Clin Orthop Relat Res (2013) 471:1622–1627
DOI 10.1007/s11999-013-2790-4

Clinical Orthopaedics and Related Research®
A Publication of The Association of Bone and Joint Surgeons®

CLINICAL RESEARCH

A Long Femoral Stem Is Not Always Required in Hip Arthroplasty for Patients With Proximal Femur Metastases

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Received: 12 June 2012 / Accepted: 4 January 2013 / Published online: 30 January 2013

Abstract
Background During hip arthroplasties for treating proximal femur metastases, a long femoral stem frequently is used, presumably protecting the entire femur against progression of the existing lesions or development of new lesions. However, it is unclear whether a long stem is really required.
Questions/purposes We therefore determined in patients with proximal femur metastases (1) the reoperation rate related to different stem lengths after hip arthroplasty, (2) the risk of tumor progression in the same femur (the progression of preexisting lesions and the development of new distal femur lesions), and (3) complications.
Methods We retrospectively reviewed 203 patients (206 femurs) with proximal femur metastases treated with hip arthroplasty. These femurs were divided into three groups based on femoral stem length: short stem (SS), 12 to 14 cm; medium stem (MS), 20 to 24 cm; and long stem (LS), 25 to 35 cm. We reviewed reoperations, disease progression in the same femur, and complications. Minimum followup was 2 days (median, 487 days; range, 2–4853 days), with most patients followed to their death.
Results Only three femurs were revised owing to tumor progression, with no difference among the SS, MS, and LS groups. Two SS prostheses were revised for nononcologic reasons. Tumor progression in the same femur was uncommon during the patient's survival, with 11 femurs showing progression of the proximal lesion and five femurs showing new distal lesions. The complication rate was higher in the LS group (28%) than the combined rate in the MS and SS groups (16%), especially acute cardiopulmonary complications (18% versus 7.5%).
Conclusions Reoperation after hip arthroplasty for proximal femur metastases is uncommon and not correlated with femoral stem length. Considering the high complication rate associated with a LS hip prosthesis, we do not believe its routine use is justified.
Level of Evidence Level III, therapeutic study. See Instructions for Authors for a complete description of levels of evidence.

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Introduction

Metastatic lesions in the proximal femur can cause substantial morbidity and mortality owing to pain and pathologic fractures [1, 7]. To prevent or fix pathologic fractures of the proximal femur, endoprosthetic hip arthroplasty is recommended when the patient's general condition or life expectancy justifies it [4, 6, 10, 14, 15]. However, controversies still exist regarding the type of prosthesis that should be used. Some surgeons [7, 9, 19] have recommended a long-stem (LS) cemented hip prosthesis to protect the entire femur against fractures in the event that proximal lesions progress or additional distal metastatic lesions develop [4]. However, the incidence of having new metastatic lesions develop requiring surgical treatment in the same femur during the lifetime of these patients with metastatic cancer is unclear. Thus, the benefit of the LS hip prosthesis may be only hypothetical, especially when considering the possibility of cardiopulmonary complications [8, 11].

We therefore determined in patients with proximal femur metastases (1) the reoperation rate related to different stem lengths after hip arthroplasty, (2) the risk of tumor progression in the same femur (the progression of preexisting lesions and development of new distal femur lesions), and (3) the complication rates.

Patients and Methods

We retrospectively reviewed patients with proximal femur metastases treated with hip arthroplasty in our institution between 1993 and 2008. The surgery performed was resection of the femoral head and neck, curettage of any residual lesion in the intertrochanteric area, and reconstruction with a hip prosthesis with or without calcar replacement. The indications for hip arthroplasty were pathologic fractures or impending pathologic fractures in the proximal femur (above the subtrochanteric level). The patients who had more extensive lesions and required proximal femur resection and reconstruction using megaprostheses were excluded from this study. Lesions below the subtrochanteric level were treated mostly with intramedullary nail fixation if we judged surgery appropriate, thus these cases were excluded from this study. The contraindications for surgery were poor general condition or severe comorbidities that impeded the safety of surgery.

