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ORIGINAL STUDY

Intramedullary nailing without curettage and cement augmentation for the treatment of impending and complete pathological fractures of the proximal or midshaft femur

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Metastases in the proximal femur and in the femoral diaphysis are usually treated with either cephalomedullary or intramedullary nailing. The benefit of curettage and augmentation of the nail with methyl methacrylate remains controversial. The authors retrospectively studied the outcomes with cephalomedullary and intramedullary nailing without curettage and methyl-methacrylate augmentation for lytic metastases of the proximal/diaphyseal femur. Twenty-one complete (11) or impending (10) pathological fractures in 19 consecutive patients were treated between January 2006 and August 2013. There were 11 women and 8 men. Their mean age was 62 years (range, 38 to 87). All patients received adjuvant chemotherapy or radiotherapy.The average postsurgical survival was 9.7 months (range 1-36 months). A single deep infection was débrided. Seventeen out of 19 patients were ambulatory, with or without a walking aid. No implant failure was noted. In other words, patients succumbed to the disease prior to hardware failure. Femoral nail insertion without curettage and cement augmentation provided satisfactory stabilization of proximal and diaphyseal femur fractures, impending or complete, even when there was massive bone destruction.

Keywords : pathological fracture ; femur ; fixation ; cement ; methyl-methacrylate ; curettage ; intramedullary nailing ; reconstruction nail.

INTRODUCTION

The incidence of metastatic bone disease is increasing, as oncological patients are living longer (*23*). The proximal femur is the bone most commonly affected with metastatic disease in the appendicular skeleton (*11*). The carcinomas which most commonly metastasize to bone are : breast, lung, prostate, kidney and thyroid (*4*).

Often, the clinical presentation of a bony metastasis is an accidental finding, as part of an oncological work up. Since a fracture is considered to be a multifactorial process, influenced by many interacting properties of both the lesion and the patient (*21*), it is difficult to accurately determine when a metastasis is threatening the structural bony integrity severely enough that it should require prophylactic fixation. A weighted scoring system to quantify the risk of sustaining a pathological fracture through a metastatic lesion in a long bone was suggested by Mirels in 1989 (*18*). If the Mirels score is 8 or high-

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er, the patient is at a high risk of sustaining a pathological fracture. Although Mirels' criteria are a good guide for communication between physicians and for initial decision-making, clinical judgment and experience are by far the best predictor of fracture risk (*11,21*). Van der Linden *et al* (*21*) found that axial cortical involvement > 30 mm, and circumferential cortical involvement > 50% were more predictive of fracture in patients with femoral metastases than Mirels' score (*21*). The metastatic involvement causes two primary clinical problems : pain and mechanical disruption (*22*). In most patients with metastatic involvement, the orthopedic challenge is limited to palliation rather than to cure, and is thus focused to restoring or maintaining the ability to bear weight and ambulate. When encountering a metastatic lesion, the surgeon needs to take into consideration multiple factors including the histological characteristics of the primary tumor, the expected life span of the patient, patient's co-morbidities, the patient's activity level, and pain (*24*).

Fractures of the femur, whether impending or complete fractures, are classically internally fixed with intramedullary devices (*1,7,8,11,21,14,17,19,22,24*) which control impaction, distraction, and torque stresses by the use of proximal and distal interlocking fixation. Such fixation must be able to withstand weight-bearing stresses on lower extremity long bones. Methyl-methacrylate is often used in combination with prostheses or intramedullary devices to supplement the fixation (*24*). The use of methyl-methacrylate can add mechanical stability to the entire construct, allowing bridging between the proximal and distal ends of the bone at the fracture site. Therefore it should be used in the majority of patients to supplement fixation. Furthermore, it helps to unload the stresses placed on the interlocking screws during weight bearing. Finally it may supplement the curettage by its exothermic polymerization (*11*). Although there is no evidence that a specific size of a lesion necessitates curettage or methyl methacrylate augmentation, some basic rules are recommended by most orthopedic oncologists. Generally speaking, a large soft-tissue mass or an important osteolysis will probably benefit from curettage (*3,11*). Additionally, open segment defects with little or no host bone contact at the ends of the fracture will also benefit from cement augmentation, reducing the risk of hardware failure (*11*). In contrast, curettage alone is usually not indicated if the entire periosteal surface of the bone is intact, when dealing with an impending fracture, as perforation of the cortex to perform the procedure may further weaken the femur. Thus, if there is no focal area of bone loss, fixation with an intramedullary nail without curettage and cementation may be of great benefit to the patient (*22*).

