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ORIGINAL STUDY

Periprosthetic femoral fractures : outcome after treatment with LISS internal fixation or stem replacement in 36 patients

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Periprosthetic fractures of the femur present a challenging surgical problem. The aim of this study was to evaluate the outcome of periprosthetic femoral fractures (PFF) which were treated with internal fixation or stem revision. Depending on the fracture type in the Duncan-Vancouver-Classification, 42 patients with PFF were treated either with a Fixateur interne (n = 23) in cases with type B1 or C fractures, or with stem revision (n = 19) in cases with type B2/B3fractures. Follow-up rate was 78% over 24 months. All but two fractures showed radiological signs of healing. Implant failure was noted in 4 cases in the LISS group. The Lysholm and Larson scores were respectively 75.5 and 71 in patients undergoing stem revision, versus 74.5 and 69 in those treated with LISS fixation .

Even taking into account the higher risk of implant failure, the treatment with LISS internal fixation has shown to be a reasonable method in the treatment of periprosthetic fractures without stem loosening.

Keywords : periprosthetic fracture ; internal fixator ; LISS ; Duncan-Vancouver classification ; stem revision.

INTRODUCTION

Periprosthetic femoral fracture (PFF) following total hip arthroplasty is a major complication with high morbidity (*5*). The incidence of periprosthetic fractures is on the rise, owing to both the increased number of primary joint replacements and the higher number of revisions, as a result of demographic changes (*4,20,21*).

The treatment of periprosthetic fractures remains challenging, as reflected by the high complication rate following surgery. With a complication rate between 31 and 52% in literature (*1,3,26*), conservative treatment is generally regarded as obsolete (*10*). Regardless of the therapeutic approach, the healing of periprosthetic fractures may be affected by concomitant morbidities and circumstances such as local and generalised osteopenia, endosteal ischaemia from metal or bone cement, and osteolysis (*31,34,37*).

Operative treatment comprises the usage of cables and wires, plates and internal fixators, as well as stem revision and strut allografts, or a combination of these. The treatment selection depends

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on the extent of the displacement and the stability of the reduction. It also depends on the bone quality, the status of the prosthesis, the location of the fracture, and the type of prosthesis (*14,20*).

Various treatment algorithms for the treatment of periprosthetic fractures have been published, but even using the same classification system, they have lead to different recommendations for comparable fractures (*25,29*). However, there is consensus about the indication for stem replacement in the case of a loose stem (*7*). This has been shown to be an efficient treatment option (*7,24,28*).

In contrast, various treatment options have been suggested for patients with a stable prosthesis. Some authors have recommended stem revision (*39*), while others have used conventional plate fixation, retrograde nailing, or non operative treatment using traction, but with a high complication rate (*6,20*).

Recent studies have reported on the use of the less invasive stabilization system (LISS) in the treatment of periprosthetic fractures (*2,12,15,16, 33,41*). The option to treat periprosthetic fractures with the LISS is based on both its favourable biomechanical characteristics and its successful utilisation in general fracture treatment (*13,17,30,36*).

The aim of this study was to assess the outcome of treatment of periprosthetic femoral fractures. Fractures were classified according to the Duncan-Vancouver classification and were treated with either stem revision, in cases with stem loosening, or with the LISS plate, in cases with a stable stem.

Table I. — Duncan-Vancouver-Classification

Typ	Location	Subtype
A	Trochanteric	AG : Greater trochanter AL : Lesser trochanter
B	Around stem or stem tip	B1 : Prosthesis stable B2 : Prosthesis loose B3 : B2 + Poor bone stock
C	Distal fracture - below the stem tip	

Table II. — Study design

Period :	04/2002 - 02/2005
Number :	42 Periprosthetic femoral fractures type : B1=14, B2=13, B3=6 and C=9
Patients :	32 f / 10 m ; Ø 73 ys.(57 - 90)
Prosthesis :	36 x THA/FAP, 6x THA + TKA
Treatment	LISS 23, Stem revision 19
Follow up :	Larson-, Lysholm-Score, activity level

THA : Total hip arthroplasty ; FAP : Femoral arthroplasty, TKA : Total knee arthroplasty.

