literature has been shown to be associated with good clinical and radiological outcomes. Studies have shown that average Knee Society clinical scores (KSS) improve significantly postoperatively. Porous tantalum arthroplasty components have also been shown to help preserve the mineral density of

the surrounding bone, making it ideal for use in elderly, osteoporotic bone (10).

The potential for the use of these cones in primary knee arthroplastic procedures involving complex proximal tibial fractures of significant bone loss, has not been discussed in literature.

The authors present a case series of elderly patients, with pre-existing osteoarthritis and complex proximal tibial fractures, who were treated with tantalum cones in a primary knee arthroplasty procedure in a tertiary academic institution under a single surgeon. Older patients with comminuted intra-articular fractures have a higher risk of failure and poorer outcomes with Open Reduction Internal Fixation as described in the literature (16). The following 3 case vignettes demonstrate the practical

- Harish Sivasubramanian¹.
- Sunil Gurpur Kini².
- Kai Yun Ang³.
- S. S. Sathappan².

¹Department of Orthopaedic Surgery, National University Hospital, Singapore.

²Department of Orthopaedic Surgery, Tan Tock Seng Hospital, Singapore.

³Yong Loo Lin School of Medicine, National University of Singapore, Singapore.

Correspondence : Kai Yun Ang, MBBS (S'pore) Yong Loo Lin School of Medicine National University of Singapore Level 11, NUHS Tower Block 1E Kent Ridge Road, 119228 Singapore. E-mail : angkaiyun@gmail.com

© 2016, Acta Orthopædica Belgica.

No benefits or funds were received in support of this study. The authors report no conflict of interests.

Acta Orthopædica Belgica, Vol. 82 - 3 - 2016

application of the biomechanical advantages and concepts of tantalum cones.

Furthermore, we also evaluate and compare the various alternatives available in the management of periarticular tibial fractures in the elderly.

MATERIALS AND METHODS

In our case series for complex proximal tibial fractures treated with tibial cones, we have collated 3 patients' case reports over the last 6 years. Our patient information has been collated and recorded via the use of online patient database systems. Specific surgical codes denoting the type of operation performed was used to draw up a list of patients, from whom further data was extracted.

The mean age of the patients operated on was 70.4 years (range 59.2-79.0). 2 patients were female and 1 was male. 2 operations were performed on the right knee and 1 on the left. 2 patients were admitted after a fall from a standing height, and 1 was admitted after a road traffic accident (RTA).

Of the 3 patients, only 1 had a pre-operative limb alignment of a varus deformity of 7.4 degrees and the remaining 2 had a pre-operative valgus deformity of an average of 15.3 degrees (range 15.0-15.5). The pre-operative angles are a composite of the patient's pre-existing osteoarthritis and the periarticular fracture. Of the tibial plateau fractures, 2 were classified as Schatzker II and one a Schatzker III (Fig. 1, 2, 3).

All patients underwent a medial parapatellar arthroplasty. Tibial cuts were determined using conventional extra-medullary tibial jigs in 2 patients. In the third patient (i.e. Case 1), navigation equipment was available at that juncture and was used in optimizing tibial cuts.

In all three patients, significant loss of subchondral bone was attributed to the valgus load injury. Following removal of cartilage fragments, the tibial cones were impacted against the endosteal rim. Minor bone deficiencies between the cone and endosteal cortex was impacted with autogenous bone graft obtained from the distal femur bone cuts. Tibial stems were used in all cases due to suboptimal bone stock. There were no intraoperative complications amongst the 3 cases.

RESULTS

The median time to operation from time of admission was 9 days (range 6-12). There were no immediate wound complications. Post-operatively, all 3 patients were able to ambulate with a walking



Fig. 1. — Case 3 – Antero-posterior X-ray of right knee showing lateral condylar depression fracture.

frame from day 1, with weight bearing as tolerated. Mean range of flexion of the knee across all 3 patients was 122 degrees (range 105-132) and the mean KSS was 88.

