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Original Article

Early results of the LPS™ limb preservation system in the management of periprosthetic femoral fractures

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ABSTRACT

Introduction: Achieving skeletal fixation in the presence of progressive bone loss is a surgical challenge, especially in cases of periprosthetic fracture (PPF). Unpredictable fracture patterns and preexisting bone loss frequently combine in this patient group. Megaprosthetic arthroplasty allows for immediate mobilisation and shorter periods of rehabilitation. We describe the clinical outcomes of a cohort of LPS™ megaprostheses performed for PPF by a single surgeon at our institution.

Methods: Between July 2013 and November 2015, 23 patients underwent endoprosthetic femoral replacement of which 16 were performed for PPF or bone loss. Patient demographics, surgical indication, operative details, implant composition, blood loss, survival, and revision surgery details were recorded in a prospectively maintained database. Patients underwent serial clinical and X-ray evaluations at 6 weeks, 3 months and 6 months post surgery with yearly reviews thereafter.

Results: The PPF cohort consisted of 9 males and 7 females with a mean age of 75 and a mean follow up of 19.2 months. The mean Oxford score prior to fracture was 41 (range 12–48), and 39 (range 13–48, $p = 0.6$) post megaprosthesis insertion. Postoperative dislocation of the megaprosthesis occurred in two patients (12.5%), with no postoperative infections recorded.

Conclusion: We report minimal postoperative changes in functional outcome scores. The results of revision arthroplasty with LPS™ proximal femur megaprosthesis were satisfactory in 15/16 patients at a mean follow-up of 19.2 months. We recommend the use of megaprostheses in patients with markedly deficient bone stock for whom other available reconstructive procedures are unavailable.

1. Introduction

Achieving skeletal fixation in the presence of progressive bone loss is a surgical challenge in patients following multiple revision arthroplasties, periprosthetic infection, malignancy or extensive limb trauma.[1–4] Periprosthetic femoral fractures (PPF) are a potentially devastating complication following total hip arthroplasty. Unpredictable fracture patterns and preexisting bone loss frequently combine in this patient group where medical comorbidities are also common.[5] Their reported incidence in the literature ranges from 1% to 4.1% intraoperatively.[6–8] The postoperative fracture risk has been described as 1% during the subsequent life of the implant.[9] Patients who suffer PPF experience higher postoperative mortality rates of 7.3%[10] and 11.0%[11] within 6 months and one year, respectively.

A variety of alternative reconstructive options are available to address advanced femoral bone loss including impaction allografting, allograft-prosthetic composite (APC) and megaprosthetic arthroplasty. Modern megaprostheses are modular, allow extensive resections and are available with porous coated or cemented fixation. Megaprosthetic arthroplasty while technically demanding allows for immediate mobilisation and shorter periods of rehabilitation, avoiding the risk of disease transmission and graft incorporation associated with allografts.[12] These reconstructions however are frequently complicated by dislocation, loosening and infection which can adversely affect limb function and prosthetic longevity.[13–15] The purpose of our study was to assess the clinical outcomes of a cohort of megaprostheses performed for PPF by a single surgeon at our institution.

2. Methods

In July 2013, the Depuy Limb Preservation System (LPS™) was introduced at GUH. The LPS includes metaphyseal segments bearing articular surfaces for proximal and distal femoral

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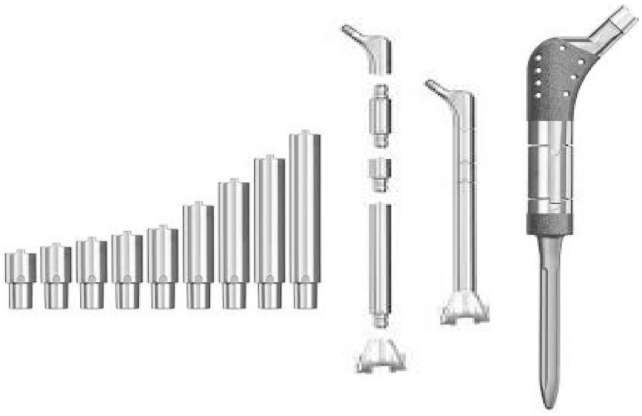

Fig. 1. Segmental implants (left), complete modular femoral implant (centre), proximal femur with one segment and non porous stem (right).

replacements, diaphyseal anchor segments allowing cemented or cementless fixation and intercalary segments which allows prosthetic lengthening in 5 mm increments (Fig. 1).

