Proximal Femoral Megaprosthesis for Failed Total Hip Arthroplasty

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Background: The purpose of this study was to assess the clinical outcome and complications of megaprostheses for massive proximal femoral bone loss after failed total hip arthroplasty.

Methods: Between June 1997 and December 2002, 12 patients (12 hips) with massive proximal femoral deficiencies had reconstruction of the hip using proximal femoral megaprostheses. The average age of the patients was 59 years (range 25 to 75).

Results: At an average of 5.7 years (range 3.3 to 9) after surgery, eight patients (67%) had a satisfactory result, one had fair and three had poor results. The complications included dislocation in 5 (42%), deep infection in 4 (33%), ectopic ossification in 1 (8%), leg shortening > 3 cm in 2 (16.7%), displacement of the greater trochanter in 3 (25%) and aseptic loosening of the megaprosthesis in 1 (8%). The early dislocation rate was 75% but this was subsequently reduced to 14% in the later period after use of an abduction brace postoperatively. The average Harris hip score of the 12 patients preoperatively was 30 points (range 16-42). The average Harris hip score of the 9 patients with a retained megaprosthesis was 83 points (range 68 to 92).

Conclusion: Patients with a failed total hip arthroplasty and massive proximal femoral bone loss can be salvaged with a proximal femoral megaprosthesis if there is no other alternative. However, this procedure is technically demanding and has a high rate of complications. The routine use of an abduction brace postoperatively is advised to reduce the dislocation rate.

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Key words: megaprosthesis, proximal femoral replacement, total hip arthroplasty.

Massive bone loss of the proximal femur is a complex problem and is usually encountered in patients whose hip prosthesis was implanted in their youth, and who have had multiple revision arthroplasties due to infection or non-infective failures, severe trauma to the proximal femur with multiple failed osteosyntheses or wide excision of a bone sarcoma.(1-5) Numerous factors may contribute to massive loss of the femoral bone stock after total hip arthroplasty (THA). These include osteolysis secondary to particulate debris, stress shielding bone loss, prior infection and periprosthetic fractures.(6-8)

There are various possible reconstructive options to treat bone loss on the femoral side that include long-stem cemented or press-fit stems, impaction allografting,(9) resection arthroplasty,(10)

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allograft-prosthetic composite (APC)[5,11] and proximal femoral megaprosthesis.[12-14] However, for a massive loss of bone stock on the proximal femur, the options of reconstruction are limited to megaprosthesis and APC.[1] Several studies have suggested that APCs survive longer than other reconstructions.[15,16] However, the use of allografts are limited because of fracture, infection, nonunion, resorption and an underlying concern of disease transmission.[17-20] Moreover, the risk of recurrent infection is of great concern if a massive allograft is used to reconstruct a skeletal defect caused by deep infection.[21] One of the alternatives to solve this problem is the proximal femoral megaprosthesis designed for neoplastic conditions.[2,22,23] Proximal femoral megaprostheses are not as technically demanding to implement, allow for a shorter rehabilitation and avoid the possibility of disease transmission that has been associated with massive allografts.[14,24,25] However, dislocation, instability, stem loosening and prosthesis failure have been concerns with the use of this device.[2,12,13,26,27]

The purpose of this study was to assess the clinical outcome and complications of megaprostheses used to reconstruct massive bone loss of the proximal femur after failed THA.

METHODS

Between June 1997 and December 2002, 12 patients had reconstruction of the hip using a proximal femoral megaprosthesis via a posterior approach. Clinical records and radiographic studies were reviewed, and interviews and examinations were conducted for each patient. The surgical reconstructions were done by one surgeon during this time period. Custom-made total hip prosthesis (United Ustar System, Taipei, Taiwan) was used in the 12 patients (9 males, 3 females) who had a mean age of 59 years (range 25 to 75 years).