All 3 patients were followed up every 6 weeks till bone union was achieved. Thereafter, patients were reviewed every 3 months. Patients were followed up on an average of 56 months (range 18-82 months). All 3 patients showed an improvement in pre-operative varus and valgus limb deformities on the latest follow-up. Radiological fracture union was achieved on an average of 3 months (range 2-5 months). Alignment of within 3 degrees of the mechanical axis was achieved in 2 out of the 3 patients (2.8 varus and 3.0 valgus). No fixed flexion deformity or hyperextension was detected in any of the 3 patients. All patients were also pain-free at the latest follow-up.



Fig. 2. — Case 3 – Lateral X-ray of right knee showing lateral condylar depression fracture.

In terms of post-operative complications, mild genu valgus of 7.2 degrees was identified in one case 6 years post-operative procedure. Navigation-assisted surgery was not used in this case. No other post-operative complications were detected on an average of 56 months follow-up (range 18-82) (Fig. 4, 5, 6, Table I).

DISCUSSION

Tantalum cones reinforce the endosteal cavity, maintaining viable bone and providing immediate structural support and enhanced biologic fixation (13). The porous nature of the metal (porosity diameter of 400 microns (11)), allows for soft tissue and bone ingrowth ; its frictional property enhances the tantalum-cancellous bone interface and offers greater initial stability compared to bone grafts and



Fig. 3. — Case 1 – CT Scan showing lateral depression fracture of left knee and poor bone stock.

conventional porous metal surfaces (13). Tantalum cones are hence ideal for physiological load transmission. The low modulus of elasticity also allows more load transfer and preservation of bone stock (11). Porous tantalum tibial cones in particular have been shown to be useful in revision arthroplasty. The modular nature of these cones allows intra-operative customization to be easily achieved (12).

The management of periarticular fractures in the elderly include operative fixation, interval total knee arthroplasty and acute total knee arthroplasty. Often, operative fixation is the choice of treatment, but literature would suggest that the rates of post-operative infection and post-traumatic osteoarthritis remain high. Honkonen found the failure of fixation to be associated with advancing age and severe osteoporosis with the risk of losing reduction as high as 31% in this group (4). Interval replacement of the knee joint has also been associated with higher post-operative complications. In a study by Weiss and Parvizi *et al* evaluating outcomes after interval total knee replacements in acute periarticular tibial fractures, it was found that on an average follow-up of 31 months, the median knee score was 78 (15). Early total knee replacements have been found to be associated with better functional scores in comparison



Fig. 4. — Case 3 — Post-operative antero-posterior weight-bearing X-ray.

to interval replacements and lower complication rates in comparison to surgical fixation (14).

In the literature, in patients presenting with proximal tibial fractures, interval replacement is done so as to address the limited deficiency after fracture consolidation. An alternative procedure would be to address the fracture and acute bone defects during acute total knee replacement. The authors have used tantalum cones in complex tibial plateau fractures in elderly patients with osteoporosis and poor bone stock. Tibial cones were used to re-establish the cortical rim in the proximal tibia and provide a stable platform and foundation for the fixation of the final tibial component. In all patients, similar to published results, radiological osseointegration was noted on an average of 3 months (range 2-5 months).

Though the use of porous tantalum tibial cones in revision arthroplasty have been well documented, there is however no description of its use in acute total knee arthroplasty. Its various biomechanical properties and advantages in terms of biological fixation and physiological load bearing suggest that