We identified 203 consecutive patients (206 femurs), treated with hip arthroplasties, through the orthopaedic oncology database and institutional tumor registry. There were 117 women (120 femurs) and 86 men (86 femurs), with a mean age of 58 years (range, 20–84 years). The preoperative oncologic status of these patients regarding primary cancer types, extent of metastases, pathologic fractures, and perioperative radiation therapy is reported (Table 1). The median postoperative followup for the entire series was 487 days (range, 2–4853 days). At last followup, 185 patients (with 188 diseased femurs) had died (median followup, 200 days; range, 2–3496 days), 10 were alive (median followup, 1270 days; range, 707–4853 days), and eight were lost to followup (median followup, 186 days; range, 16–640 days.) No patients were recalled specifically for this study; all data were obtained from medical records and radiographs.

Table 1. Preoperative oncologic status of the patients

Oncologic status	Number of femurs
Total number of femurs	206
Primary cancer	
Breast	57
Renal cell	43
Lung	29
Multiple myeloma	21
Prostate cancer	14
Others (14 types)	42
Concomitant visceral metastases	133
Additional distal femur lesions	45
Pathologic fracture of proximal femur	125
Perioperative radiation therapy	100

The type of prosthesis and stem lengths were chosen by the individual surgeon. The majority (203 patients) was treated with cemented bipolar hemiarthroplasty, one was treated with a press-fit bipolar hemiarthroplasty, and two were treated with THA. The surgically treated femurs were divided into three groups based on the length of the femoral stem: the short-stem (SS) group included those with the standard stem lengths, ranging from 12 to 14 cm; the medium-stem (MS) group included those with stem lengths ranging from 20 cm to 24 cm; and the LS group included those with stem lengths ranging from 25 cm to 35 cm. There were 35 femurs in the SS group, 99 in the MS group, and 72 in the LS group.

After surgery, the patients were followed daily when they were in the hospital, then every 3 months at the clinic with appropriate physical examination and imaging studies, including radiographs and bone scan or MRI when indicated. If the patient died at an outside facility, the death date and reason were recorded by our tumor registry.

We reviewed medical records and radiographic images for each patient to determine differences in reoperation rate, complication rate, incidence of tumor progression in the same femur, variation of radiation therapy, and patient survival time. We used the Kaplan-Meier method to estimate the overall survival rate. Survival time was calculated from the date of surgery to the date of death of the patient. The log-rank test was used to evaluate the difference in the overall survival rate among the SS, MS, and LS groups. Fisher's exact test was used to test the difference in reoperation rate, complication rate, and rate of receiving radiation therapy among the three groups. S-PLUS® 8.0 (TIBCO Software Inc, Palo Alto, CA, USA) statistical software was used.

Results

The reoperation rate was low during the patient's survival time (Table 2): five of the 206 femurs required prosthesis revision or additional internal fixation. Three of these reoperations were in the SS group, attributable to aseptic loosening, nonpathologic periprosthetic fracture, and progression of the proximal lesion, respectively. These were revised to either a LS prosthesis or proximal femur megaprosthesis. The other two reoperations were in the MS and LS groups; both were attributable to new distal lesions and treated with distal femur plating (one MS) or total femur replacement (one LS). The overall reoperation rate was higher ($p = 0.034$) in the SS group (8.6%) than in the MS group (1.0%), and the LS group (1.4%). However, only three of the 206 femurs (1.5%) required reoperation owing to oncologic reasons including either proximal lesion progression or new distal lesions, with no difference ($p = 0.734$) among the SS, MS, and LS groups. This reoperation rate was based on the poor survival rate of these patients. The overall survival rate was 93% at 1 month and 40% at 1 year after surgery, with no difference ($p = 0.191$) among the SS, MS, and LS groups.

Tumor progression in the same femur was low during the patient's survival. We identified progression of the proximal lesion in 11 of the 206 femurs (one SS, three MS, seven LS) (Table 3). The prosthesis showed loosening in only one of these 11 femurs (in the SS group); that patient had revision of the prosthesis to a proximal femur megaprosthesis. New distal lesions were found in five femurs (one SS, two MS, two LS) (Table 4), but only two (one LS, one MS) required reoperation with total femur replacement and distal femur plating, respectively. Of the 45 femurs with preexisting distal lesions (28 LS, 13 MS, four SS), two showed progression of the distal lesions (both in the LS group and neither required reoperation). Of the 11 femurs with proximal lesion progression, eight did not receive radiation to the affected area. Of the seven femurs with either new distal lesions (five) or progression of preexisting distal lesions (two), five did not receive radiation, and the other two received postoperative radiation without covering the distal femur.

