Original article

Should age be a factor in treatment choice of periprosthetic Vancouver B2-B3 proximal femur fractures? A retrospective analysis of mortality and functional outcomes in elderly patients

Gianluca Canton[1], Nicholas Rasio[1], Mauro Garlatti[1], Chiara Ratti[1], Anže Kristan[2], Luigi Murena[1]

[1]Orthopaedics and Traumatology Unit, Cattinara Hospital – ASUGI, Department of Medical, Surgical and Life Sciences, Trieste University, Trieste, Italy; [2]Traumatology Department, University Medical Centre Ljubljana (Slovenia), Department of Surgery, Faculty of Medicine, University of Ljubljana (Slovenia)

Abstract. *Background and aim of the work:* Revision Arthroplasty (RA) is considered the treatment of choice for periprosthetic femur fractures (PFF) presenting with a loose stem. In the elderly RA may be associated with high post-operative mortality and complications. The aim of this study is to compare mortality and functional outcomes of open reduction internal fixation (ORIF) and RA for B2-B3 PFF in the elderly. *Methods:* The study population included 29 patients (>65 years) surgically treated for B2-B3 PFF at the Orthopedic and Traumatology Unit of Cattinara University Hospital in Trieste (Italy) between January 2015 and December 2019. 16 patients were treated with ORIF and 13 with RA. Mortality and functional outcomes were analyzed. *Results:* In-hospital (6,25% vs 7,69%) and 3 months (6,25 vs 15,38%) mortality was higher in the RA group. Mortality rates were particularly high in the > 85-year-old patients within four months from RA treatment. One year (38,46% and 16,67%) and overall mortality (69,22% and 25%) was higher after ORIF. Average time to weight-bearing and ambulation was 2.6 and 5.25 months for ORIF patients and 1.3 and 2.4 months for RA. A correlation was found between delayed weight-bearing and overall mortality. *Conclusions:* Age is a risk factor for short term mortality following RA. Patients >85 years of age could benefit from a less invasive procedure such as ORIF. Long term outcomes are generally better for patients who undergo RA but further studies are necessary to evaluate the risk-benefit ratio of RA treatment compared to ORIF in elderly patients. (www.actabiomedica.it)

Key words: Periprosthetic fracture, Vancouver, elderly, internal fixation, osteosynthesis, revision arthroplasty

Introduction

With the ageing of the population and the rise in number of total hip arthroplasty (THA) and hip hemiarthroplasty (HA) procedures, treatment related complications are also increasing. Periprosthetic femoral fractures (PFF) represent one of the most frequent and severe of these complications. Incidence of PFF is reported between 0.045 and 4.1% and is expected to raise by a mean of 4.6% every decade over the next 30 years (1). Many studies analyzing risk factors and hardware specific factors have been published. Risk factors that have been associated with PFF are osteoporosis, advanced age, rheumatoid arthritis , female gender, previous revision arthroplasty and stem loosening (2-3). Although still matter of debate, cemented implants seem to be a protective factor for PFF (4). Currently, the most used classification system for PPT is the Vancouver classification introduced by Duncan and Masri (5). This classification evaluates location of the fracture

and divides PPF into 3 categories (A,B and C) furtherly categorizing B type fractures according to loosening of the implant and quality of bone stock (6). Treatment of PFF is often demanding and costly and prognosis concerning outcomes and mortality is not very encouraging (7). The mostly used treatment algorithm is based on Vancouver classification. In detail, in type B1 fractures, characterized by a stable implant, open reduction internal fixation (ORIF) is suggested as the treatment of choice. In type B2-3 fractures, defined by implant loosening, revision arthroplasty (RA) with or without augmentation (in B3 type characterized by poor bone stock quality) is the suggested treatment (6). However, a debate has recently arisen on the possibility to treat selected B2 and B3 fractures with ORIF instead of revision arthroplasty. Several reports comparing ORIF to revision arthroplasty in these fractures have found equivalent or advantageous outcomes for ORIF treatment (8-12). These reports suggest that if anatomical reduction of the fracture can be achieved, secondary stability of the implant is obtained(8). The advantages of this technique are the shorter surgical time, lower complexity and reduced surgical costs. Moreover, this approach could be particularly beneficial in the elderly and in patients with multiple comorbidities where the complexity and surgical impact of revision arthroplasty may have a negative effect on overall prognosis (9). The aim of the present study is to evaluate mortality and functional outcomes of ORIF compared to RA in elderly patients with Vancouver B2 and B3 fractures and to understand if patient's age could be a determining factor in the choice of treatment.