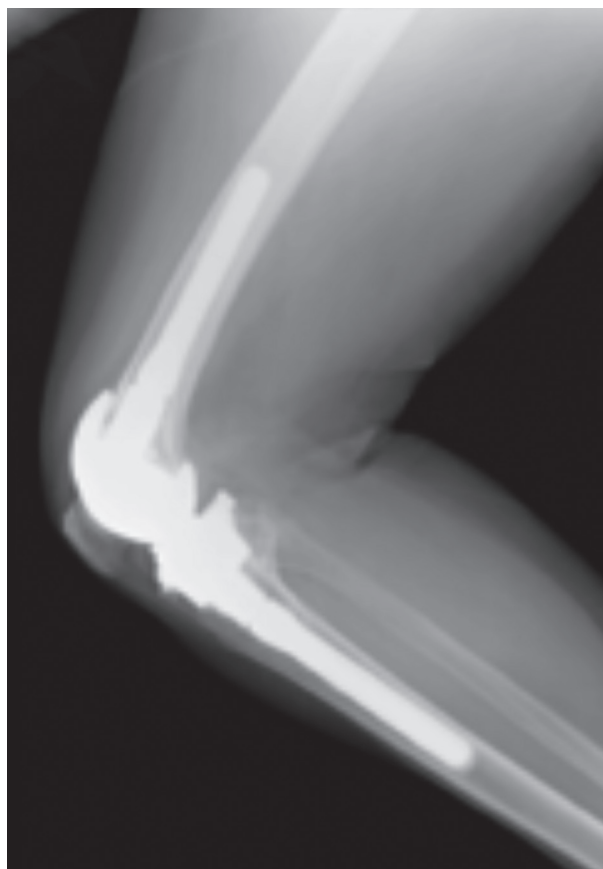


Fig. 5. — Case 3 — Post-operative lateral knee X-ray, showing evidence of callus formation 2 months post total knee arthroplasty.

the use of cones in primary knee arthroplastic procedures may be beneficial, particularly in cases of substantial, osteoporotic bone loss.

The distinct advantage seen with the use of these cones in elderly individuals is the quick time to weight bearing. All the patients in our series were able to weight bear as tolerated from the first post-operative day. This helps to reduce the various morbidities, both medical and surgical, associated with prolonged immobilization and costs associated with hospital stay. Tantalum cones also help prevent subsidence of the bone and the overlying tibial implant components, a common indication for revision total knee arthroplasty in elderly individuals with osteoporotic bone (14).

Comparison of the results of our study with various literature regarding the use of bone grafts shows

Table I. — Summary of patients' information and results

Case	1	2	3
Age	73.0	59.0	79.2
Sex	F	M	F
Nature of trauma	Fall	Fall	RTA
Right/Left knee	L	R	R
Pre-operative limb alignment/degrees	Valgus 15.0	Varus 7.4	Valgus 15.5
Schatzker classification	II	III	II
Navigation assisted surgery (Y/N)	Y	N	N
Stem (Y/N)	Y	Y	Y
Prosthesis	Zimmer NexGen	Zimmer LCKK	Zimmer NexGen
Time to operation/days	6	10	12
Post-operative weight-bearing status	Weight-bearing as tolerated from POD 1		
Post-operative ROM			
Operation day/degrees	0 – 60	0 – 30	0 – 60
Post-operative day 1		0 – 60	
By end of first week/degrees	0 – 90	0 – 90	0 – 90
Physiotherapy initiated to attain maximal flexion (Y/N)	Y	Y	Y
Post-operative complications	None	None	Genu valgus 7.2 degrees
Time to radiological union/months	5	2	2
Limb alignment/degrees	Valgus 2.8	Varus 3.0	Valgus 7.2

better KSS scores and mean range of motion of our patients. In a study by Georgeanu and Predescu *et al* reviewing the results of the use of bone grafts in dealing with proximal tibial deficiencies in primary total knee arthroplasty, it was found that the average post-operative KSS score was 78.8 with the post-operative functional KSS score being 76.6 (3). Kawano and Severino *et al* showed that on average follow-up of 53.7 ± 23.4 months in 18 patients for whom autologous bone grafting was used, the average range of flexion was noted to be 105.3 ± 9.5 degrees. Furthermore, the study found a post-operative valgus angle of 3-8 degrees in 73% of their patients (6).

The rapidity and ease of cone implantation, in comparison to the preparation involved in structural bone allograft and prosthetic constructs, also results in shorter operative times, better potential cost savings and lower patient morbidity (8). Furthermore, structural allografts have increased incidence of complications such as graft resorption, collapse,



Fig. 6. — Case 1 – Post-operative antero-posterior X-ray

non-union and infection. Studies by Laskin and Cuckler reported a failure rate of 33% of bone grafts in primary arthroplasty at 5-year follow-up (2,8).