Between July 2013 and November 2015, 23 patients underwent endoprosthetic femoral replacement of which 16 were performed for PPF or bone loss. Appropriate informed consent was acquired from patients prior to inclusion in the study. A database was created prospectively recording patient demographics, surgical indication, operative details, implant composition, blood loss, survival, and revision surgery details where appropriate. Patients underwent serial clinical and X-ray evaluations at 6 weeks, 3 months and 6 months post surgery with yearly reviews thereafter. The Oxford hip score was used to objectively grade hip function.

2.1. Surgical technique

Cases of PPF necessitating fixation were treated using a standardised operative protocol. Following standard intravenous tranexamic acid and prophylactic antibiotic administration the patient is placed in the lateral decubitus position with the operative limb draped freely. A direct lateral approach centred distally over the femoral shaft and curving posteriorly over the greater trochanter is deepened through the subcutaneous tissue and fascia lata to expose the greater trochanter and Vastus Lateralis. The Vastus is dissected from the Vastus ridge proximally and from proximal to distal along the linea aspera posteriorly, ligating the perforating branches of the profunda femoris sequentially. Posterior dissection progresses until the most distal extent of the fracture is visualised. The greater trochanter and as much of the attached lateral femoral cortex as the fracture pattern allows is isolated with saw cuts along the anterior and posterior aspects of the proximal femur. The remaining fragments are retained with the muscle attachments for later fixation. The extended trochanteric fragment is then reflected anteriorly to expose the femoral stem and surrounding cement mantle. The cement/implant composite is extracted and excision of the inferior pseudocapsule then affords excellent exposure of the acetabular component which can be revised if necessary. The femur is osteotomised transversely just distal to the fracture. The canal is reamed sequentially to a diameter 2 mm larger than the selected diaphyseal anchor to accommodate a cement mantle for anchor fixation. The trochanteric segment, distal anchor and appropriate length of intercalary segments are trialled for stability and version is selected by marking the femur opposite the notch on the shoulder of the anchor segment. Cemented femoral fixation with Palacos™ (Heraeus Medical) and a modular head appropriate to the acetabular component was used in all cases after reduction of the implant of the trochanteric fragment is secured with a 150 mm trochanteric cable plate that incorporated cerclage wires around the trochanter and any femoral shaft fracture fragments. The wound was then closed in layers without vacuum drainage or compressive dressings (Table 1).

Table 1
Indications for use of LPS™ megaprosthesis.

Surgical indication	
Periprosthetic fracture	16
Aseptic loosening of femoral stem	3
Aseptic loosening of femoral ORIF	2
Proximal femoral metastases	1
Neck of femur fracture with poor proximal bone stock	1

Patients are mobilised with physiotherapy the day after surgery, with unlimited progressive weightbearing as tolerated.

3. Results

Between July 2013 and November 2015, 23 patients underwent endoprosthetic femoral replacement of which 16 were performed for PPF or bone loss. The PPF cohort consisted of 9 males and 7 females with a mean age of 75 years (range 59–94). Surgery was indicated in those with poor proximal bone stock in combination with a Vancouver B1, B2, B3 and C fracture patterns (Fig. 2).

As indicated in Table 2, the majority of femoral stems revised in the PPF cohort were cemented, with only two uncemented stems included in the study. The stems revised reflect the practice within the region over the preceding number of years. The mean resection length was 207.5 mm (range 90–305), with one whole femur resection equivalent to a resection length of 475 mm. The mean hospital length of stay (LOS) was 21.7 days (range 5–48). The mean intraoperative blood loss was 1439 ml (range 400–2750), with no correlation identified between length of resection and volume of blood loss ($p = 0.2$). Upon discharge from the hospital six patients mobilised with crutches while 9 mobilised with frames. One patient whose pre-morbid state was non-ambulatory secondary to advanced dementia remained thus. The mean Oxford score prior to fracture was 41 (range 12–48), while the mean Oxford score post megaprosthesis insertion was 39 (range 13–48, $p = 0.6$). This demonstrates a minimal loss of function despite undergoing surgery which involved bone loss with altered fixation of abductor and adductor muscle groups.

Table 2
Patient demographics of PPF cohort.

Gender	
Male	9
Female	7
Mean age	75 (range 59–94)
Primary implant	
Exeter™ (Stryker)	9
Charnley™ (DePuy Synthes)	5
Corail™ (Depuy Synthes)	2
Stem fixation	
Cemented	10
Uncemented	2
Hybrid	2
Cemented hemiarthroplasty	2
Components revised	
Stem only	16
Both components	0
Survival of primary implant	73 months (range 2–168)
Classification of periprosthetic fractures	
Vancouver B1	1
Vancouver B2	7
Vancouver B3	7
Vancouver C	1

Fig. 2. Vancouver C PPF of left femur, extending to within 5 cm of distal metaphysis.

