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Comparative analysis of non-simultaneous bilateral fractures of the proximal femur

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Abstract

Purpose We performed a monocenter cohort study to determine surgical revision and mortality after sustaining an initial and a non-simultaneous contralateral proximal femoral fracture.

Methods We identified all patients surgically treated for a contralateral femoral fracture between 2006 and 2015. Patient demographic characteristics and follow-up were identified by our electronic database; failed information regarding revision and mortality were obtained by telephone, as well as the evaluation of the mobility for all alive patients. The endpoint of the study was set for every patient at least 2 years postoperatively.

Results Within a total of 2296 patients, we identified 250 patients (10.8%) treated for a contralateral fracture. The mean interval between the two occurrences was 5.2 years and the mean age at the time of contralateral fracture was 84.4 years. Almost every third fracture occurred later than 5 years after the initial fracture, and even every tenth fracture later than 10 years. More than 50% of the patients also had dementia at this time. The total surgical revision rate was 17.2% after initial, and 20.4% after contralateral fracture, but this difference was statistically not significant ($p = 0.31$). However, revisions for infection or hematoma were more than twice after contralateral fracture ($p = 0.006$). The 1-year mortality rate was 36%, and dementia (log rank $p < 0.001$) and male gender (log rank $p < 0.001$) were significant negative predictors for the survival rate. After a mean of 42 months, the follow-up of the 67 alive patients recorded a mean Parker Score of 5.2 items.

Conclusion Contralateral femoral fracture was accompanied by a higher revision and mortality rate—but patients were also 5 years older. Dementia and male gender were significant negative variables for the survival time. In the future, the highest priority will be the prophylaxis of falling to avoid or at least to decline the number of these fractures in geriatric patients.

Keywords Proximal femoral fracture · Contralateral femoral fracture · Outcome

Introduction

A further increase in the number of proximal femoral fractures can be expected due to the change in demographics as people are getting older [1]. Recently, a large cohort study evaluated an increase of 7.4% per year over a period of 10 years within the same environmental and referral structures [2]. Mortality rates of less than 30% in the first postoperative year are usually reported in large study collectives with elderly patients [3–7]; however, there are few data beyond the first postoperative year [2, 3].

Regarding contralateral proximal femoral fractures a meta-analysis by Zhu et al. [8] showed that 18 of 23 studies included less than 100 patients, and only three articles involved more than 200 patients [7, 9, 10]. This meta-analysis summarized an incidence rate for contralateral fracture of 8.5%, especially with a rate of 70% in the first 3 years postoperatively, and 27% of the overall patients died within the first year [8].

With this monocentric cohort study, we aim to review the data on contralateral femoral fractures by an own high number of cases, as well as to evaluate possible differences regarding initial and contralateral surgical treatment.

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Patients and methods

In our level one trauma center, all the in-hospital medical records and ambulant patient's files were prospectively recorded with an electronic database, so that information on specific procedures could be determined also by a manual search at any time.

The inclusion criteria for this study were all patients who received surgical treatment for contralateral proximal femoral fractures between January 2006 and December 2015. Exclusion criteria were pathological fractures caused by a tumor disease, simultaneous bilateral or segment fractures, isolated fractures of the trochanteric region, femoral head fractures, periprosthetic or peri-implant fractures as well as an age younger than 18 years.

After registering the study patients from the database, the descriptive data such as gender, age, fracture side, fracture type (cervical versus trochanteric), duration between emergency admission and surgical treatment, surgical procedure (osteosynthesis versus arthroplasty), surgical duration in minutes, hospitalization in days as well as cognitive impairment were collected (Table 1).

Finally, a follow-up was performed with evaluation of any revision (including revisions external performed) as well as determination of mortality—with an endpoint at least 2 years postoperatively for every patient.

Definition of an infection required the clinical findings and microbiological evidence of a pathogen according to the criteria by Parvici et al. [11]. A hip dislocation treated exclusively with a closed reduction as well as a nerve injury of the leg, e.g., femoral nerve lesion, are typical major complications. Therefore, we included both like a revision. At the time of the follow-up, the mobility score according to Parker and Palmer was obtained for all still alive patients [12]. Missing data were obtained from the patients by phone, through the relatives or general practitioners for patients who had died or developed dementia in the meantime.