The purpose of this study was to present the authors' results using intramedullary fixation alone, without curettage and supplemental methyl-methacrylate, for the treatment of 19 patients who had either a complete or an impending pathological fracture of the proximal or midshaft femur. Approval from the Institutional Ethics Committee was obtained.

PATIENTS AND METHODS

All patients treated surgically for pathological fractures and impending pathological fractures of the femur, during the period from January 2006 to August 2013, were retrospectively reviewed. All patients in this cohort were treated and followed in the authors' department, an oncology service associated with a large tertiary academic hospital.

Patients either presented spontaneously to the emergency department or were referred by the treating oncologist. Radiographs of the pelvis, the entire femur and the knee joint were obtained on admission. They were sufficient to evaluate the extent of bone involvement according to the Mirels score (*18*). In addition, all patients underwent a technetium 99 bone scan to identify other bone lesions which may require prophylactic fixation. More advanced imaging was not routinely used because of the financial and logistic implications. The authors consulted the treating oncologist for each patient about their oncological condition, treatment options and expected survival.

Twenty-one femurs were stabilized in 19 patients : 11 women and 8 men (Table I). The mean age at the time of surgery was 62 years, ranging from 38 to 87. The study included 11 complete pathological fractures and 10 impending pathological fractures, due to metastases from primary tumors in the following locations : breast (9 patients, 11 femurs, 2 patients with bilateral lesions),

Table I. — 21 lytic femoral metastases in 19 patients : outcomes after osteosynthesis.

Case number	Gender/ Age	Primary tumor	Complete/ impending	Region	Survival Complications Implant failure (0)	Ambulatory
1	M 48	lung	complete	mid	10 months	yes
2	F 81	mult.myel.	complete	sub	3 months	yes
3*	F 67	breast	complete	sub	18 months	yes
3*	F 67	breast	impending	per	18 months	yes
4	M 81	prostate	complete	mid	3 months	yes
5	F 54	breast	complete	sub	16 months	yes
6	M 80	lung	impending	mid	6 months	yes
7	M 55	lung	complete	sub/mid	5 months	yes
8	M 66	lung	impending	per	4 mo alive	yes
9	F 87	lung	complete	mid	11 months	yes
10	F 58	breast	impending	per/mid	36 months	yes
11	M 53	colon	complete	per	4 months	yes
12	F 63	breast	complete	sub	1 month	no
13	F 38	breast	complete	per/sub	6 months	yes
14	M 72	mult.myel.	impending	per	10 months	yes
15*	F 64	breast	impending	per/sub	11 months infection	yes
15*	F 64	breast	impending	per	11 months	yes
16	M 63	mult.myel.	impending	per/mid	6 months	yes
17	F 51	breast	impending	per	17 months	yes
18	F 48	breast	complete	mid	3 months	no
19	F 52	breast	impending	per	16 months	yes

mult.myel. = multiple myeloma ; per = pertrochanteric ; sub = subtrochanteric ; mid = midshaft
* patients 3 and 15 : bilateral

lung (5 patients), colon (one patient) and prostate (one patient) (Fig. 1). There were also 3 fractures due to multiple myeloma (3 patients). The mean follow-up period was 4 months (range 1-13.8 months).

Thirteen lesions were located in the proximal part of the femur, either subtrochanteric or pertrochanteric, or both. Five lesions were confined to the femoral shaft. Three lesions involved both the proximal and midshaft femur. Impending pathological fractures were diagnosed from plain radiographs alone or in some cases from isotope bone scintigraphy and computerized tomography. All of the 9 patients (10 femurs) with an impending fracture had a known primary malignancy and all had lytic lesions. The location of the fractures is reproduced in Table I. All patients marked 8 or more on the Mirels score, suggesting a high risk of fracture. The authors' major contraindication to internal fixation was a life expectancy of less than one month.