Table 3
Postoperative clinical indices of satisfaction.

Mean length of stay post revision	21.7 (range 5–48)
Mean postoperative follow up	19.2 months (range 9–26)
Oxford hip score	
Preoperative	41.6
Postoperative	39.8
Postoperative functional status	
Ambulatory	3
Walking stick	8
Crutches	0
Frame	4
Nonambulatory	1
Complications	
Dislocation	2
Leg length discrepancy	1

We report three postoperative complications in the PPF cohort. Postoperative dislocation of the megaprosthesis occurred in two patients (12.5%). Patient A dislocated 8 days postoperatively which continued to sublux after reduction prompting revision of the acetabular component at 6weeks postoperatively for recurrent instability symptoms. Patient B was a non-ambulator at baseline whose asymptomatic dislocation was discovered on a routine screening radiograph at 6 weeks postoperatively. Revision surgery was declined in this case. One patient with a postoperative leg length discrepancy of 4 cm has been managed conservatively with the use of a shoe raise. These patients – like the remainder of the cohort – are under routine review in the outpatient department and continue to function well (Table 3).

4. Discussion

Reconstruction options when faced with significant proximal femoral bone loss in complicated revision arthroplasty include APC – allograft-prosthetic composites[14,15] insertion of a megaprosthesis[16,17] or resection arthroplasty.[18] Resection arthroplasty is employed as a last resort in cases of intractable pain, limb shortening and significantly impaired functional ability.[19] APC conserves bone stock for future procedures and as such, is reserved for young, active patients, where appropriate. Megaprostheses are commonly utilised to reconstruct the proximal femur in older and sedentary patients, with osteoporosis and diminished bone stock in the proximal femur.[20,21] Early mobilisation and immediate full weight bearing can be allowed if the megaprosthesis is successfully implanted.[22]

In patients with significant bone loss the reconstructive goals of pain relief and restoration of function may be difficult to achieve. Our experience of reconstruction with megaprostheses in this series in encouraging. However, we report two incidences of recurrent instability in our cohort which is in accordance with previously published studies.[14,23,24] The aetiology of this instability is most likely attributable to the inability to achieve a secure repair of the abductor mechanism and soft tissues to the metal prosthesis, on the background of multiple surgeries to the hip.[25]

There were no postoperative infections noted during our postoperative follow up. It must be noted that none of our patients had a failed primary arthroplasty secondary to deep infection. Regardless, our outcomes compare favourably to reported incidences of postoperative deep infection which range from 6.5% to 16%.[17,22,23,26]

We report minimal postoperative changes in functional outcome scores, as measured by the Oxford hip score, in our cohort. Our results are comparable to similar published studies characterising the postoperative functional outcomes of megaprostheses.[27,28]

The results of revision arthroplasty with proximal femur megaprosthesis were satisfactory in 15 of 16 patients at an average follow-up of 19.2 months. We recommend the use of megaprostheses in patients with markedly deficient bone stock for whom other available reconstructive procedures cannot be performed.

Conflicts of interest

The authors have none to declare.

References

1. Ilyas I, Kurar A, Moreau P, Younge D. Modular megaprosthesis for distal femoral tumors. *Int Orthop.* 2001;25(6):375–377.
2. Veth RP, Nielsen HK, Oldhoff J, et al. Megaprostheses in the treatment of primary malignant and metastatic tumors in the hip region. *J Surg Oncol.* 1989;40(3):214–218.
3. Parvizi J, Sim FH. Proximal femoral replacements with megaprostheses. *Clin Orthop Rel Res.* 2004;420:169–175.
4. Wang JW. Structural or strut cortical allografts in revision hip arthroplasty with femoral deficiencies. *J Orthop Surg Taiwan.* 1997;14(2):95–101.
5. Lewallen DG, Berry DJ. Periprosthetic fracture of the femur after total hip arthroplasty: treatment and results to date. *J Bone Joint Surg.* 1997;79(12):1881.
6. Kelley SS. Periprosthetic femoral fractures. *J Am Acad Orthop Surg.* 1994;2–3:164–172.