The study was approved by our institutional review board. All the contacted patients gave their verbal consent for this study.

Statistics

The statistical analyses were performed by means of SPSS for Windows, version 24.0 (SPSS Inc., Chicago, IL, USA). The metric variables were presented as mean values, while the measures of dispersion were indicated as standard deviations. The metric variables were reviewed by means of the Kolmogorov–Smirnov test regarding their normal distribution. The tested variables were not distributed normally (Kolmogorov–Smirnov test $p < 0.05$). Therefore, non-parametric tests were consistently consulted for samples where distribution was not normal in the sample comparisons. The Mann–Whitney U test was applied to compare two independent samples where distribution was not normal. Two related samples where distribution was not normal were reviewed for significant differences using the Wilcoxon test. The comparison of dichotomized data of related samples was performed by means of the modified Chi-squared test according to McNemar. A Kaplan–Meier survival analysis [13] was conducted to evaluate group differences in mortality; the log rank test was used to compare survival probabilities. Significance was tested bilaterally in all conducted tests and a p value of < 0.05 was considered as statistically significant for all statistical tests.

Results

A total of 2296 patients with proximal femoral fractures were surgically treated between 2006 and 2015. Within, 250 patients were treated for a contralateral fracture, resulting in an incidence rate of 10.8%. A total of 72 patients (28.8%) were treated for initial fracture before 01/01/2006 and sustained contralateral fracture within the study period, and the others were treated for both fractures within the study period of 10 years.

The mean age at the time of the initial fracture was 79.3 years (median 82.0 years; SD ± 9.7), and female were especially affected (199/250; 79.6%). The mean age of the female and male was almost identical (79.3 versus

Table 1 Variables of the total 250 study patients divided into initial versus contralateral fractures

Variables	Initial fracture	Contralateral fracture	p value
Age (mean)	79.3 (SD ± 9.7)	84.3 (SD ± 8.5)	0.000
Female/male	199/51	199/51	–
Fracture side: right/left	129/121	121/129	–
Dementia: yes/no	70/180	132/118	0.000
Cervical/trochanteric fracture	133/117	118/132	0.082
Time to surgery (h)	32.0 (SD ± 33.2)	26.6 (SD ± 21.6)	0.201
Osteosynthesis/arthroplasty	125/125	118/132	0.358
Duration of hospitalization (days)	15.7 (SD ± 6.0)	15.1 (SD ± 8.2)	0.074

Table 2 Operative revisions within initial and contralateral fractures, demonstrated infection and haematoma as the most indications

Variables	Total (n=94)	Initial fracture (n=43)	Contralateral fracture (n=51)	p value
Infection	17	3 (1.2%)	14 (5.6%)	0.013
Haematoma	32	12 (4.8%)	20 (8.0%)	0.186
Infection/haematoma total	49	15 (6.0%)	34 (13.6%)	0.006
Cut out osteosynthesis	14	8	6	–
Other osteosynthesis failure	1	1	0	–
Hip dislocation	7	3	4	–
Trochanteric dislocation	2	0	2	–
Peri-implant fracture	6	4	2	–
Periprosthetic fracture	4	3	1	–
Coxarthrosis posttraumatic	2	2	0	–
Femoral head necrosis	3	3	0	–
Aseptic loosening prosthesis	3	3	0	–
Non-union	2	1	1	–
Others	1	0	1	–

79.0 years). Table 1 contains the further demographic data including fracture type and surgical treatment, and 74% (185/250) of the patients had the same fracture type.

The contralateral fractures occurred after a mean of 5.2 years (0–780 months), whereas the most (18.4%, 46/250) occurred within 1 year, and 48% within 3 years after the initial fracture. On the other side, 28.4% occurred later than 5 years, and even 10.8% (27/250) later than 10 years. There were gender-specific differences regarding the time interval: male suffered a contralateral fracture significantly sooner than female (mean 33.2 versus 69.9 months; $p=0.002$; Mann–Whitney U test). At last, significantly more patients were affected by dementia at the time of the contralateral fracture (Table 1).

