ORIGINAL ARTICLE

Type C periprosthetic fractures treated with locking plate fixation with a mean follow up of 2.5 years

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Summary
Background: Type C periprosthetic femoral fractures present fixation problems related to the extent of the fracture and the quality of the bone stock.

Objectives: The authors report a continuous and prospective series of type C periprosthetic femoral fractures to assess the mechanical stability of the femoral implant and the clinical outcome at the medium term.

Material and methods: Between April 2004 and November 2006, we treated 17 patients (15 females, two males) presenting a prosthetic hip fracture (12 cases), between the hip prosthesis and the knee (one case), and with a knee prosthesis (four cases). All the implants had no sign of loosening at the time of fracture. The patients’ mean age was 76.7 years (range, 39–93 years). Internal fixation was obtained with a locking compression plate (LCP) Synthes™ bridging the implant in place to prevent a weak zone. The rehabilitation protocol consisted in full weightbearing as much as possible.

Results: The mean follow-up of the series was 31.5 months (range, 4–51 months). Four deaths were recorded during the follow-up. Minimally invasive surgery was performed in 15 patients. Total loading was possible immediately in 10 patients, partial loading at 20 kg in three patients, and no loading was possible until 6 weeks in four patients. Two infections and a bending-type mechanical complication of the plate secondary to a fall were observed. Consolidation was obtained in all cases with the appearance of callus formation beginning in the 6th week.

Discussion: The technique used allies the principle of closed internal fixation (with preservation of the fracture hematoma) with mechanical stability. The screws locking to the plate warrant an internal fixator with increased stability that is sufficient for early loading with no risk of losing the secondary axis. Despite this increased rigidity, we did not observe any particular stress on the femoral implants. We recommend bridging the implant and spaced
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locking for better distribution of the stresses during loading. This hardware, with, if possible, insertion using a reduced approach, seems adapted to periprosthetic femoral fractures, particularly in the elderly.

Level of evidence: Level IV, prospective therapeutic study.

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Introduction

Periprosthetic femoral fractures are rare, occurring in 0.1%—2% of total hip arthroplasty (THA) implants and approximately 0.3%—2.5% of total knee arthroplasty (TKA) implants [1]. This disorder has been consistently increasing in frequency with the rise in the number of arthroplasties and the aging of the population. In a preliminary investigation [2], we reported satisfactory results in a series of 21 patients presenting a femoral fracture following prosthesis implantation or osteosynthesis, which were treated with a locking plate fixation placed with minimally invasive surgery followed by immediate weightbearing. We investigated the course of type C periprosthetic fractures (using the Vancouver classification for the THA [3] and the SOFCOT classification for the TKA [4]), concentrating on the effect of locking plates on the fixation of the prosthetic femoral implant. We therefore prospectively evaluated 17 type C periprosthetic femoral fractures with a mean follow-up of 2.5 years.

Patients and methods

Patients

We prospectively included all the type C periprosthetic femoral fractures treated with an LCP fixation (Synthes™) between April 2004 and November 2006 in our department. The inclusion criteria were a femoral fracture with a non-loosened implant treated with this material. During this period, all the femoral fractures with non-loosened implants were treated with this technique. The series reported herein includes 17 patients: 15 females and two males aged a mean of 76.7 years (range, 39—93 years). In 12 patients, the fracture was around a THA, between a TKA and THA in one patient, and around a TKA in four patients. All the implants presented a fixation that was judged on X-rays as satisfactory. According to the Parker and Palmer Index [5], the mean preoperative level of autonomy was 4.5 (range, 0—9). All the fractures were type C around the THA according to the Vancouver classification [3] and around the TKA according to the SOFCOT classification [4].

Method

The surgical technique was identical to that reported in a previous publication [2]. The osteosynthesis material used was the plate with screws of 4.5 mm and 5 mm, Synthes™, locking compression plate (LCP) system in titanium with locking screws. Two anatomical models were used, adapted to the fracture site [2]: a diaphyseal anatomic plate (Fig. 1) or a distal femoral anatomic plate (Fig. 2). These plates were not modified or twisted so as not to lose their anatomic shape. Surgery was performed on an orthopaedic table in supine position or on a standard table (most often in the supine position). The type of installation depended on the type of fracture: installation on a standard table for treatment of distal-third fractures or the middle third of the femur, and installation on an orthopaedic table for fractures of the middle third or the proximal third. The approach was minimally invasive, adapted to the fracture site and the plate type. Reduction was always attempted indirectly using radioscopically guided external maneuvers: traction in the axis or varus/varus maneuvers (made possible by the orthopaedic table or operative assistance during installation on the standard table), placing a cushion under the distal fragment in cases of lower limb fractures to prevent the recurvatum secondary to the traction of the gastrocnemius muscles. If the reduction was imperfect, certain techniques were used, as described previously [2]: the anatomic nature of the distal femoral plate, the plate-to-bone screw fixation, or intrafocal temporary pin fixation. This osteosynthesis material should be considered internal fixation with plate anatomical characteristics that make it possible to mold the bone to the plates. The objective was to obtain reduction at the scale of the entire bone segment while recuperating a femoral anatomical axis, rather than at the scale of the fracture itself. The plate was slid into submuscular,
Figure 2  Spiroid femoral shaft fracture with femoral implant in the left hip treated with distal femur anatomic locking compression plate (LCP) with locking screw. A. Preoperative status, anteroposterior (AP) and lateral views. Parker score = 6. B. X-ray at 24 months of follow-up. Loading was authorized after surgery. Parker score = 6 at revision.