MATERIALS AND METHODS

Between April 2002 and February 2005 we treated 42 periprosthetic femoral fractures. The Duncan-Vancouver Classification system was chosen in order to characterize the status of the prosthesis (stable/unstable) (*7,11,21*) (table I). Patients with a stable stem (B1 and C fractures) were treated with a LISS-plate (14 type B1 and 9 C). B2 and B3 fractures (unstable stem) were treated with revision to a longer femoral stem to bypass the fracture, if possible (13 type B2, 6 type B3) (table II). Type A fractures were excluded. AP and lateral radiographs of the femur were used as the basis for evaluation of fracture and stem stability. Typical signs for loosening were stem displacement, radiolucent lines or a clear gap between the cortical bone and the stem. If more than 30 % of the stem were detached from the cortical bone, the stem was considered loose. When in doubt, a dynamic x-ray examination was additionally performed. If possible, we performed an intraoperative manual testing of the stem stability.

The average age of the patients was 73 years (range 57 to 90) with 10 males and 32 females. Most fractures occurred following a minor trauma, usually a fall. The average time between joint replacement and periprosthetic fracture was 4.6 years (range : 0.25 to 17.5). The time between injury and operative treatment ranged from 0 to 2 days.

Fourteen patients had at least one revision before the periprosthetic fracture. Three of the 14 patients had already presented a periprosthetic fracture and suffered a new fracture due to implant failure (1 case, screw pull-out) or a further fall (2 cases). The time interval between the last revision and the fracture was at least 4 month (range : 4-60). Six patients had a total knee arthroplasty on the ipsilateral side.

The design, the biomechanics, and the use of the LISS have been previously described (*9,18,36*). A lateral

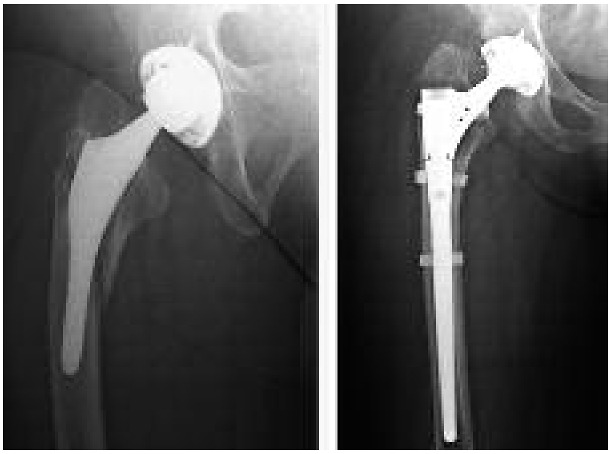

Fig. 1. — (a) : a 64-year-old female with a Vancouver B2 fracture ; (b) after treatment with stem replacement (Revitan® long stem, Zimmer®, Winterthur, Switzerland).

approach to the distal femur provided access for the introduction of the LISS, following temporary fracture reduction. Definitive reduction was then obtained using the ancillary instrumentation. Implants were fixed using either uni- or bicortical self-drilling locking screws, with small skin incisions. In the region pertaining to the shaft of the prosthesis, special bolts for monocortical fixation were used.

Stem revision was performed through an anterolateral or posterior approach, depending on the previous approach and the possibility to extend the approach if necessary. If the femoral component was difficult to remove because of partial fixation to the cortical bone, a transfemoral approach was used. In such cases, the transfemoral approach saves time, reduces bleeding, and is a tissue-friendly technique *(8,27)*. Patients were treated with a long, distally fixed, uncemented revision prosthesis (fig 1), (Wagner SL-Revision®, PFMR®, Revitan® ; Zimmer®, Winterthur, Switzerland).

A 13-hole femoral LISS plate was used in 17 patients, and an 11-hole custom shortened LISS plate in 2 patients.

Although the LISS plate enables a mini-invasive implantation after closed reduction, a minimal invasive technique was not possible in 9 patients, owing to the necessity to remove an implant from previous surgery (3 cases) or to the type of fracture which required an open reduction (6 cases).

Bone grafting was performed in 5 of the 19 LISS cases, because of osteoporotic bone stock or considerable fracture instability.

Follow-up included clinical and radiographic examinations.

We recorded age, gender, side, type of prosthesis, date of implantation of the primary prosthesis, primary diagnosis, the event leading to fracture, date of injury, time delay to surgery, the type of implant, any early or late complications associated with the fracture or surgical procedure, and the duration of hospital stay. Radiographically, the presence of callus across the fracture site was used as the determinant of fracture healing. At clinical follow-up, the ability of the patient to bear full weight without pain was evaluated. Infection was determined with at least one clinical sign of infection, positive microbiology and subsequent therapeutic intervention *(35)*. Malunion was defined as an angular deformity, leg length discrepancy greater than one centimetre, and a rotational deformity greater than or equal to 10° *(32)*, with the rotation being assessed clinically.