7. Katz JN, Wright EA, Harris MB, Losina E. Incidence, risk factors and consequences of periprosthetic and femoral fracture among those who survived total hip replacement for more than a decade. *Osteoarthr Cartil.* 2012;20:S163–S164.
8. Garcia-Cimbrelo E, Munuera L, Gil-Garay E. Femoral shaft fractures after cemented total hip arthroplasty. *Int Orthop.* 1992;16(1):97–100.
9. Beals RK, Tower SS. Periprosthetic fractures of the femur. An analysis of 93 fractures. *Clin Orthop Relat Res.* 1996;327:238–246.
10. Young SW, Walker CG, Pitto RP. Functional outcome of femoral peri prosthetic fracture and revision hip arthroplasty: a matched-pair study from the New Zealand Registry. *Acta Orthop.* 2008;79(4):483–488.
11. Bhattacharyya T, Chang D, Meigs JB, Estok DM, Malchau H. Mortality after periprosthetic fracture of the femur. *J Bone Joint Surg Am.* 2007;89(12):2658–2662.
12. Horowitz SM, Glasser DB, Lane JM, Healey JH. Prosthetic and extremity survivorship after limb salvage for sarcoma. How long do the reconstructions last? *Clin Orthop Rel Res.* 1993;(293):280–286.
13. Clarke HD, Berry DJ, Sim FH. Salvage of failed femoral megaprostheses with allograft prosthesis composites. *Clin Orthop Rel Res.* 1998;356:222–229.
14. Haentjens P, De Boeck H, Opdecam P. Proximal femoral replacement prosthesis for salvage of failed hip arthroplasty: complications in a 2–11 year follow-up study in 19 elderly patients. *Acta Orthop Scand.* 1996;67(1):37–42.
15. Head WC, Emerson Jr RH, Malinin TI. Structural bone grafting for femoral reconstruction. *Clin Orthop Rel Res.* 1999;369:223–229.
16. Donati D, Giacomini S, Gozzi E, Mercuri M. Proximal femur reconstruction by an allograft prosthesis composite. *Clin Orthop Rel Res.* 2002;394:192–200.
17. Johnsson R, Carlsson Årn;, Kisch K, Moritz U, Zetterström R, Persson BM. Function following mega total hip arthroplasty compared with conventional total hip arthroplasty and healthy matched controls. *Clin Orthop Rel Res.* 1985;192:159–167.
18. Ross A, Tuite J, Kemp H, Scales JT. Massive prosthetic replacement for non-neoplastic disorders. *Bone Joint Surg B.* 1995;77:351–356.
19. Grauer JD, Amstutz HC, O'Carroll PF, Dorey FJ. Resection arthroplasty of the hip. *J Bone Joint Surg Am.* 1989;71(5):669–678.
20. Sim FH, Chao EY. Segmental prosthetic replacement of the hip and knee.In: *Tumor Prostheses for Bone and Joint Reconstruction: The Design and Application*. New York: Thieme-Stratton; 1983:247–266.
21. Freedman EL, Eckardt JJ. A modular endoprosthetic system for tumor and non-tumor reconstruction: preliminary experience. *Orthopedics.* 1997;20(1):27–36.
22. Brady OH, Kerry R, Masri BA, Garbuz DS, Duncan CP. The Vancouver Classification of periprosthetic fractures of the hip: a rational approach to treatment. *Techn Orthop.* 1999;14(2):107–114.
23. Malkani AL, Settecerri JJ, Sim FH, Chao EY, Wallrichs SL. Long-term results of proximal femoral replacement for non-neoplastic disorders. *Bone Joint J.* 1995;77(3):351–356.
24. Donati D, Zavatta M, Gozzi E, Giacomini S, Campanacci L, Mercuri M. Modular prosthetic replacement of the proximal femur after resection of a bone tumour. *Bone Joint J.* 2001;83(8):1156–1160.
25. Gottsauner-Wolf F, Egger EL, Schultz FM, Sim FH, Chao E. Tendons attached to prostheses by tendon-bone block fixation: an experimental study in dogs. *J Orthop Res.* 1994;12(6):814–821.
26. Zehr RJ, Enneking WF, Scarborough MT. Allograft-prosthesis composite versus megaprosthesis in proximal femoral reconstruction. *Clin Orthop Rel Res.* 1996;322:174–223.
27. Schindler OS, Cannon SR, Briggs TW, Blunn GW. Stanmore custom-made extendible distal femoral replacements. *Bone Joint J.* 1997;79(6):927–937.
28. Tan PK, Tan MH. Functional outcome study of mega-endoprosthetic reconstruction in limbs with bone tumour surgery. *Ann Acad Med Singap.* 2009;38(3):192.