The overall postoperative complication rate was 20% (Table 2). It was higher ($p = 0.038$) in the LS group than in the combined MS and SS groups (28% versus 16%). There was a high rate of acute cardiopulmonary complications (11.2%), including intraoperative desaturation (one LS), intraoperative cardiac arrest (one LS), postoperative

Table 2. Postoperative data of the three groups with different stem lengths

Variable	SS	MS	LS	p value
Number of femurs	35	99	72	
Reoperation (all reasons)	3	1	1	0.034
Reoperation (oncologic reasons)	1	1	1	0.734
Progression of proximal lesions	1	3	7	0.145
New distal lesions	1	2	2	1.0
Overall complications	4	17	20	0.038 (LS versus MS + SS)
Cardiovascular complications	2	8	13	0.020 (LS versus MS + SS)

* Values are expressed as number of femurs; SS = short stem; MS = medium stem; LS = long stem.

Table 3. Progression of proximal lesions

Patient	Sex	Age (years)	Primary tumor	Stem length	Radiation	Survival (days)	Additional surgery
1	F	64	Breast	Long	No	900	No
2	F	51	Breast	Long	No	917	No
3	M	52	Lung	Short	Yes	291	Proximal femur replacement (POD 192)
4	M	69	Renal cell carcinoma	Medium	No	168	No
5	F	35	Breast	Long	No	300	No
6	F	55	Breast	Medium	Yes	1278	No
7	F	52	Multiple myeloma	Long	No	944	No
8	F	67	Lung	Long	No	291	No
9	M	43	Renal cell carcinoma	Long	No	280	No
10	F	57	Renal cell carcinoma	Medium	No	307	No
11	M	51	Unknown	Long	Yes	615	No

POD = postoperative day.

Table 4. Development of new distal lesions

Patient	Sex	Age (years)	Primary tumor	Stem length	Radiation	Survival (days)	Location of lesion	Additional surgery
1	F	46	Breast	Long	Yes	390	Distal metaphyseal, below stem	No
2	F	47	Unknown	Short	No	361	Distal metaphyseal, below stem	No
3	F	46	Breast	Medium	No	691	Distal metaphyseal, below stem	No
4	F	67	Lung	Long	Yes	291	Distal metaphyseal, below stem	Total femur replacement (POD 142)
5	M	46	Renal cell carcinoma	Medium	No	519	Distal metaphyseal, below stem	Plate fixation and cement (POD 355)

POD = postoperative day.

respiratory distress (six LS, five MS, one SS), pneumonia (five LS, three MS), and pulmonary embolism (one SS). Cardiopulmonary complications were significantly higher ($p = 0.020$) in the LS group than in the combined MS and SS groups (18% versus 7.5%). The two patients with intraoperative desaturation or cardiac arrest were in the LS group and were successfully resuscitated.

Discussion

Proximal femur metastases can cause pain and pathologic fracture that impede patients' ambulation and decrease their activity level and quality of life. When surgical treatment is indicated, hip arthroplasty with a long femoral stem has been recommended [2, 4, 7, 9, 19]. The idea is to prophylactically protect the entire femur to avoid reoperation owing to prosthesis loosening or periprosthetic fractures caused by progression of proximal lesions or development of new distal lesions. However, the incidence of these events is unknown and cementing a LS hip prosthesis may be associated with higher risk of cardiovascular complications. Thus, we question the traditional view of ubiquitous use of a long femoral stem for hip arthroplasty in patients with proximal femur metastases, and therefore determined in patients with proximal femur metastases (1) the reoperation rate related to different stem lengths after hip arthroplasty, (2) the risk of tumor progression in the same femur (the progression of preexisting lesions and the development of new distal femur lesions), and (3) complications.

We caution readers concerning the limitations of our study. First, owing to the retrospective nature of the study we had a large variation in tumor type, tumor extent, and comorbidities. Second, the study period spanned 15 years so there was high variation in adjuvant treatment protocols. Third, the surgeries were performed by multiple surgeons; thus, there may be variations in the details of surgical technique, especially cementing and femoral canal preparation. Different designs of prostheses were used, which may have inherent variation in their clinical performance. All these variations may create confounding factors and thus have lowered the level of evidence of this study to Level III. However, we reviewed a large series of consecutive patients. We had complete medical records and most patients were followed until death. Therefore our findings represent the current clinical reality of patients with proximal femur metastases treated with hip arthroplasty.

