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Influence of treatment modality on morbidity and mortality in periprosthetic femoral fracture. A comparative study of 71 fractures treated by internal fixation or femoral implant revision.

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Abstract

Introduction

The incidence of periprosthetic femoral fracture is constantly increasing, with high associated morbidity and mortality. Surgical treatment is guided by the Vancouver classification, but the influence of type of treatment on morbidity and mortality has been

little analyzed. The theoretic advantage of implant revision over internal fixation is that it should allow earlier weight-bearing, although the impact of this on morbidity and mortality and autonomy has not been demonstrated. We conducted a case-control study, to assess the influence of type of treatment (implant revision or internal fixation) 1) on mobility and autonomy and 2) on morbidity and mortality.

Hypothesis

The study hypothesis was that clinical results and morbidity and mortality do not differ between these two types of treatment.

Methods

A retrospective study included 70 patients with a total of 71 femoral periprosthetic fractures treated between 2007 and 2014. Two treatment groups, comparable for mean age, gender and ASA and Parker scores, were studied. Mean age was 78 ± 13.5 years (range, 23–95 years). Thirty-six fractures (50.7%) were treated by implant revision via a posterolateral approach, using a revision stem with ($n = 11$) or without cement ($n = 25$) (REVISION group); immediate postoperative weight-bearing was authorized. Thirty-five fractures (49.3%) were treated by open reduction and internal fixation, using a locking plate (ORIF group); weight-bearing was authorized only in the third month. Mean follow-up was 43 ± 27 months (range, 0.75 –107 months).

Results

Autonomy on Parker score was reduced by 2 points at 1 year's follow-up. Mean preoperative scores were 7.32 ± 1.79 (range, 3-9) and 7.43 ± 1.79 (range, 4-9) in the REVISION and ORIF group, respectively, ($p=0.8$), falling to 5.06 ± 2.6 (range, 0-9) and 4.5 ± 2.01 (range, 0-9) respectively at follow-up ($p=0.349$). Sixteen patients in the REVISION group versus 13 in the ORIF group had made adaptations in their home or changed place of residence ($p=0.2$).

At last follow-up, 18 patients (28.6%) had died: 12 (37.5%) in the ORIF and 6 (19.3%) in the REVISION group ($p < 0.05$). Survival with death as endpoint at a mean 3.5 years was $88 \pm 11\%$ in the REVISION group versus $51 \pm 11\%$ in the ORIF group ($p = 0.02$). Three implant replacements were performed in each group ($p = 0.83$). Twelve medical or surgical complications occurred in the ORIF group (37.5%) and 11 in the REVISION group (34%) ($p = 0.9$).

Conclusion

Implant revision for periprosthetic femoral fracture showed significantly lower overall mortality than internal fixation, without difference in terms of treatment failure or complications requiring revision surgery.

Key-words: Periprosthetic Femoral Fracture; Total Hip Arthroplasty; Implant Revision; Internal Fixation; Morbidity; Mortality.

Level of evidence: III, case-control study

1. Introduction

The incidence of periprosthetic hip fracture is constantly increasing, ranging from 0.1% to 6% depending on the report [1-3]. It is the third most frequent cause of revision of total hip arthroplasty, after aseptic loosening and dislocation [4]. Treatment is complicated in an elderly population with numerous comorbidities, leading to high intra- and post-operative complications rates of 10% to 50% depending on the report [5,6] and high perioperative mortality, varying according to length of follow-up and type of treatment [5,7-9]. Surgical treatment is guided by the Vancouver classification [10,11],

which recommends open reduction and internal fixation (ORIF) for fractures with stable and well-fixed implants, and stem replacement in case of loosening [12,13]. While ORIF might seem to be less aggressive than implant revision, the impact of type of treatment on mobility and mortality/morbidity has been little studied. We conducted a case-control study, to assess: the influence of type of treatment (implant revision or internal fixation) 1) on mobility and autonomy and 2) on morbidity and mortality. The study hypothesis was that clinical results and morbidity and mortality do not differ between these two types of treatment.