The operation was performed under general anesthesia, with the patient supine on a fracture table or free on a radiolucent table, according to the surgeon's preference. Antegrade intramedullary nailing was preferred in all 21 femurs. Several nailing systems were used : Trigen (Smith & Nephew, Memphis, TN) long trochan-

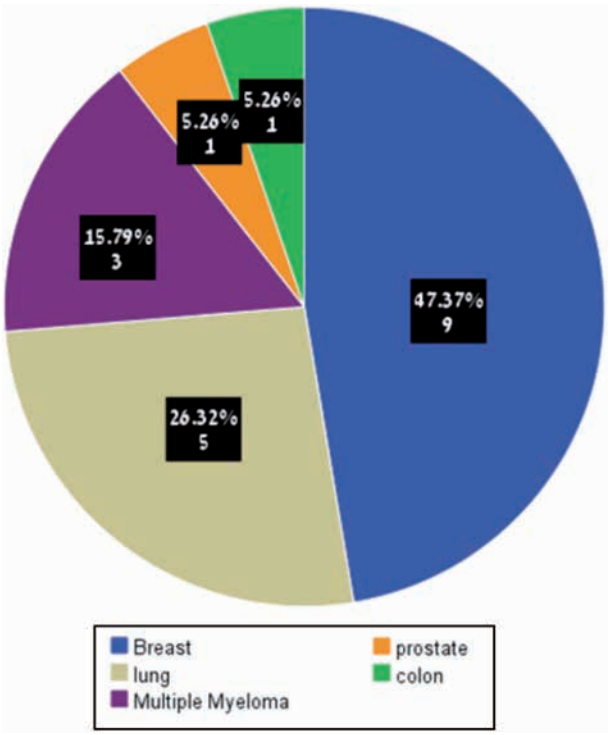

Fig. 1. — Distribution of the treated lesions according to the type of primary tumor.

teric antegrade nails (TAN) in 13 femurs, Aesculap long (Targon PF, B. Braun, Germany) in 3 femurs (Fig. 3), and long proximal femoral nail antirotation (PFNA) (Synthes, Hertfordshire, UK) in 5 femurs. Cephalomedullary devices were the rule in all cases except one, where a Trigen IMN was used (Table I : case 1) (Fig. 4). All nails were distally locked with one or two screws. Curettage or cement augmentation were omitted. Two patients (Table I, cases 3 and 15) had bilateral procedures : patient 3 in a single session, patient 15 with a two-week interval.

RESULTS

Four outcome measures were studied : survival, complications, weight bearing and revision.

Eighteen out of 19 patients died. The average postsurgical survival was 9.7 months, ranging from one month to 3 years. The mean survival as a function of the type of primary tumor was greatest in patients with breast cancer : 13.7 months (Fig. 2). There were no peroperative deaths.

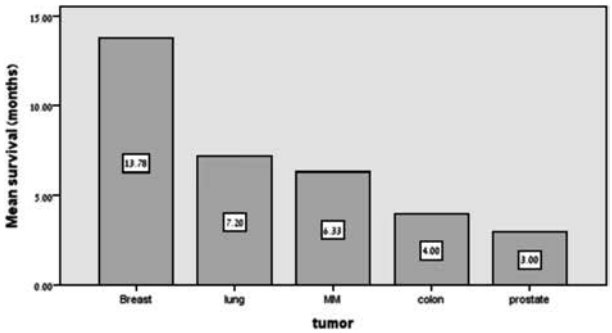

Fig. 2. — Mean survival in months according to the tumor type (MM = multiple myeloma).

One patient (case 15, table I), a 64-year-old female who underwent bilateral nailing for impending fractures, developed a deep wound infection, which required débridement in the operating theatre ; the wound eventually healed.

Seventeen of the 19 patients (89%) were able to walk with or without a walking aid after the operation.

Implant failures or cutouts of the nails were not seen.

DISCUSSION

The management of pathological fractures of the proximal femur can be challenging to the most experienced trauma surgeons. Surgery may be delayed due to poor general condition. Peri-operative complications are frequent. Moreover, poor bone stock may compromise the mechanical environment of the fracture. Lesions of the trochanteric and subtrochanteric region leave the choice between a reconstruction nail with locking screws into the femoral head, or an endoprosthesis (*(1,2)*.

Primary outcomes

As primary outcomes were chosen : survival, complications, weight bearing status, and need for revision of the implants.