We found a low rate of reoperation after hip arthroplasty (prosthesis revision or additional fixation) attributable to oncologic reasons and no correlation with stem length. SS prostheses showed a relatively higher overall reoperation rate owing to nononcologic reasons (aseptic loosening and periprosthetic fracture), possibly attributable to poor bone quality in the proximal femur with metastatic lesions. Nevertheless, LS prostheses did not appear to have advantages over MS prostheses when considering the reoperation rate attributable to all reasons and did not appear to have advantages over MS or SS prostheses when considering reoperation rate attributable to oncologic reasons. In addition, our findings showed even a long femoral stem cannot completely protect the entire femur, especially the distal metaphyseal and epiphyseal areas.

Progression of the preexisting lesions and development of new distal lesions were uncommon after hip arthroplasty in our patients. One contributing factor is likely the poor survival of these patients. Even with the recent advances in treatment for primary cancers, the survival of patients with bone metastases remains poor [9, 14, 18]. Wedin [20] reported survival rates of 30% at 1 year and 0.8% at 3 years after surgical treatment for skeletal metastases. For patients undergoing hip arthroplasty for treatment of a pathologic or an impending pathologic hip fracture, the

1-year survival rate is reportedly only 40% and the median survival duration 8.6 months [13]. Jacofsky and Haidukewych [9] reported 10% of the patients with proximal femur metastases died within 30 days and 78% within 1 year after surgery. Our data showed a similar survival rate and confirmed the poor prognosis of patients with proximal femur metastases. Even though the overall survival of these patients may not be substantially improved, systemic treatments (chemotherapy, targeted therapy, and bisphosphonates) and local radiation therapy have been more effective in slowing the progression of bone metastases [3, 5, 16, 17]. Therefore, disease progression in the same femur may not be substantial in many patients during their survival time. This is confirmed by our findings. Most of our patients with progression of the proximal lesions or development of new distal lesions did not have radiation therapy. It can be postulated the low incidence of proximal lesion progression and/or the development of new distal lesions in our series could be decreased further with an optimal radiation protocol.

The use of a long femoral stem should be questioned more extensively when considering the intraoperative and postoperative complications. Concerns regarding a LS prosthesis include cardiopulmonary complications, technical difficulties related to insertion, and more difficult revisions if an infection or periprosthetic fracture occurs [2]. Our study confirmed LS prostheses are associated with more complications, especially acute cardiopulmonary complications, when compared with SS and MS prostheses. In 1991, Patterson et al. [11] reported seven patients who had cardiac arrest during hip arthroplasty with a cemented LS femoral component. Three patients were successfully resuscitated, but four died in the operating room. Herrenbruck et al. [8] reviewed 55 consecutive patients requiring LS femoral arthroplasty and found adverse clinical events, including hypotension, sympathomimetic administration, and oxygen desaturation, occurred in 62% patients. This included coma in two patients and death in a third. In contrast, Randall et al. [12] reviewed 29 patients with LS cemented hip arthroplasty and reported no postoperative cardiopulmonary events. However, worsening mental status occurred postoperatively in 3% of patients, intraoperative cement-associated hypotension occurred in 14% of patients, and sympathomimetics were administered in 31% of patients [12]. These authors emphasized modifying conventional surgical techniques to minimize cement-associated cardiopulmonary complications, including aggressive medullary lavage, intraoperative canal suctioning during cementation, use of early low-viscosity bone cement, and slow insertion of the LS prosthesis [12]. A cementless LS may decrease the risk of complications as no cementation is required. However, the poor bone quality and need for postoperative radiation may affect the bone ingrowth desired for a cementless stem.

Considering the low reoperation rate regardless of the stem length, but higher complication rate associated with a LS hip prosthesis in our study, we believe the ubiquitous use of a LS hip prosthesis in every patient with proximal femur metastases is not justified. Factors including lesion extent, tumor type, and patient's response to adjuvant treatments should be considered when choosing the stem length. SS or MS prostheses may be suitable for most patients with proximal femur metastatic lesions, and LS prostheses can be reserved for patients with concomitant large lesions in the femoral shaft. Careful attention should be paid to reaming and cementing to minimize cardiopulmonary complications. Regardless of the length of stem used, postoperative radiation and further systemic treatment should be considered.

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