2. Material and Methods

2.1 Patients

A retrospective study included 70 patients with 71 periprosthetic femoral fractures managed between January 1st, 2007 and December 31st, 2014. Fractures were classified on the Vancouver system [14,15], and those with loose implants underwent revision and those with well-fixed implants underwent ORIF. These two groups of patients were comparable for age, gender, side, and ASA [16] and Parker-Palmer scores [17] (Table 1). Only mean body-mass index (BMI) differed significantly between groups, due to one obese patient (BMI, 40) in the ORIF group (Table 1). Primary implant data are shown in Table 2. Fracture was mainly due to minor trauma, with only 1 case of high-energy trauma. Thirty-five fractures were fixed by locking plate (ORIF group), with weight-bearing delayed to the 3rd month. Thirty-six fractures were treated by implant revision via a posterolateral approach, using a revision stem with or without cement (REVISION group); full immediate postoperative weight-bearing was authorized. Mean follow-up was 43 months (i.e., 3.5 years).

2.2 Methods

Thirteen surgeons were involved in treatment: 36 patients (51.4%) were operated on by senior surgeons and 34 (48.6%) by senior registrars, all working in a orthopedics-traumatology department with yearly turnover of more than 1,000 hip or knee replacements in orthopedics and more than 350 in traumatology. In the ORIF group, fixation was on an open direct approach, using an LCP (Depuy Synthes, Solothurn, Switzerland; n=27) or NCB-PP (Zimmer, Warsaw, IN; n=8) locking plate. Implants comprised: cementless locked revision stem (Optimale, Amplitude, Valence, France; n=19 or Atlantis Symbios, Yverdon, Switzerland; n=6), or long cemented stem (PF cemented revision stem, Zimmer, Warsaw, IN; n=11). Two patients with partial hip replacement underwent conversion to total arthroplasty with dual-mobility cup. Three patients underwent bipolar revision with dual-mobility cup.

2.3 Assessment

Functional status was assessed on Parker-Palmer score [17], preoperatively and at 1 year. Overall autonomy was assessed in terms of changes in home conditions. Complications were inventoried: death, reoperation, implant change, infection, dislocation, new fracture, non-union, cement-related shock.

2.4 Statistics.

Patient characteristics, functional scores, mortality and complications rates were reported as mean \pm standard deviation for continuous variables and as percentage for categoric variables. Normal distribution of quantitative variables was tested on the Kolmogorov-Smirnov test; normally distributed variables were compared on Student t test and non-normally distributed variables on Wilcoxon test. Qualitative variables were compared on χ^2 test. All analyses were 2-tailed. The significance threshold was set at $p < 0.05$. Two Kaplan-Meier survival analyses with 95% confidence intervals were

performed at last follow-up, and compared between groups on log-rank test; the two endpoints were death from all causes and implant revision for all causes. A post-hoc power test was performed for the principal study endpoint. The study had an 80% chance of detecting a clinically significant difference (2 ± 1.6 points) in Parker mobility score, despite 7 patients (10%) lost to follow-up [18]. Clinical and radiological data were collected in consultation with an independent investigator for 55 patients and by telephone (with patient, care-giver or family doctor, X-rays being sent by mail) for 9 patients.

3. Results

Parker mobility scores fell by more than 2 points at 1 year's follow-up. Mean pre-operative scores were 7.32 ± 1.79 (range, 3-9) in the REVISION group, and 7.43 ± 1.79 (range, 4-9) in the ORIF group ($p=0.8$, non-significant); 1-year scores were respectively 5.06 ± 2.6 (range, 0-9) and 4.5 ± 2.01 (range 0-9) ($p=0.349$). Sixteen patients in the REVISION group versus 13 in the ORIF group reported changes in home conditions ($p=0.2$).

Three patients were lost to follow-up (failure to return to consultation and unreachable by telephone) in the ORIF group and 4 in the REVISION group, and were excluded from mortality analysis. Eighteen of the 63 patients (28.5%) died before last follow-up: 6/32 (19.3%) in the REVISION group and 12/32 (37.5%) in the ORIF group ($p=0.04$). Survival in terms of mortality at a mean 3.5 years' follow-up was $88 \pm 6\%$ in the REVISION group and $51 \pm 11\%$ in the ORIF group ($p=0.0219$). At last follow-up (107 months in the REVISION group and 89 months in the ORIF group), survival in terms of mortality was respectively $62 \pm 11\%$ and $29 \pm 11\%$ ($p=0.0219$) (figure 1). The 6 deaths in the REVISION group comprised 1 early death from pulmonary embolism on

postoperative day 21, and 5 late deaths ≥ 2 years post-fracture, at respectively 29, 31, 46, 54 and 89 months postoperatively. Two patients died of stroke and 2 were admitted to nursing homes for loss of autonomy. The 12 deaths in the ORIF group occurred at 13, 17, 18, 21, 23, 26, 29, 33, 37, 41, 43 and 91 months postoperatively. Nine were related to decubitus complications in bed-ridden patients; 2 of these showed delayed consolidation, preventing resumption of weight-bearing at 3 months. One patient died of generalized cancer, 1 of unexplained convulsions, and 1 for no known major cause.