However, literature would suggest that there are some limitations and disadvantages to the use of tantalum tibial cones. The high cost of these implants and the lack of data regarding long-term follow-up prevent the use on a large scale (11). Currently, the only indication for its use would be severe bone loss corresponding to Anderson Orthopaedic Research Institute (AORI) Type II or III. Radnay and Scuderi recommends the use of cones only in bicondylar Type III defects (12). However, it has also been suggested that the most severe tibial deficiencies that do not have a proximal supportive rim for interference fit of even a portion of the cone, is more appropriately fit with a tumour megaprosthesis or a tibial allograft (6). It has also been suggested that the potential removal of these implants might be difficult for further revision procedures (1,5,7,9).

CONCLUSION

A literature review shows good promise in the use of tantalum cones in revision arthroplasty and our case series show good results in patients requiring arthroplasty in the setting of proximal tibial fractures. Early total knee replacement for complex periarticular tibial fractures in the elderly are associated with better outcomes, and tantalum metal cones may prove to be valuable in addressing suboptimal bone stock in this acute setting. Long-term studies should be conducted to ascertain the durability of tantalum components before it can be routinely used in complex cases of knee arthroplasty.

REFERENCES

1. **Benoit B, Fouad Z, Laflamme GH, Rouleau D, Laflamme GY.** Augmentation of tibial plateau fractures with Trabecular Metal : a biomechanical study. *J Orthop Surg Res* 2009 ; 4 : 37.
2. **Cuckler JM.** Bone loss in total knee arthroplasty : graft augment and options. *J Arthroplasty* 2004 ; 19 : 56-58.
3. **Georgeanu V, Predescu V, Atasiei T, Cristea S.** Approach of tibial bone defects in primary total knee arthroplasty. *AT-EQUAL* 2010 ; 33.
4. **Honkonen SE.** Indications for surgical treatment of tibial condyle fractures. *Clin Orthop* 199 ; 302 : 199-205.
5. **Howard JL, Kudera J, Lewallen DG, Hanssen AD.** Early results of the use of tantalum femoral cones for revision total knee arthroplasty. *J Bone Joint Surg Am* 2011 ; 93 : 478-484.
6. **Kawano CT, Severino NR.** Autologous bone graft for tibial defects on knee total arthroplasty. *Acta Orthop Bras* 2005 ; 13 : 120-123.
7. **Kini SG, Sathappan SS.** Role of navigated total knee arthroplasty for acute tibial fractures in the elderly. *Acta Orthop Belg* 2013 ; 133 : 1149-54.
8. **Lachiewicz PF, Bolognesi MP, Henderson RA, Soileau ES, Vail TP.** Can tantalum cones provide fixation in complex revision knee arthroplasty ? *Clin Orthop* 2012 ; 470 : 199-204.
9. **Laskin RS.** Total knee arthroplasty in the presence of large bony defects of the tibia and marked knee instability. *Clin Orthop* 1989 ; 248 : 66-70.
10. **Meneghini RM, Lewallen DG, Hanssen AD.** Use of porous tantalum metaphyseal cones for severe tibial bone loss during revision total knee replacement. *J Bone Joint Surg Am* 2009 ; 90 : 78-84.
11. **Minoda Y, Kobayashi A, Iwaki H, Ikebuchi M, Inori F, Takaoka K.** Comparison of bone mineral density between porous tantalum and cemented tibial total knee arthroplasty components. *J Bone Joint Surg Am* 2010 ; 92 : 700-706.
12. **Qiu YY, Yan CH, Chiu KY, Ng FY.** Review article : Treatments for bone loss in revision total knee arthroplasty. *J Orthop Surg* 2012 ; 20 : 78-86.
13. **Radnay CS, Scuderi GR.** Management of bone loss : augments, cones, offset stems. *Clin Orthop* 2006 ; 446 : 83-92.
14. **Sheth NP, Lonner JH.** Clinical use of porous tantalum in complex primary total knee arthroplasty. *Am J Orthop* 2009 ; 38 : 526-530.
15. **Vermeire J, Scheerlinck T.** Early primary total knee replacement for complex proximal tibia fractures in elderly and osteoarthritic patients. *Acta Orthop Belg* 2010 ; 76 : 785-793.
16. **Weiss NG, Parvizi J, Trousdale RT, Bryce RD, Lewallen DG.** Total knee arthroplasty in patients with a prior fracture of the plateau tibia. *J Bone Joint Surg Am* 2003 ; 85-A : 218-221.