extraperiosteal contact with the bone using radioscopic guidance. The principle was to bridge the material in place to prevent a peak of stresses in a mechanical weak zone between the material and the osteosynthesis plate. Bridging the implant was required and must be obtained in all cases, thus guiding the choice of the plate (model length). The specification for these osteosyntheses must be precise [2] so that postoperative weightbearing can be achieved in the greatest number of cases.

Evaluation criteria

Since the population studied was elderly, we deemed the most relevant clinical evaluation criterion to be the degree of autonomy following the example of proximal femur fractures [2]. Therefore, clinical revision was based on the Parker and Palmer score [5] at the last follow-up. The radiological data consisted in dating bone consolidation (appearance of callus formation on two cortical) and measuring the axes while searching for a possible malunion. Implant fixation was evaluated. We defined as pathological an angle measuring more than $10^\circ$ in the frontal and/or sagittal plane on a plain radiographic view and in the horizontal plane (axial rotation) clinically [2].

Results

The series comprised 17 patients with a mean follow-up of 31.5 months (range, 4–51 months) with four deaths. Minimally invasive surgery was performed on 15 patients and open surgery at the fracture site in two cases. Full weight-bearing was possible immediately in 10 cases, with partial

Figure 3  Plate bending mechanical complication. A. Preoperative status of a fracture with a bipolar prosthesis, complicated earlier with a fracture of the greater trochanter treated with a Courpied plate. Parker score = 4. B. Immediate AP postoperative x-ray with the locking screws spaced on the distal part, allowing the distribution and the absorption of stresses, and proximal wiring providing better proximal strength against the pullout forces. Immediate post-operative loading authorized. C. AP x-ray at 6 weeks of the osteosynthesis of the femoral fracture. Plate bending at more than $30^\circ$ after a fall. Note the bony callus formation beginning 6 weeks after the initial osteosynthesis. This bending was reduced by an external maneuver with the help of orthopaedic table. D. X-ray at the 31 months of follow-up. A $15^\circ$ varus persisted after unbending with external reduction. At the last follow-up, the Parker score was 4.
weightbearing at 20 kg for 6 weeks in three cases, and no weightbearing for 6 weeks in four cases. At revision, the Parker and Palmer score [5] was a mean 3.8 (range, 0—9). We encountered two infections:

(1) one case of osteoarthritis of the knee with *Staphylococcus aureus* with no entry port found (proximal approach used to place a diaphyseal plate with no distal incision, with installation on an orthopaedic table and traction using a boot) treated with adapted antibiotic therapy;

(2) a deep *Escherichia coli* and *S. aureus* infection treated with lavage and adapted antibiotic therapy.

We report one bending-type mechanical complication of the plate secondary to a fall 6 weeks after osteosynthesis. The plate was straightened using an external maneuver. Progression was satisfactory (Fig. 3). Bone union of the fractures was obtained, with appearance of callus formation beginning in the 6th week. Except for the plate bending following a fall (15° varus), no axis defect greater than 10° was found. Despite loading in 13 of 17 cases, there was no modification of the femoral axis over time. At revision, analysis of the x-ray films demonstrated no modification in the femoral implant stability.

**Discussion**

The largest series of type C periprosthetic femoral fractures that we have found was a multicenter study done under the auspices of the SOFCOT with 248 cases, but without reporting specifically the results of osteosynthesis using locking plate fixation: Molina et al. [6] reported a retrospective series of 580 femoral fractures around THA implants, including 180 type C fractures treated in 92% of the cases by osteosynthesis; Vogt et al. [7] reported a retrospective series of 68 fractures around TKA implants, with 28 type C fractures with no details on the material used; Laffargue et al. [8] analyzed a prospective series of fractures around THA implants with 28 type C cases out of a total of 115 patients; and Brilhaut and Burdin [9] prospectively analyzed fractures around TKA implants, with 12 type C fractures in a series of 28 cases in which none of the patients were treated with locking plate fixation. The series centered on conservative treatment of periprosthetic fractures using locking plate fixation report of relatively few type C fractures. To our knowledge, the largest series are the following: Ricci and Borelli [10] reported 30 type C fractures treated with a locking plate fixation in a series of 59 patients, Kobbe et al. [11] published a report of 11 type C fractures in 16 patients at a mean follow-up of 34 months, and finally, we have reported 13 type C fractures [2]. Smaller series of type C fractures were found: Curral et al. [12] reported five cases, Chakravarthy et al. [13] six cases, Kumar et al. [14] six cases, and Fulkerson et al. [15] six cases.