Methods

The study population included 29 patients treated surgically for periprosthetic B2 and B3 fractures according to the Vancouver classification at the Orthopedic and Traumatology Unit of Cattinara University Hospital in Trieste (Italy) between January 2015 and December 2019. Exclusion criteria were the following: patients aged < 65 years old, periprosthetic fractures following revision surgery, intraoperative periprosthetic fractures, polytrauma patients and periprosthetic fractures between hip and knee implants (Vancouver D fractures according to the "unified classification system"). Patients' data were retrospectively analyzed through institutional medical records and registry data between June and December 2020. For all patients the following was registered: age, sex, primary surgery and implant specifics (HA/THA, cemented/non-cemented), time to surgery and treatment choice. Fracture type was classified on pre-operative radiographic and/or CT studies by two of the authors independently (NR and MG). Mortality was registered at the following endpoints: in-hospital, 90 days, 1 year and overall mortality (considered up to 5 years from treatment, mean time 763 days). Functional outcomes were analyzed over a 1-year FU. To evaluate functional outcomes, mean time to full weight bearing and ambulation recovery was considered. Mortality and functional outcomes were analyzed comparing patients who underwent ORIF and patients who underwent RA. Furthermore, mortality and functional outcomes were studied dividing the population into 3 subgroups according to age at the time of treatment (<75years, 75-85 years, >85 years). Results of ORIF and RA were then compared within each subgroup and between subgroups. The study was conducted under the principles of the Declaration of Helsinki, all participants provid-ed written informed consent to participate in this study.

Statistical Analysis

Two separate software were used for statistical analysis. SPSS software was used to analyze the difference of survival rates in all subgroups according to age and treatment choice through Kaplan-Meier function. Comparison between survival curves was studied using Log Rank Test (Mantel-Cox). R software was used to evaluate time-dependent variables such as time to weight bearing and ambulation through the extended Kaplan-Meier function to evaluate the relationship between mortality and functional outcomes with the Cox model.

Results

Of the 29 patients considered for the study, 21 (72.5%) were female and 8 (27.5%) were male, average

age was 81,65 yrs (min 65yrs, max 95 yrs). Regarding the type of implant 24 (83%) fractures occurred following THA and 5 (17%) following HA. Fractures occurred exclusively on non-cemented implants. Average time to surgery was 3.18 days (min 1 day, max 14 days). Sixteen (55%) patients were treated with ORIF whilst 13 (45%) with RA. Average time to weight bearing was 1.95 months and average time to ambulation was 3.67 months. In-hospital mortality was higher in RA patients (7,69% vs 6,25%). At 90 days, mortality was again higher in RA patients (15,38% vs 6,25%). In contrast, 1 year and overall mortality was higher in ORIF patients compared to RA patients, respectively 38,46% vs 16,67% and 69,23% vs 25%. Survival curves show a trend inversion approximately at 4 months Figure 1.

Mean time to weight bearing was 2,6 months in ORIF patients vs 1,3 months in RA patients and mean time to ambulation was 5,25 months in ORIF patients vs 2,4 months in RA patients. A summary of patients characteristics is reported in table 1.

Subgroups according to age at time of treatment identified 6 patients in the < 75 yrs group, 11 patients in the 75-84 yrs group and 12 patients in the ≥ 85 yrs group. Comparing survival curves of ORIF patients and RA patients in different subgroups, an increase in mortality rates for the first 4 months after RA was noted in the ≥ 85 yrs subgroup compared to other subgroups Figure 2, Figure 3.