Since there is no specific scoring system for the clinical outcome after periprosthetic fractures, we used two commonly used systems : the Larson (IOWA Hip Score) and the Lysholm score *(19,23)*. Additionally, the activity levels were assessed qualitatively by patient interview at follow-up. These were then compared to the pre-injury activity levels.

RESULTS

Thirty three out of 42 patients – 18 with LISS fixation and 15 with stem revision – received a follow-up clinical examination. An overall follow-up rate of 78% was achieved after a mean period of 24 months (range : 6-39 months). Six of the remaining 9 patients had died. Two were not in adequate general condition, and one patient could not be persuaded to return to our institution for a follow-up examination. A telephone survey was however carried out for these patients.

The average operating time in the LISS group was 170 minutes (range : 135 to 180), and in the stem-revision group, 247 minutes (range : 180 to 260). The average hospital stay was 15.4 days (range : 7-30) for the LISS group and 18.1 days (range : 13-32) for the stem-revision group.

Uncomplicated primary fracture healing was observed in 24 cases. Radiographic evaluation revealed 2 delayed unions in the LISS group. All patients, except five (3 LISS-treated and 2 with stem revision) regained their pre-injury activity

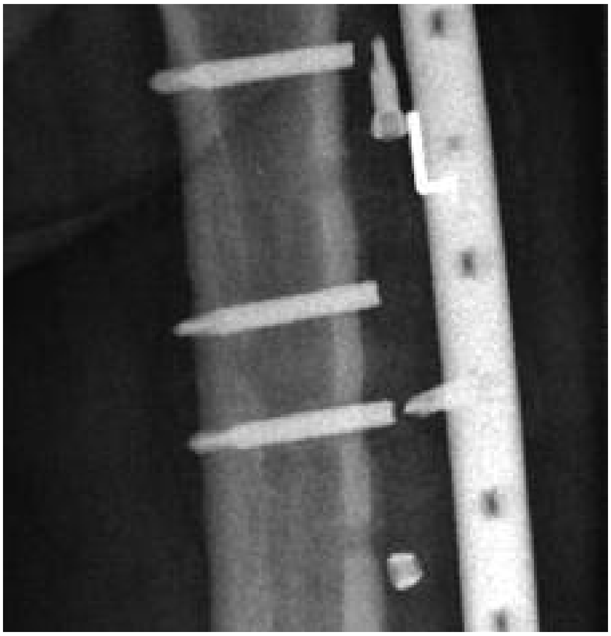

Fig. 2. — LISS related complications. Screw breakage and screw pull out occurred in a 69-year-old patient, 3 months after plate fixation of a Vancouver C fracture.

levels. The average Lysholm score was 74.5 (range : 48-100) in the LISS-group, and 75.5 (range 59-88) in the group with stem revision. The average Larson scores (IOWA-Hip-Score) were 69 (range 46-89) and 71 (range 59-86) respectively (table III).

Overall, four complications were noted in the LISS group : implant breakage in two patients and implant pull-out in the other two (fig 2). All 4 patients underwent re-osteosynthesis. Figure 3 shows the radiographic course of a patient who had presented an implant breakage, 6 months after primary ostheosynthesis. Re-ostheosynthesis was performed using a LISS plate and an additional cortico-cancellous bone graft on the medial femoral side.

All patients were able to bear full weight at the time of the last follow-up.

DISCUSSION

Direct comparison between the results in the two patient groups was not attempted, owing to their different preoperative fracture situations.

Table III. — Results

	Stem replacement	LISS
Number :	17	19
Ø Age (years)	72.4	72.7
Lysholm :	75.5±8	74.5±7
Larson (IOWA)	71±6	69±7
Activity level :	15/17 (90%)	16/19 (85%)

This study showed that the LISS internal fixator allows successful stabilisation of periprosthetic fractures. The high primary stability encourages union of the fracture, even with poor bone quality. Within the 42 cases reviewed, the LISS treated patients showed a nearly similar clinical outcome, when compared to those who underwent stem revision. Based on these findings, we believe it is preferable to avoid replacing the stem in cases with a stable prosthesis, as it avoids several drawbacks of major revision surgery, such as intraoperative fractures, a higher extent of soft tissue trauma, a prolonged operation time, a higher intraoperative blood loss and an overall higher mortality rate.