The revision rate after the initial fracture was 17.2% (43/250) and after a contralateral fracture 20.4% (51/250), but this difference was not significant ($p=0.31$). The indications for revision are presented in Table 2, which recorded that infections and haematomas represented more than 50% of all revisions. Both complications occurred more than twice as often after a contralateral fracture; the comparative analysis on this was statistically significant ($p=0.006$). Furthermore, revision rate was more frequent in the first 30 postoperative days after a contralateral versus initial fracture (76.5 versus 53.5%). On the other side, only few revisions were performed after the first postoperative year (initial 8/43; contralateral 1/51).

The postoperative mortality rate after a contralateral fracture was 10, 28 and 36%, at 1 month, 6 months and 1 year, respectively. The Kaplan–Meier analysis (Fig. 1 for the whole study patients) showed a statistically significant gender-specific difference on this (Fig. 2; log rank $p<0.001$), just as for patients with dementia (Fig. 3; log rang $p<0.001$).
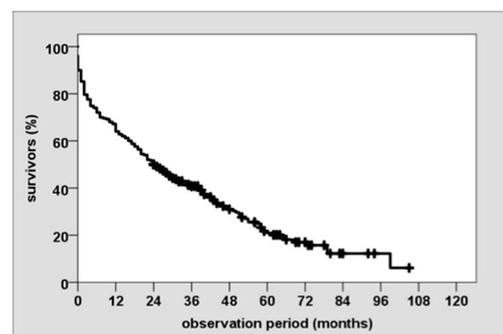
Fig. 1 Kaplan–Meier survival analysis for the total study group
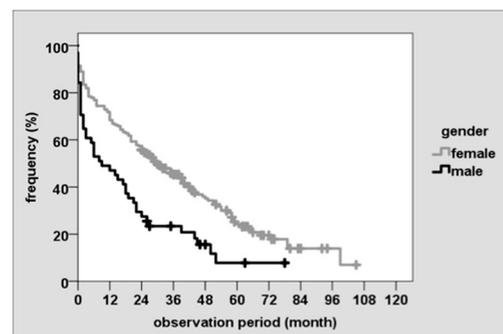
Fig. 2 Kaplan–Meier survival analysis divided by gender

At the time of the follow-up (mean 3.9 years; 2–9), 67 patients (26.8%) were still alive and could be reached by phone, of which 26 were in a nursing home and 14 with dementia. The mean age of these patients at the follow-up was 86.0 years (62–98). The evaluated mobility score according to Parker and Palmer [12] was on average 5.2
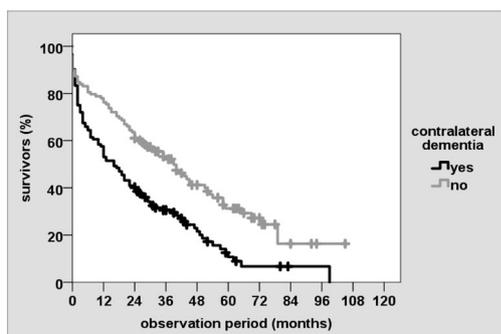
Fig. 3 Kaplan–Meier survival analysis for patients with or without dementia at the time of contralateral fracture

points (0–9), where the walking ability of only 10/67 patients was unimpaired (max. 9 points).

Discussion

To the best knowledge, this retrospective cohort study is the first analysis that provides a high number of contralateral femoral fractures with a minimum follow-up of 2 years for the entire collective. It must be emphasized that all patients or their relatives were reached despite a follow-up period of many years. Therefore, we have no "lost to follow up" for patients and the both endpoints of the study—any revision and mortality. To what extent this objectives was also reached or missed in other studies remains unclear due to missing information or absent flow diagram [7, 14, 15].