Again, in the ≥ 85 subgroup an inversion in mor-

Table 1. summary of patients' demographics and outcomes according to type of surgery

SURGERY	B2+B3 ORIF	B2+B3 RA
N° patients	16	13
Gender	13F, 3M	8F, 5M
Mean Age	84,75	77,8
MORTALITY (%)		
In-Hospital	6,25	7,69
3 months	6,25	15,38
1 year	38,46	16,67
Overall	69,23	25
Functional outcomes (months)		
Weight-bearing	2,6	1,3
Ambulation	5,25	2,4

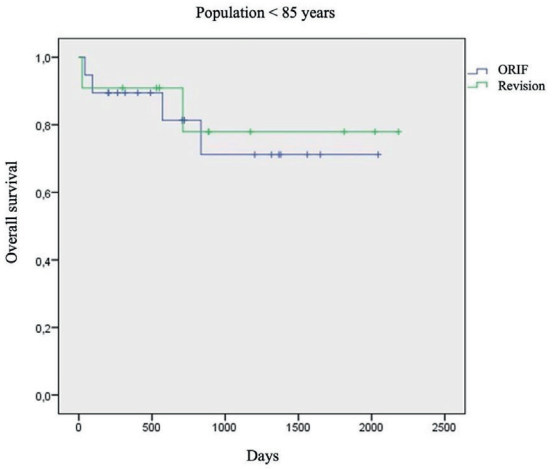

Figure 2. Survival curve of the < 85-year-old population

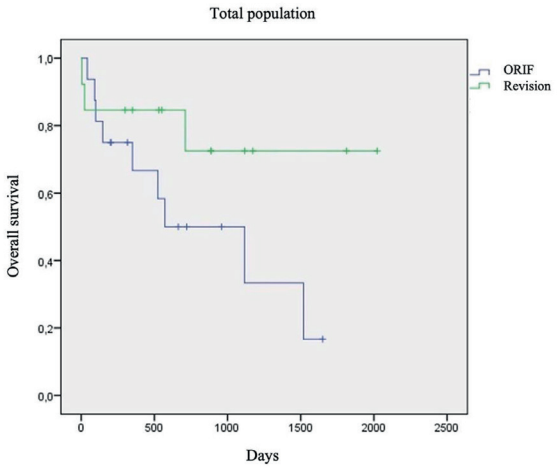

Figure 1. Survival curve of the whole population studied

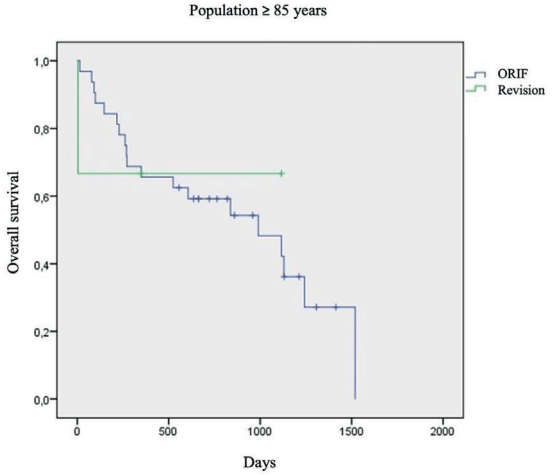

Figure 3. Survival curve of the ≥ 85-year-old population

tality rates with a higher mortality in the ORIF group was noted after four months. A statistically significant (p-value 0.04) relationship between overall mortality and delay in weight bearing in the ≥85 subgroup was found, as seen in Figure 4.