The series that we report is comparable to the epidemiological data in the literature as defined by Mabit et al. [16]: female patients with a mean age between 75 and 80 years who present a fracture with a THA implant secondary to a low-energy fall injury occurring in the home. The indication for conservative treatment with osteosynthesis in the context of a type C fracture with a non-loosened femoral prosthesis admit no discussion [1,10,11,17,18]. The choice of the osteosynthesis material in conservative treatment of periprosthetic fractures on stable implants has yet to find consensus, even if the advent of locking screw plates was a turning point in the management of this pathology. Although most authors report good results and recommend using this osteosynthesis material, some advise against it. In a biomechanics study, Zdero et al. [19] concluded that the best mechanical resistance was obtained with plate osteosynthesis without locking screws associated with a strut allograft (compression, torsion, flexion, as well as breakage tests). Buttaro et al. [20] found no advantage to the locking screw system in a series of 14 type B1 periprosthetic fractures reporting six mechanical failures. We believe that the results of this series should be considered in light of the extension and the approach site, thus forfeiting the biological nature of the osteosynthesis.

Like other authors [9—15,21—23], we have shown the advantage of these locking plate fixations in treating periprosthetic femoral fractures [2]. The results reported here with a mean 2.5 years of follow-up are favorable and we recommend continuing in this direction. This locking plate fixation system provides better stability in osteoporotic bone [23—25] and allows loading, provided that the assembly is mechanically effective and respects the mechanical specifications [2]. We again recommend early loading so that the patient’s autonomy is preserved. Performing osteosynthesis with a minimally invasive technique, allying the principle of a limited incision with preservation of the hematoma and periosteal vascularization by not using a direct approach, and primary stability independent of the friction effect (between bone and plate) participate in the good results obtained in terms of consolidation. The association of the locking plate and minimally invasive surgery allows early loading and promotes good-quality callus formation [25—27], as in centromedullary nailing. These two elements cannot be dissociated. The clinical results that we observed confirm that this early loading is beneficial.

The series of periprosthetic fractures treated with locking plate fixation are multiplying [9—15,20—23], but few report results with more than 2 years of follow-up [10—12,15]. The results reported in the literature are generally good in terms of consolidation, with low infection rates and preservation of this elderly population’s level of autonomy. However, certain series report mechanical failures in these osteosyntheses: three cases of screw breakage [10], two cases of plate breakage [11], three cases of plate breakage and three cases of disassembly with plate pullout [20], one case of mechanical failure with plate pullout [13], and one case of disassembly with plate pullout [15]. It is difficult to find the causes of these disassembly events, but the authors raised the issue of early loading in two cases [11]. Of the 10 cases of full weightbearing, we observed no mechanical complication. The literature reports three cases of plate breakage after consolidation (6, 8, and 12 months) [20], proving that the osteosynthesis system absorbs the loading stresses (compression, torsion, or flexion). The question of femoral implant mechanical fixation has not arisen at the medium term [10—12,15]. Only Molina et al. [6], in a series of type C fractures, have evaluated implant fixation, finding 72% of the implants stable for 21% with non-evolving radiolucency and 7% fixation failure, but without relating
the type of osteosynthesis, notably the locking plate fixation systems. We report no modification in implant loosening over time. It is clear that the follow-up in the present study is insufficient to evaluate the survival of the prosthesis in terms of periprosthetic fracture. However, in the context of a periprosthetic fracture, this traumatic episode could induce a modification of the prosthetic interfaces. The type of osteosynthesis assembly with a long plate and implant bridging could have altered the transmission of stresses after consolidation through femoral rigidification. It even seems that the opposite occurs with relative protection of the implant by absorption of the stresses by the osteosynthesis material in view of the plate breakage after consolidation [20]. The least functional demand on the part of the patients after periprosthetic fracture must be taken into account in femoral implant survival. Indeed, this traumatic episode can be compared to the fracture of the femoral neck in the elderly individual, a turning point in maintaining the patient’s level of autonomy.

Conclusion

The locking plate fixation system seems to be well adapted to treatment of type C periprosthetic femoral fractures, allowing early loading with no loss of reduction and without altering the femoral implant resistance at the medium term. For these type C fractures, the fracture’s behavior and the extent of progression should be considered independently of the prosthesis.

Conflict of interest statement


References