There were 3 implant replacements in each group (3/32: 9.4%). At a mean 3.5 years' follow-up, mean overall survival was $86 \pm 13\%$. The revision rate at last follow-up in the 2 groups taken together was $13 \pm 5\%$ ($p=0.82$) (figure 2).

The complications rate was 11/36 (30.5%) in the REVISION group, and 12/35 (34%) in the ORIF group ($p=0.9$) (Table 3). In the REVISION group, there were no cement-related complications, whereas 9 of the 11 complications (82%) occurred in the cementless stem subgroup ($p=0.3$).

4. Discussion

Periprosthetic femoral fracture is the third most frequent reason for revision of total hip arthroplasty, following aseptic loosening and dislocation [4,19]. The Vancouver classification is most widely used to describe these fractures and guide surgery [1,10]. Internal fixation in type-B periprosthetic fracture is more controversial, as the complications rate is high [20], related to the difficulty of distinguishing types B1 and B2. Lindhal et al. [5] reported type B1 as a risk factor for failure, and Corten et al. [21] reported a 20% risk of misinterpretation of type B1 revealed on ultimate

intraoperative testing. The present case-control study compared patients managed for type B fracture by implant revision versus internal fixation retaining all implants.

Autonomy in terms of Parker mobility score fell by 2 points at 1 year postoperatively, without significant difference between treatment groups, in agreement with Joetsl et al. [22]. In the present study, almost half the patients were obliged to make changes at home or change place of residence, in agreement with Moreta et al. [23], who reported that 48% of patients recovered their former level of life, only 10% being able to walk unaided and 80% requiring 1 or 2 canes. In the present study, type of treatment did not impact morbidity: there were no significant differences in walking ability, institutionalization, or complications; mortality, on the other hand, was lower after implant revision, with 88% survival, versus 51% in the ORIF group ($p=0.02$).

Many studies of periprosthetic fracture reported radiologic and clinical results, but rarely mortality [20,24-27]. It ranges from 11% to 20%, depending on the series [8,28,29], which is higher than for primary arthroplasty [30], but lower than for femoral neck fracture [31]. The impact of type of treatment on mortality has been little analyzed [9], with only 1 comparative study to our knowledge [9]; in this retrospective study, however, choice of treatment was determined not by implant loosening but by an arbitrary change in strategy for periprosthetic fracture: internal fixation before 2001, and revision after [9]. In the present study, survival was significantly better in the REVISION group, at a mean 43 months and at last follow-up, in agreement with other reports [8,9]. Mortality in the ORIF group was also earlier, in agreement with Langenhan et al. [9], who reported significantly lower overall mortality at 6 months and at last follow-up after revision than after ORIF.

We believe that early resumption of weight-bearing after implant revision improves morbidity and mortality following periprosthetic fracture. Although locking

plates improve fixation in porous bone [32-34] and several biomechanical studies showed their superiority in allowing theoretic immediate resumption of weight-bearing [35-38], this is in fact difficult to achieve in practice, and few studies have assessed immediate resumption of weight-bearing after internal fixation by locking plate [39]. In the literature, complications rates range between 10% and >50% [4-6,19,40]. In the present series, they were 37.5% in the ORIF group and 34% in the REVISION group; that the difference was non-significant was probably due to lack of power. At last follow-up, the revision rate in the 2 groups taken together was 13±5%, in agreement with the literature, which reports rates of 10% to 17% [5, 9,40].

Some reports favor cementless revision [41,42], while others favor cement, especially in elderly patients with diminished bone quality [1,3,20,43]. The present results suggest a higher risk of complications with uncemented stems: 36 % versus 18% (although $p=0.3$: non-significant). There were no new fractures after revision with a cemented stem and no cases of cement-related shock. Functional recovery and autonomy were similar in both cases.