Discussion

Management and treatment choice of Vancouver B2-B3 PFF may be challenging in certain patients. The benefits of RA treatment, demonstrated in younger and active patients, might not be the same in elderly and fragile patients. Historically, treatment choice was based on the Vancouver classification alone and, according to the algorithm proposed by the authors, PFF associated with loose stems should always be treated with RA (6). Supporting this, many studies (13-16) have found that RA treatment may reduce mortality rates by allowing earlier weight-bearing and consequentially reduce complications associated with bedridden patients. In the present study earlier weight beating was obtained in patients who underwent RA treatment and indeed better overall survival rates were seen in these patients, although at the cost of a higher post-operative mortality. In contrast, other authors believe that treatment should be personalized evaluating specific patient characteristics to assess the best treatment strategy (17, 18, 9, 8). A recent systemic review by Stoffel et al. (2) comparing RA and ORIF treatment in Vancouver B2-B3 found no apparent differences between these two procedures, although methodological weaknesses were found in most of the studies analyzed. Independently of treatment choice, prognosis for PFF Vancouver B2-3 fractures is poor. One year mortality rates have been reported between 3% and 34% (11-4-17-12-19). Difference in mortality rates reported can be explained by population specifics such as age distribution. Age at the time of surgery has been shown to be an independent mortality risk factor by different authors (21-23). One year mortality rate in the present study was 28%, with a mean population age of 81,64 years. The result is in line with Philips et al, who report a mortality rate of 34% (20) in a population with a mean age of 86 years. Comparing this outcome in different sub-groups, patients over 85 yrs were found to have the highest mortality rate (34,29%). In the present study In-hospital and 90 days mortality were found to be higher in patients who underwent RA compared to patients who underwent ORIF treatment, respectively 7,69% vs 6,25% and 15,38% vs 6,25%. These findings were particularly evident in the >85 subgroup where the survival curve showed a dramatic drop in survival rate in the first months after RA. This can be explained by the hemodynamic impact and general complications that a complex surgical procedure such as RA may have on fragile and elderly patients. Conversely, 1-year mortality was found to be higher in ORIF patients compared to the RA patients, respectively 38,46% vs 16,67%. However, age distribution of the different interventions may have biased the results, as RA cases are predominantly distributed in the younger subgroups. Nonetheless, other literature reports found a higher mortality rate for ORIF. Bhat-

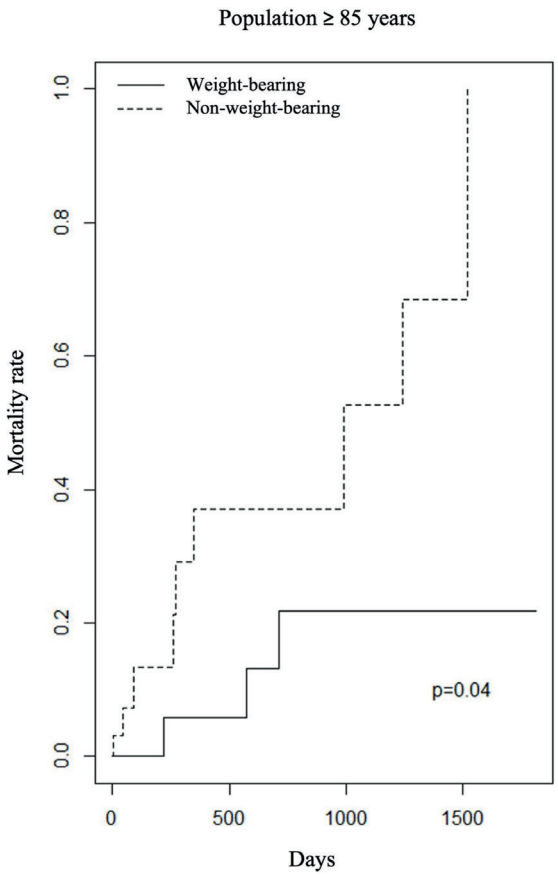

Figure 4. Correlation between weight-bearing and overall mortality rates in the ≥ 85-year-old population

tacharyya et al. report a 1 year mortality rate of 33% for ORIF and 12% for RA ($p<0.05$)(14). In contrast, Gitajn et al. did not find any correlation between treatment and mortality at 1 and 5 years after surgery. The authors state that the only factor affecting long term mortality outcomes is patients comorbidities evaluated through the CCI (Charlson comorbidity index)(24). Similar findings were reported by Tucker et al., who found the ASA score to be the only factor affecting long term mortality (25). Time to weight-bearing and to ambulation was analyzed to understand if, as some authors stated, earlier weight-bearing could be a protective factor for long term mortality. Whilst time to ambulation did not correlate with mortality rates, time to weight-bearing was found to have a protective effect on overall survival. This result was statistically significant in the >85 years of age group (P-value 0.04). Again, this appears in contrast with Gitajn et al and Tucker et al. findings. In fact, the main limitation of the present study is the lack of evaluation of patient's comorbidities as these could have had a negative effect on both mortality and functional outcomes. Furthermore, the presence of severe comorbidities could have acted as a bias factor in treatment choice, especially in the >85 year subgroup, influencing the surgeon to choose RA only in the fittest patients.