First, our evaluation gathered an incidence rate of 10.8%, which is in concordance with the rate of a meta-analysis by Zhi e al. [8], who reported 8.5%. Second, the study documented a mean interval of 5.2 years for a contralateral after an initial fracture, which coincides with the result by the authors Gaumetou et al. [16], who analyzed 241 patients and evaluated a mean interval of 5.6 years. However, in many studies the mean interval was only 2 up to 3.4 years and thus significantly shorter [7, 9, 14, 15, 17–19], which is certainly due to shorter periods of follow-up and "lost to follow-up". Third, our data demonstrated, that the highest risk for a contralateral fracture was within the first year after the initial fracture. This was also reported by other authors [7, 9, 14, 19]. On the other hand, 1/3 of the contralateral fractures occurred more than 5 years later after the initial fracture, and even every tenth fracture later than 10 years. This was the result of our mid-to-long-term follow-up, but there are no similar scientific data on this yet.

According to other studies, our collective was also characterized by an advanced age with predominantly women [7, 9, 14, 16]. On the other hand, male gender developed a contralateral femoral fracture significantly faster, on average

more than 5 years earlier than female—but without obvious difference in age at the time of the initial fracture. This analysis was not developed in other similar studies; the cause of this difference was not ascertainable from our data.

Our analysis was also in agreement with other authors, that contralateral fractures primarily had the same fracture pattern as the initial fracture [7, 14]. In this study, the first author reviewed all pre- and postoperative X-rays of the study patients again and made an objective differentiation of cervical neck versus trochanteric fracture.

We also saw a higher rate of surgical revisions after a contralateral fracture despite the shorter follow-up period, but this was statistically not significant. However, the subanalysis regarding the two most common complications for surgical revision—infection and haematoma—detected a statistically significantly higher risk that one of these both complications occurred after a contralateral fracture. Advanced age as well as much more patients with dementia at the time of the contralateral fracture may play an important role. Just recently, it was documented that dementia represents an independent variable for complications [20]. In the literature, there is also a lack of an accurate presentation of surgical revisions or complications on this topic: Only Van der Steenhoven et al. [18] evaluated that the complications after a contralateral fracture were twice as likely than after an initial fracture, but the investigation covered only a period of 30 days postoperatively as well as only a small sample size ($n = 71$).

In agreement with the data from other authors [7, 8, 15], we documented a higher 1-year mortality rate after contralateral fracture than reported after proximal femoral fractures per se—which amount 20–30% [2, 5, 7]. Advanced age as well as dementia has demonstrated an significant influence on reduced survival rate, in addition with many other different patients factors [2].

At the time of our follow-up, only ten patients were still able to walk without impairment. However, this does not reflect the status of the affected hip joint or the leg, but more the general condition of the frequently multimorbid patient. The authors Sawalha and Parker investigated the preoperative as well as postoperative mobility after contralateral fractures [7]. Regardless of the initial health condition, the situation 1 year postoperatively had worsened in about 50% of the cases. It should be pointed out that the health status of the elderly patients can worsen due to the course of time alone—and not exclusively by the incident of the fracture only.

Eventually, the weakness of this retrospective study must also be revealed: The level of evidence (level 3) is low and the results must be interpreted as medium-term despite some patients demonstrating long-term follow-up. It remained unclear regarding the bone matrix to what extent there was an osteoporosis in patient's initial versus contralateral

fractures. A bone density measurement of the femur was not routinely performed, and a statement on bisphosphonate therapy could also not be obtained retrospectively. Finally, current clinical and/or radiological follow-up examinations were also not performed because the patients are often suffering from dementia and living in a nursing home. Therefore, future long-term studies should try to include a hip evaluation and PROMs.

Conclusion

The contralateral femoral fracture was accompanied by a higher mortality rate. About every third fracture occurred 5 years after the initial fracture, and even every tenth fracture later than 10 years. More than 50% of the patients also had dementia at this time. The risk for a postoperative infection or a haematoma was twice as high compared to the initial fracture. Dementia and male gender were significant negative variables for the survival time. In the future, the highest priority will be the prophylaxis of falling to avoid or at least to decline the number of these recurrences in geriatric patients.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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