Clinical data of the 12 patients are summarized in Table 1. The primary diagnoses were fracture of the hip in 5 patients, osteoarthritis in 3, osteonecrosis in 3 and malignant fibrous histiocytoma of the hip in 1. All 12 patients had a failed hip arthroplasty with massive bone loss of the proximal femur, including 4 APC with infection, 1 APC with allograft fracture, 2 periprosthetic fracture associated with infection (Fig. 1-A), 3 aseptic loosening and 2 septic loosening of the hip arthroplasties. The average number of operations before the megaprosthesis replacement was 6.5 (range 3-22). The most common reason for proximal femoral bone loss was infected THA (8 patients). The microorganisms isolated from the 8 hips were oxacillin-sensitive Staphylococcus aureus (OSSA) in 1, Mycobacterium tuberculosis in 1, coag (-) Streptococcus in 1, Peptostreptococcus in 1, Staphylococcus epidermidis in 2, oxacillin-resistant Staphylococcus aureus (ORSA) in 1, and mixed infection by OSSA and Pseudomonas in 1. The reimplantation procedure for these 8 patients was performed in two stages as described in our previous report.[28] The first stage involved a resection arthroplasty with removal of infected synovium, granulation tissue, necrotic bone and soft tissue, and all foreign bodies including prosthesis, metallic devices and bone cement. Meanwhile, vancomycin or cefazolin impregnated cement beads were implanted at the time of resection arthroplasty. Antibiotic usage was according to the results of bacterial cultures of the surgical specimens and their sensitivity tests. Intravenous antibiotics were given after resection arthroplasty for an average of 5 weeks (range 4-6 weeks). After that, oral antibiotics were given for an additional 4 to 6 weeks until erythrocyte sedimentation rate (ESR) (normal range 0-20 mm/hr) and C-reactive protein (CRP) (normal range 0-5 mg/L) returned to within normal ranges. One patient who had tuberculosis of the hip was treated with anti-tuberculosis therapy for 3 months. We routinely checked the levels of CRP and ESR during the follow-up. Reimplantation was performed after the ESR level reached 20 mm/hr and bacterial cultures of the hip aspirate were negative. At reimplantation, all the megaprostheses had antibiotic impregnated cement used in the fixation of the femoral component. The antibiotics impregnated in the cement were vancomycin in 6 hips and cefazolin in 2 hips. The amount of antibiotic impregnated in the cement was 1 gm of vancomycin or cefazolin in each pack of bone cement. The average interval from resection arthroplasty to definite reimplantation with a megaprosthesis was 3.5 months (1-8 months) in 8 hips with staged surgery.

Surgical techniques

The reconstructive technique used involved assessing the anticipated surgical defect, and select-

Table 1. Clinical Data of 12 Patients

Case No.	Gender/ age (years)	Primary diagnosis	Final diagnosis	Number of previous operations	Causative organism	Preop HHS (points)	Length of segment (mm)	Attachment of Hip abductor	Postop. Use of abduction brace	Duration of follow-up (years)	Postop HHS (points)	Ambulation aids	Complications	Reoperations
1	M/59	Hip fracture	APC infection	5	Staph. aureus	32	260	Tape	No	9	Failed	Wheelchair	1 Postop. dislocation recurrent infection	Permanent GS operation both hips
2	F/56	OA	APC infection	4	Coag. (-) Streptococcus	33	120	Tape	No	8.5	83	No	GT displacement	
3	M/46	AVN	Periprosthetic fracture infection	11	Peptostrep tococcus	32	180	Tape	No	7.5	92	No	1 Postop. dislocation LLD > 3 cm	
4	F/58	Hip fracture	THA infection	3	Staph. epidermidis	20	135	Tape	No	6	Failed	Wheelchair	1 Postop. dislocation recurrent infection	Permanent GS operation of the hip
5	M/69	OA	Periprosthetic infection fracture	6	Mycobact- erium tuberculosis	42	100	Wire	Yes	5.5	92	No	Ectopic ossification	
6	M/69	Hip fracture	AL THA	3		38	135	Wire	Yes	5.5	74	One cane		
7	M/62	AVN	APC infection	4	Staph. epidermidis	33	150	Wire	No	5.4	Failed	Wheelchair	3 Postop. dislocation recurrent infection	Permanent GS operation of the hip
8	M/63	MFH	APC infection	8	Staph. aureus pseudomonas	32	160	Wire	Yes	5	80	One cane	GT displacement stem loosening	Revision megaprosthesis
9	M/25	Hip fracture	Infected revision THA with allograft	22	ORSA	34	130	Tape	Yes	4.5	90	No	LLD > 3 cm	
10	M/75	Hip fracture	AL Bipolar hemiarthroplasty periprosthetic fracture	3		24	170	Tape	Yes	4	88	No	2 Anerior Dislocation GT displacement	
11	F/67	OA	APC infection	6		16	200	Wire	Yes	4	68	Walker	Infection (ORSA)	Revision megaprosthesis
12	M/58	AVN	AL revision THA	4		26	130	Wire	Yes	3.3	77	No		