Conclusions

A treatment algorithm based only on Vancouver's classification is not able to provide the correct treatment choice in every situation. Factors such as age, comorbidities and functional demands should be analyzed in choosing the procedure. Age is a risk factor for short term mortality following RA procedures and should be considered when planning surgery. Patients over 85 years of age are particularly fragile and could benefit from a less invasive procedure such as ORIF. Long term outcomes are generally better for patients who undergo RA but further studies are necessary to evaluate the risk-benefit ratio of RA compared to ORIF in elderly patients.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

References

1. Pivec R, Issa K, Kapadia BH, et al. Incidence and Future Projections of Periprosthetic Femoral Fracture Following Primary Total Hip Arthroplasty: An Analysis of International Registry Data. J Long Term Eff Med Implants, 2015;25(4):269-275. doi:10.1615/jlongtermeffmedimplants.2015012625
2. Deng Y, Kieser D, Wyatt M, Stringer M, Frampton C, Hooper G. Risk factors for periprosthetic femoral fractures around total hip arthroplasty: a systematic review and meta-analysis. ANZ J Surg, 2020;90(4):441-447. doi:10.1111/ans.15473
3. Sidler-Maier CC, Waddell JP. Incidence and predisposing factors of periprosthetic proximal femoral fractures: a literature review. Int Orthop, 2015;39(9):1673-1682. doi:10.1007/s00264-015-2721-y
4. Bissias C, Kaspiris A, Kalogeropoulos A, et al. Factors affecting the incidence of postoperative periprosthetic fractures following primary and revision hip arthroplasty: a systematic review and meta-analysis. J Orthop Surg Res, 2021;16(1):15. doi:10.1186/s13018-020-02152-0
5. Duncan CP, Masri BA. Fractures of the femur after hip replacement. Instr Course Lect, 1995;44:293-304
6. Masri BA, Meek RMD, Duncan CP. Periprosthetic Fractures Evaluation and Treatment. Clin Orthop Relat Res, 2004;(420):80-95. doi:10.1097/00003086-200403000-00012
7. Streubel PN. Mortality after periprosthetic femur fractures. J Knee Surg, 2013;26(1):27-30. doi:10.1055/s-0033-1333905
8. Baum C, Leimbacher M, Kriechling P, Platz A, Cadosch D. Treatment of Periprosthetic Femoral Fractures Vancouver Type B2: Revision Arthroplasty Versus Open Reduction and Internal Fixation With Locking Compression Plate. Geriatr Orthop Surg Rehabil, 2019;10:215145931987685. doi:10.1177/2151459319876859
9. Solomon LB, Hussenbocus SM, Carbone TA, Callary SA, Howie DW. Is internal fixation alone advantageous in selected B2 periprosthetic fractures? ANZ J Surg, 2015;85(3):169-173. doi:10.1111/ans.12884
10. Flury A, Hasler J, Pagenstert G, Dimitriou D, Helmy N, Finsterwald M. Open reduction and internal fixation might be a valuable alternative to stem revision in Vancouver B2 periprosthetic femoral fractures, irrespective of the stem's design. Arch Orthop Trauma Surg, 2020;(0123456789). doi:10.1007/s00402-020-03568-3
11. Joestl J, Hofbauer M, Lang N, Tiefenboeck T, Hajdu S. Locking compression plate versus revision-prosthesis for Vancouver type B2 periprosthetic femoral fractures af-