The study had several limitations. 1) It was retrospective, with small sample size. The sample did, however, comprise all analyzable patient records for a department with high volumes of traumatology and arthroplasty. The sample was large enough, and thus power great enough, to analyze autonomy as an endpoint, but insufficient for precise analysis of morbidity and mortality. Recovery of walking capacity could not be assessed in a standardized manner. Postoperative protocols, however, were identical for all patients, with immediate resumption of weight-bearing after femoral implant revision, whereas at least 3 months' non-weight-bearing was required after ORIF by locking plate. 2) In the REVISION group, fixation was cemented or cementless, which might introduce bias; however, this factor did not affect the rehabilitation protocol. 3) At 3.5 years, mean

follow-up was short for assessing implant results, but seemed to us to be sufficient for assessing morbidity and mortality. The study also had several strong points. 1) It was original and comparative; to our knowledge, no other comparative study had a larger series. 2) The 2 groups were comparable for age, gender, comorbidity, functional status, number of primary and revision implants and time to periprosthetic fracture; only BMI differed, due to 1 obese patient in the ORIF group – but we doubt this could have influenced our results. 3) The strongest point was that surgical treatment was guided by the current Vancouver guidelines [1,10]. 4) Thirteen junior and senior surgeons participated, limiting any center effect and facilitating extrapolation. 5) And finally, all type-B fractures underwent revision, and all type-B1 and C fractures without loosening were fixed by locking plates.

5. Conclusion

Implant revision in periprosthetic femoral fracture was associated with significantly lower overall mortality than ORIF, without difference in the rates of failure or complications requiring revision surgery. These results contradict the idea that implant revision is heavier and more risky than internal fixation.

Conflicts of interest: X. Flecher has no conflicts of interest to disclose in relation with the present study, but otherwise is an education consultant for Zimmer. S. Parratte has no conflicts of interest to disclose in relation with the present study, but otherwise is a consultant for Zimmer, Adler Ortho, Stryker and Arthrex. J.N. Argenson has no conflicts of interest to disclose in relation with the present study, but otherwise is a consultant for Zimmer. S. Cohen and M. Ollivier have no conflicts of interest to disclose

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Table 1: Patient characteristics

	ORIF n=35	REVISION n=35 patients (36 hips)	
Mean age (years)	78.03 (23-94)	78.04 (42-95)	p=0.99
Gender	9 male 26 female	13 male 22 female	p=0.35
ASA score [16]			
ASA 1	4	6	p=0.9
ASA 2	16	12	p=0.9
ASA 3	15	17	p=0.9
Body-mass index	27.3	24.8	p=0.03
Side	20 right 15 left	21 right 15 left	p=0.9 p=0.9
Parker score [17]	7.43 (4-9)	7.32(3-9)	P=0.80
Vancouver classification			
A	0	0	NA
B1	25	0	NA
B2	0	36	NA
B3	0	0	NA
C	10	0	NA

Table 2: Type of primary implant and surgery.

	ORIF n = 35	REVISION n = 36	
Cemented/uncemented stem	17 (48%)/18 (52%)	4 (11%)/32 (89%)	p<0.001
Primary indication			
Osteoarthritis/neck fracture	20 (57%)/15 (43%)	22 (61%)/14 (39%)	p=0.9
Type of arthroplasty			
Partial/total	4 (11%)/31 (89%)	5 (13%)/31 (87%)	p=0.9
Primary/already revised	28 (80%)/7 (20%)	30 (83%)/6 (17%)	p=0.1
Mean time to fracture (years)	6.02 ±5.7 (0.02-19)	6.3±5.4 (0.16-21)	p=0.84
Mean time to surgery (days)	2.2±2.4 (0-12)	3.3±2.5 (0-11)	p=0.083
Mean operative time (minutes)	102±21 (55-153)	133±54 (55-280)	p=0.0019

Table 3: Distribution of complications

Type of complication	ORIF n=35	REVISION n=36		P
		Cementless n=25	Cemented n=11	
Surgery site infection	4	3	2	0.8
Dislocation	1	3	0	NA
Fracture	3	3	0	NA
Non-union	3	0	0	NA
Sciatic palsy	1	0	0	NA
Total complications	12	11		0.9

Figure legends

Figure 1: Kaplan-Meier survival analysis with death as endpoint. At a mean 3.5 years' follow-up, survival was $88\pm 6\%$ in the REVISION group and $51\pm 11\%$ in the ORIF group ($p=0.02$). At last follow-up (107 months in the REVISION group and 89 months in the ORIF group) survival was respectively $62\pm 11\%$ and $29\pm 11\%$ ($p=0.02$).

Figure 2: Kaplan-Meier survival analysis with endpoint defined as revision of ≥ 1 implant for all causes. At a mean 3.5 years' follow-up, overall survival was $86\pm 13\%$. At last follow-up, the revision rate in the 2 groups taken together was $13\pm 5\%$ ($p=0.82$).