Abbreviations: HHS: Harris hip score; M: male; APC: allograft-prosthetic composite; Staph.: Staphylococcus; GS: Girdlestone; F: female; OA: osteoarthritis; GT: greater trochanter; AVN: avascular necrosis of the femoral head; LLD: leg length discrepancy; THA: total hip arthroplasty; AL: aseptic loosening; MFH: malignant fibrous histiocytoma; ORSA: oxacillin-resistant Staphylococcus aureus.

ing an appropriate prosthesis and articulating segment. All revision arthroplasty was performed through a posterior approach. A metal-backed, porous-coated acetabular component was cemented to the pelvis if more than 50% of the acetabulum was covered by morselized allografts. Two screws, of sufficient length to purchase deep into the superior and superoposterior quadrant of the acetabulum, were inserted to firmly fix the cup and bone grafts before the cement was cured. Antibiotics were impregnated in the cement for acetabular component fixation in 7 hips: cefazolin for 2 hips, vancomycin for 5 hips. In the remaining 5 hips, the fixation of the acetabular component was noncemented. The host femur was reamed to allow a 1 to 2 mm cement mantle about the prosthetic stem. After trial fitting, the modular megaprosthesis was fixed into the host femur with antibiotic-loaded cement. Care was taken to minimize cement extrusion at the bone-prosthesis interface. Seven hips had wire fixation of the greater trochanter to the megaprosthesis. The remaining five hips had the abductors attached to the megaprosthesis using Mersilene tape because the bone stock of the greater trochanter was poor or absent (Table 1) (Fig. 1-B). Onlay allografts were used to reconstruct the junction of the host femur and the porous surface of the prosthesis in 9 hips (Fig. 1-B). The average length of the replaced proximal femora was 156 mm (range 100-260 mm).

Postoperatively, parenteral cephalosporin and gentamycin were administered for 5 days. Additional oral antibiotics were given for 7 to 14 days to 7 patients who had a history of hip infection. The patient with the tuberculosis infected hip was treated with anti-tuberculosis therapy postoperatively for 9 months. The total length of anti-tuberculosis therapy for this patient was 12 months, which included 3 months of therapy before revision. The patients were kept in bed with skin traction for 7 days, after which ambulation without weight bearing on the operated limb was allowed for 6 weeks. Between 6 to 12 weeks postoperatively, progressive weight bearing was advised. Full weight bearing was commenced if patients felt no pain and had stable hips on walking, usually after 12 weeks of follow-up. In the 4 patients treated early in the study period, the postoperative regimen did not include the use of an abduction brace. However, because of the high rate of postoperative dislocation (75%, 3 out of 4 hips), 7 of the following 8 patients were placed in a hip abduction brace for a period of 12 weeks, with the exception of one who did not comply with our advice of using an abduction brace postoperatively. The abduction brace kept the hip in 30° of abduction and limited range of motion of the hip from 30° to 90°.

Clinical and radiographic evaluation

Radiographic data were obtained from anteroposterior and lateral views of the hip and femur. The bone-implant interface and migration of the acetabular component, in horizontal and vertical directions, were examined on the immediate postoperative and the final follow-up radiographs. Acetabular loosening was considered to be present if the sum of acetabular migration in the horizontal and vertical direction was (4 mm, the alternation of inclination