ter total hip arthroplasty. Injury, 2016;47(4):939-943. doi:10.1016/j.injury.2016.01.036
12. Stoffel K, Blauth M, Joeris A, Blumenthal A, Rometsch E. Fracture fixation versus revision arthroplasty in Vancouver type B2 and B3 periprosthetic femoral fractures: a systematic review. Arch Orthop Trauma Surg, 2020;140(10):1381-1394. doi:10.1007/s00402-020-03332-7
13. Korbel M, Sponer P, Kucera T, Procházka E, Proček T. Results of treatment of periprosthetic femoral fractures after total hip arthroplasty. Acta Medica (Hradec Kralove), 2013;56:67-72. doi:10.14712/18059694.2014.26
14. Bhattacharyya T, Chang D, Meigs JB, Estok DM 2nd, Malchau H. Mortality after periprosthetic fracture of the femur. J Bone Joint Surg Am, 2007;89(12):2658-2662. doi:10.2106/JBJS.F.01538
15. Langenhan R, Trobisch P, Ricart P, Probst A. Aggressive surgical treatment of periprosthetic femur fractures can reduce mortality: comparison of open reduction and internal fixation versus a modular prosthesis nail. J Orthop Trauma, 2012;26(2):80-85. doi:10.1097/BOT.0b013e31821d6f55
16. Cohen S, Flecher X, Parratte S, Ollivier M, Argenson J-N. 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. Orthop Traumatol Surg Res, 2018;104(3):363-367. doi:10.1016/j.otsr.2017.12.018
17. Spina M, Rocca G, Canella A, Scalvi A. Causes of failure in periprosthetic fractures of the hip at 1- to 14-year follow-up. Injury, 2014;45(S6):S85-S92. doi:10.1016/j.injury.2014.10.029
18. Niikura T, Lee SY, Sakai Y, Nishida K, Kuroda R, Kurosaka M. Treatment results of a periprosthetic femoral fracture case series: treatment method for Vancouver type b2 fractures can be customized. Clin Orthop Surg, 2014;6(2):138-145. doi:10.4055/cios.2014.6.2.138
19. Phillips JRA, Moran CG, Manktelow ARJ. Periprosthetic fractures around hip hemiarthroplasty performed for hip fracture. Injury, 2013;44(6):757-762. doi:10.1016/j.injury.2012.09.015
20. Phillips JRA, Moran CG, Manktelow ARJ. Periprosthetic fractures around hip hemiarthroplasty performed for hip fracture. Injury, 2013;44(6):757-762. doi:10.1016/j.injury.2012.09.015
21. Drew JM, Griffin WL, Odum SM, Van Doren B, Weston BT, Stryker LS. Survivorship After Periprosthetic Femur Fracture: Factors Affecting Outcome. J Arthroplasty, 2016;31(6):1283-1288. doi:10.1016/j.arth.2015.11.038
22. Shields E, Behrend C, Bair J, Cram P, Kates S. Mortality and Financial Burden of Periprosthetic Fractures of the Femur. Geriatr Orthop Surg Rehabil, 2014;5(4):147-153. doi:10.1177/2151458514542281
23. Füchtmeier B, Galler M, Müller F. Mid-Term Results of 121 Periprosthetic Femoral Fractures: Increased Failure and Mortality Within but not After One Postoperative Year. J Arthroplasty, 2015;30(4):669-674. doi:10.1016/j.arth.2014.11.006
24. Gitajn IL, Heng M, Weaver MJ, et al. Mortality Following Surgical Management of Vancouver B Periprosthetic Fractures. J Orthop Trauma, 2017;31(1):9-14. doi:10.1097/BOT.0000000000000711
25. Finlayson G, Tucker A, Black ND, McDonald S, Molloy M, Wilson D. Outcomes and predictors of mortality following periprosthethic proximal femoral fractures. Injury. 2019;50(2):438-443. doi:10.1016/j.injury, 2018.10.032

Received: 10 December 2021
Accepted 18 January 2022
Correspondence:
Nicholas Rasio, MD
Orthopaedics and Traumatology Unit, Cattinara Hospital, ASUGI, Faculty of Medicine, Surgery and Health Sciences, University of Trieste (Italy)
Strada di Fiume 447
34149, Trieste (Italy)
Phone: +39 040 399 4730
E-mail: rasio.nick90@gmail.com