The average postsurgical survival was 9.7 months. Similar studies reported a postsurgical survival ranging from 5.6 months to 15.4 months (*1,9,13,16*). These differences probably

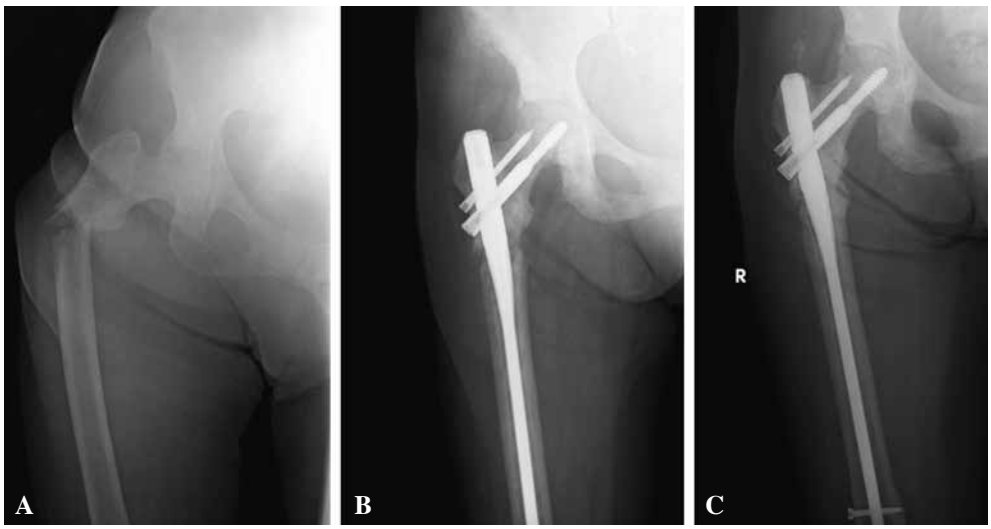

Fig. 3. — A : 67-year-old woman (case 3) with a subtrochanteric fracture through a metastasis from a breast carcinoma. B and C : long proximal femoral nail without cement augmentation results in stable fixation and gradual healing after 3 and 10 months.

Fig. 4. — A and B : 48-year-old man (case 1) with lung carcinoma and extensive cortical involvement (circle) of the right femur. C and D : locked nail leads to a stable fixation at 18 months.

reflect the different degrees of metastatic tumor involvement in each series. In the current series patients with breast cancer had by far the longest survival. Complications : one deep infection (4,76%) is quite acceptable, given the delicate background of these fractures. Weight bearing status : all patients were ambulatory, except 2 (cases 12 and 18). Implant failure : none.

Cement or not ?

Although methyl methacrylate augmentation leads to an increased purchase between bone and implant, it has also several drawbacks. Impaired fracture healing due to thermic necrosis is one of them (*5*). Furthermore, removal of the cement might be a problem in cases where revision surgery would be necessary. The low shear and tension strength of calcium phosphate and calcium sulfate cement is another disadvantage (*15*). Finally, cement augmentation often necessitates open intramedullary nailing, which means extensive dissection, bleeding from the tumor, and delayed wound healing (*20*).

In spite of all these drawbacks, Harrington *et al* (*9*) reported quite acceptable results with internal fixation and bone cement for the treatment of

impending and complete pathological fractures. They treated 130 pertrochanteric fractures with either intramedullary rods or plate-nails, and 47 femoral shaft fractures with either intramedullary rods, compression plates or long-stem femoral prostheses. They noted only 4 cases (2.25%) of mechanical failure of fixation, besides the classical complications such as infection, thromboembolism and delayed wound healing. They concluded that the use of adjunct cement affords immediate stability and allows most patients to resume walking. Of course, modern interlocking nails were not available at that time, and the investigators relied on older stabilization methods for which cement augmentation would probably be valuable.

On the other hand, the reconstruction nail has provided a useful tool in the treatment of pathological fractures of the femur. The idea of using nailing alone is, of course, not new. Previous studies have demonstrated stable fixation using several nailing systems (*1,6-8,10,14,17,25*). In line with these studies, our series confirms that proper mechanical stabilization of pathological femoral fractures can be achieved using antegrade nailing without curettage and augmentation. This may allow to avoid open exposure of the tumor site and application of methyl-methacrylate which may unnecessarily prolong the surgery and expose the patient to risks of cementation in long bones (*5*).

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