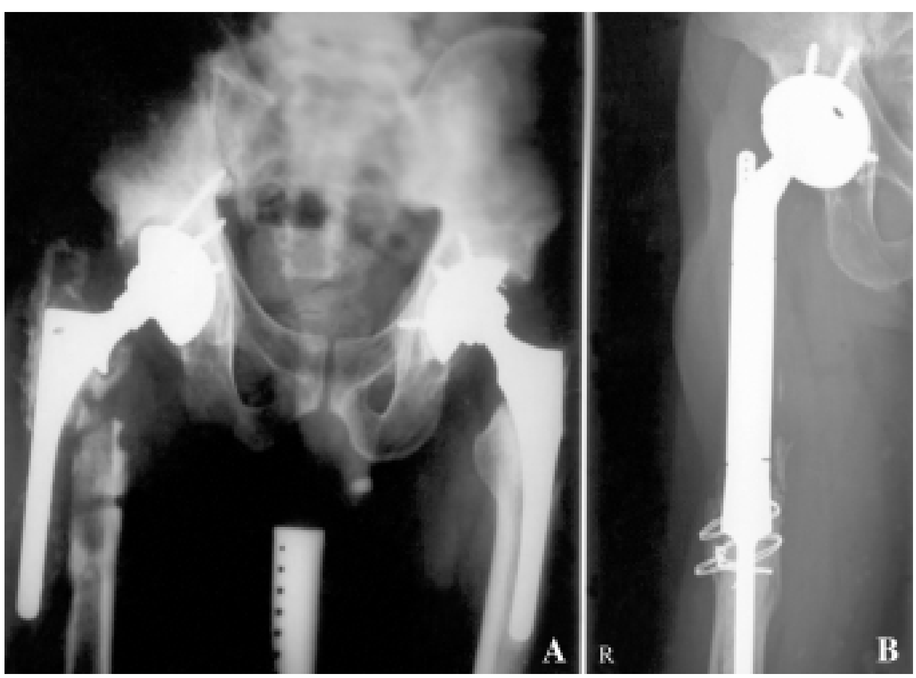

Fig. 1-A to 1-B. Case 3: A 46-year-old man who sustained a periprosthetic fracture with septic loosening of the revision total hip arthroplasty. (1-A) An anteroposterior view of the pelvis showing a periprosthetic fracture of the femur, loosening of the total hip arthroplasty and severe proximal femoral bone deficiency. (1-B) An anteroposterior view of the hip and the proximal femur seven years postoperatively showing a well-fixed acetabular component and the megaprosthesis. Note good healing of the allograft struts to the prosthesis and host bone. The patient had a postoperative Harris hip score of 92 points.

angle was > 5 degrees, there was a radiolucent line of > 1 mm in three zones as described by DeLee and Charnley[31] or screw breakage had occurred. Loosening of the femoral component was assessed by using the method described by Sim and Chao[2] with zones 1 to 10 around the femoral stem.

The modified Harris hip score (HHS) was used for the clinical evaluations of all patients at each visit.[32]

RESULTS

Clinical evaluation

The average clinical follow-up was 5.7 years (range 3.3-9 years). The average HHS of the 12 patients preoperatively was 30 points (range 16-42). Three patients had a permanent Girdlestone operation because of persistent deep infection or recurrent infection. The HHS of the remaining 9 patients with a retained megaprosthesis was 83 points (range 68 to 92 points) at the final follow-up. Ambulatory ability was evaluated in these 9 patients: 6 patients walked without aid, 2 needed a cane and 1 needed a walker for walking.

Radiographic evaluation

One hip had a complete radiolucent line > 1 mm in the cement-bone interface of the femoral component at 1.8 years postoperatively. There was no loosening of the acetabular component. However, 3 hips had an incomplete radiolucent line in zones 1 and 2 described by DeLee and Charnley. Three hips, two with tape fixation and one with wire fixation of the greater trochanter to the megaprosthesis, showed displacement of the greater trochanter on the follow-up radiographs. The distance of migration of the greater trochanter in these hips was 7, 9 and 12 mm, respectively. All the 9 hips with onlay allograft struts, which were used to re-enforce the junction of the host femur to the megaprosthesis, had complete healing of the allografts to the host femur (Fig. 1-B).

Complications

The complication rate was high, including dislocation of the hip in 5 patients (42%), deep infection in 4 (33%) ectopic bone formation in 1 (8%), leg length discrepancy (LLD) > 3 cm in 2 (16.7%), displacement of the greater trochanter in 3 (25%) and aseptic loosening of the megaprosthesis in 1 (8%) (Table 1). In the early period of the study, 3 out of 4 hips (75%) had postoperative dislocations. This was reduced to 1 dislocation in the subsequent 7 patients (14%) who wore an abduction brace postoperatively for 12 weeks. The remaining 1 patient (case 7) did not comply with the use of an abduction brace and had repeated dislocations of the hip postoperatively.

Three patients had a permanent Girdlestone operation for a recurrent or persistent deep infection. Two patients had a successful revision of the megaprosthesis, one because of infection and the other because of aseptic loosening of the megaprosthesis. The remaining 7 megaprostheses were well-fixed at the latest follow-up.

DISCUSSION

Reconstruction for severe proximal femoral bone loss in complicated revision arthroplasty include APC,[5,11,33] replacement of the proximal femur with a megaprosthesis[12-14,26,27] or resection arthroplasty.[10] However, resection arthroplasty remains the last resort because of persistent pain, limb shortening and poor ambulatory ability.[10]

Many authors tended to use megaprostheses to reconstruct the proximal femur in older and less active patients, who had osteoporosis and severe bone deficiency in the proximal femur.[1,2,14,22,34] Early mobilization and immediate full weight bearing can be allowed if the megaprosthesis is successfully implanted.[34] APC, which provides bone stock for later use, is reserved for young, active patients.[20] In the current report, the mean age of the 12 patients was 59 years, with the youngest one being 25 years old. Eight patients had a failed THA because of infection including 4 APC reconstructions, which were considered not a good indication for massive allograft reconstruction, and 1 patient had failure of previous APC reconstruction. The age of the remaining 3 patients was 58, 69 and 75 years, respectively.