The follow-up rate of 78% is comparable with other publications. This was also due to the advanced patient age (*12,15,17,41*). Clinical evaluation of pre-injury levels was somewhat limited for the patients who had multiple pre-existing co-morbidities and/or previous surgery ; the pre-injury status of the affected limb could therefore not be reliably determined in every case. For this reason, the evaluation of the pre-injury status was based on subjective data collection from the patients and their relatives, when necessary. In some cases, a contralateral prosthesis made clinical assessment of rotational deformity and leg length difficult. Another limitation was the relatively short mean follow-up time of 24 months.

Complication rates following treatment of periprosthetic femoral fractures after THA using various techniques have ranged from 31 to 52% (*1,3,26*). We saw more major complications in the LISS group (4/18 = 22%), including screw or plate breakage or screw pullout. These complications are also reported in literature (*16,36,38*). To reduce their incidence, it is advisable not to use

Fig. 3. — An 84-year-old female with a femoral neck fracture (a) was treated with hemi- arthroplasty (b). Fourteen months after implantation she suffered a periprosthetic Vancouver C fracture (c). A minimally invasive LISS plate ostheosynthesis was performed (d, e). After 6 months she suffered a LISS plate breakage (f). Revision surgery was performed using a new LISS plate and a strut graft fixed at the medial femoral side (g, h).

every screw hole, especially those close to the fracture. Too rigid fixation of the LISS plate, using too many screws, involves a risk of implant failure due to stress concentration in the fracture area.

Depending on the type of fracture, especially when confronted with a medial bone defect or a medial tapered bone wedge which causes medial instability, we would recommend an additional strut graft on the medial cortex of the femur (fig 3). In our experience a medial cortical defect is a risk factor which may lead to plate breakage/failure or non union ; in such cases, an additional medial strut graft will improve stability and reduce the stress. The strut graft can be fixed with cables or with the plate locking screws.

Other disadvantages of the percutaneous placement of the LISS could include malpositioning on the femur, resulting in rotational and axial malalignment (*16,36*). Overall, our complication rate was slightly lower than reported in literature. This may be related to the limited number of cases and to the relatively short follow-up period, but it may also reflect the beneficial effect of the stable internal fixation, regardless of bone quality, and the lack of soft tissue complications.

The main advantage of the LIS-System is that it usually enables the use of minimal invasive techniques in order to prevent additional soft tissue damage, and it also shortens the operation time. This should be given consideration, especially in older patients with multiple morbidities. In our study, there were however 9 cases in which the LISS was applied with an open / non-minimal invasive technique because of the need to remove the original stem or because of the type of fracture which required open reduction.

In a recent investigation concerning the risk factors which may lead to failure after treatment of periprosthetic fractures, Lindahl *et al* found a high complication rate in B1 fractures treated with open reduction and internal fixation alone. They related this to failure to recognize stem loosening at the time of operation (*22*). They suggested that, if there is any doubt about the status of the implant, it should be considered loose, and treated as such. Plate fixation should be reserved for fractures in which there is no doubt about the stability of the implant. Although we did not detect any overlooked stem loosening in this series, we accept that the minimal invasive application of the LISS may limit the possibility to test the stem status intraoperatively. We therefore recommend a thorough dynamic x-ray examination of the fracture prior to the LISS implantation.

Tsiridis *et al* investigated 18 Vancouver type B fractures and suggested a combination of dynamic compression plates and stem revision in cases with a loose stem, as well as the further application of strut allografts in selected cases (*40*). Our data supports the concept of relying on either stem revision or LISS fixation, as we could achieve fracture healing in all cases at the last follow-up.

A biomechanical study from Wilson *et al* investigated both the stability provided by plate osteosynthesis, allograft struts and a combination of both in simulated B1 fractures (*42*). They found a higher stability when plates were combined with allografts. We therefore advocate strut grafting in fractures with potential instability as a result of cortical bone defects.

Another reason for using strut grafts is the frequently poor quality of the bone stock, as periprosthetic fractures predominantly occur in an elderly population with osteoporosis. Several patients in this study were osteoporotic ; for this reason, we used bicortical screws inasmuch as possible, and we used strut grafts to improve the bone quality and the stability. Furthermore, an antiosteoporotic drug therapy should be initiated collaterally in such patients.

In conclusion, periprosthetic femoral fractures can be successfully treated with both LISS fixation and stem replacement, depending on their type in the Duncan-Vancouver classification, with a similar postoperative functional outcome. Based on our findings, we believe that there is no need for stem replacement in cases with a stable stem ; the less invasive stabilization system appeared as an excellent option in the treatment of such periprosthetic fractures. Despite a risk of implant failure, the minimal invasive application of the LISS and the shorter operation time result in reduced soft tissue trauma, less blood loss and a minimization of serious risks from general anaesthesia.

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