Although the megaprosthesis of the proximal femur has promising short- and medium-term results when used in tumor and non-tumor conditions, it has a high rate of complications, including dislocation, fracture, infection and stem loosening.[12,13,20,26,27] The rate of dislocation is the highest, ranging from 18% to 50% in various reports.[12,13,20,26,27] The causes of dislocation are multifactorial, including old age with loose soft tissue, multiple previous operations with compromised abductors, inability to achieve secure repair of the abductors to the metal prosthesis and inappropriate soft tissue tension postoperatively.[1] Haentjens et al. reported a dislocation rate of 37% even after their special technical precautions, which included less than 30° of cup inclination, reattachment of the abduction apparatus and limb-lengthening by about 1 cm.[12] Postoperative care is important too. Sim and Chao immobilized the limb in a balanced suspension splint for 7-10 days postoperatively and reported dislocation in one of 10 cases.[2] Ross et al. reported an early dislocation rate of 43%, which was subsequently reduced to 5% by routine use of an abduction brace postoperatively.[27] In the current report, the dislocation rate was high (3 out of 4) in our early experience. However, after the routine use of an abduction brace postoperatively in the later period of this study, only 1 dislocation was seen in 7 patients who complied with the use of the abduction brace. The remaining 1 patient (case 7), who had repeated dislocations, did not use the abduction brace postoperatively despite of our advice.

Aseptic loosening of the acetabular and femoral components is another issue in proximal femoral megaprosthesis use. Malkani et al. reported aseptic loosening of 4 femoral and 7 acetabular components in 33 hips at an average of 11 years after proximal femoral replacement for non-neoplastic disorders.[13] In their report, they attributed the high rate of loosening of the acetabular components to use of a 32 mm diameter femoral head. As to the femoral component, the diaphyseal cement fixation predisposes the bone-cement-prosthesis to high torsional and compressive stresses leading to early loosening. We tried to reduce the stress on the femoral stem by adding onlay strut grafts bridging the porous surface of the megaprosthesis and the host femur.[1] So far, only 1 femoral component was revised because of aseptic loosening.

As for postoperative deep infection, the reported incidences range from 6.5% to 16%.[12,13,20,26,27] The infection rate of 33% in our series is relatively high. Eight patients (67%) in the current report had a failed THA because of infection; 4 of them had had an APC reconstruction. The average number of operations before revision to a megaprosthesis was 6.5. Multiple operations and a history of infection are the risk factors that account for the high infection rate in this series.

The results of revision THA with proximal femur megaprosthesis were satisfactory in 8 of the 12 patients at an average follow-up of 5.7 years. Patients with failed THA and massive proximal femoral bone loss can be salvaged with this procedure. However, this procedure is technically demanding and has a high complication rate. Postoperative use of an abduction brace is advised to reduce the dislocation rate.

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股骨近端人工關節用於失敗的全人工髖關節置換

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背 景： 本回溯性研究的目的在於評估全人工髖關節置換後導致股骨缺損，而以股骨近端人工關節重建的臨床結果及其併發症。

方 法： 由 1997 年至 2002 年間，有 12 例 (12 髖關節) 以股骨近端人工關節來重建失敗的全人工髖關節，病人平均年齡爲 59 歲，12 例中有 8 例因感染，另外 4 例因非感染引致全人工髖關節鬆脫，平均股骨近端人工關節置換長度爲 15.6 公分。

結 果： 平均追蹤時間爲 5.7 年 (範圍，3.3 至 9 年)，8 例 (67%) 得到滿意結果，1 例一般 (fair)，3 例爲差 (poor)。併發症包括感染 (33%)，脫臼 (42%)，長短腳大於 3 公分 (16.7%)，大轉子移位 (25%)，異位骨化症 (8%)，股骨莖鬆脫 (8%)，手術前 12 例平均 HHS 評分爲 30 分 (範圍，16 至 42 分)，9 例股骨近端人工關節仍保留者平均 HHS 評分爲 83 分 (範圍，68 至 92分)。

結 論： 如果沒有其他更好的方法。全人工髖關節失敗後導致大量股骨缺損，以股骨近端人工關節來重建，是一個好方法。然而，此種手術技術層面高而且術後併發症較高，術後使用外展支架可減少脫臼機率。

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關鍵詞：巨大人工關節，近端股骨置換，全人工關節置換。

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