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Research Article

Surgery of Vancouver Type B2 Periprosthetic Femoral Fracture after Total Hip Arthroplasty in Elderly Patients: An Alternative way with Internal Fixation

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Abstract

Background: The periprosthetic femoral fractures after hip arthroplasty represent a challenge for orthopedic surgeons in the oldest patients. The type B2 fracture with stem loosening is usually treated by revision of the implant. We assessed if internal fixation alone could be an alternative for treating the elderly population. This surgical procedure is less complex and can provide enough stability, thus allowing patients to recover their mobility.

Methods: Twenty six patients with type B2 fracture were treated. 16 patients had a revision surgery while 10 received internal fixation. The Parker Score, the Functional Ambulation Classification and ambulatory scores were all used before and after surgery.

Results: The two groups were homogeneous in terms of demographic data, preoperative status and perioperative data. Only the duration of surgery was significantly lower in the internal fixation group.

In postoperative, no scores showed differences between groups. In both groups, we observed significant difference in pre vs early post-operative scores with a decrease of the functional status. At the late postoperatively stage, no significant differences were observed compared to pre-operative scores.

The occurrence of complications was similar between the groups. 20% of patients died after internal fixation procedure and 13% after revision.

Conclusions: There are no differences in terms of autonomy recovery between both procedures. We thus can envision internal fixation as an adequate alternative in elderly patients.

Introduction

Periprosthetic femoral fractures following hip arthroplasty represent a severe complication mainly occurring with elderly patients. The number of these fractures has dramatically increased over recent decades, and this number is expected to grow further due to population ageing. It is also associated to significant risk factors such as ASA score, Deyo-Charlson index, age, gender, the local bone quality and type of implant [1]. According to Abdel et al. [2], the probability of post-operative periprosthetic femoral fracture is also increasing and has reached a rate of 3.5% at 20 years. A Swedish registry study in 1049 patients with periprosthetic fractures reported an incidence of 0.4% after primary hip arthroplasty and 2.1% after revision arthroplasty, with type B2 fractures much more common than B1 fractures among the primary group, and the occurrence increasing with ageing population [3].

The treatment of these fractures is widely recognized as a real challenge and a complex procedure for orthopedic surgeons. To help in the decision-making process, the Vancouver classification was developed as a valid and reliable guideline, as it includes fracture site, implant stability and the surrounding bone quality [4-6]. According to the Vancouver classification, the periprosthetic fractures are classified in three categories based on fracture location. Type A fractures are located in the proximal femur and are subdivided in AG when involving the greater trochanter and AL for the lesser trochanter. Type B fractures occur around the stem, which is stable for subtype B1, loose with adequate bone stock in subtype B2 and, finally, loose with poor bone stock in subtype B3. All the fractures below the stem are categorized as type C [7,8]. The current recommendation for

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B2 fractures is revision of the femoral stem to a longer stem with or without internal fixation. Due to the lack of scientific evidence, most orthopedic surgeons have adopted to the Vancouver classification as an algorithm treatment despite the fact that this classification is not reflecting the patient's physiology status, his or her functional expectation, the surgeon's experience [4,9]. This could conduct in the future to a modified classification nomenclature [10].

In this perspective, we assessed the possibility of applying another treatment from that usually recommended for patients with higher co morbidities and a poor level of activity status, by offering less invasive surgery. Many studies are focused on the need to treat the type B2 by revision surgery, but recent studies suggest that internal fixation could be an adequate alternative treatment to manage this periprosthetic fracture in fragile patients [9,11-16].

This study aimed to compare the clinical and functional outcomes of two cohorts presenting a B2 periprosthetic fracture and treated either with internal fixation (ORIF) or with revision arthroplasty. Our objective was to demonstrate that ORIF could be a suitable alternative treatment for old patients and provides complete bone union, associated to good results in terms of functional and mobility status.

Materials and Methods

Patients

We conducted a retrospective study approved by the Ethics Committee of our institution across our hospital. The clinical data was collected by reviewing medical records. The fractures (periprosthetic femoral fractures of B2 type) were classified by the authors (AC, ST) according to the Vancouver classification [7]. The stem loosening showed only radiologically. We verified on the radiographs the presence of edging or the embedding of stem.

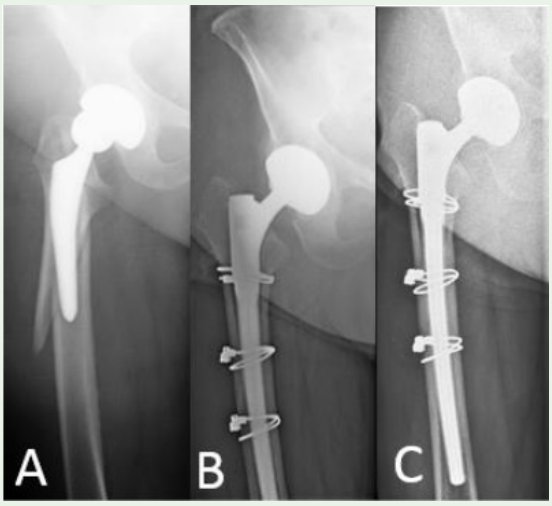

Figure 1: Clinical case of revision surgery.
Anteroposterior radiography (A) of a right total hip arthroplasty in a sixty-eight years old woman with a Vancouver B2 fracture. The trauma was minor and occurred three weeks after the primary arthroplasty. (B) Anteroposterior radiography of the same hip after revision arthroplasty with cerclages wires at 6 months and (C) 1.5 years.

Inclusion criteria were complete bone union on radiography and at least 6 months of follow-up. The complete bone union was defined as a bridge of callus in a minimum of three cortical on two orthogonal views on the latest radiography. Exclusion criteria were loss of follow-up, bone non-union, early death and surgical technique including only cerclage wires.

The surgical treatment was internal fixation (ORIF) or revision, depending on the surgeon's decision. The fracture mechanism for all patients was a low-energy trauma.

Surgical procedure

The revision surgery (Figure 1) included long stem revision with or without plate and/or cables wires and cemented or not. Internal fixation (Figure 2) performed with LCP, LC-DCP and Dall Miles plate with or without cable wires. Neither autologous bone graft nor allograft was used. All surgeries were performed by four senior surgeons of our hospital. The postoperative rehabilitation program was weight-bearing as tolerated and assisted early mobilization for the two groups. Physical therapy sessions were prescribed immediately after surgery, with the agreement to end the sessions when progress was no longer being made, as decided with the physical therapist.

Outcomes assessment

Primary outcomes focused on functional scores. We assessed the ambulatory status of patient using a categorical classification (5 levels): level 0-able to walk independently, 1-able to walk with a cane, 2-able to walk with two crutches, 3-walking with walker, and 4-unable to walk. We also assessed ambulatory status and functional outcome using the Parker mobility score [17] and the New Functional Ambulation Classification (FAC modified) (Tables 2 and 3). All scores were assessed and based on the status of patients before fracture, at an early post-surgery stage, and a late (in average 26.3 months) post-surgery stage.

Secondary outcomes focused on several parameters. Co morbidities were assessed using the Charlson score [18]. The duration of surgery, length of hospital stays and the follow up were reported.

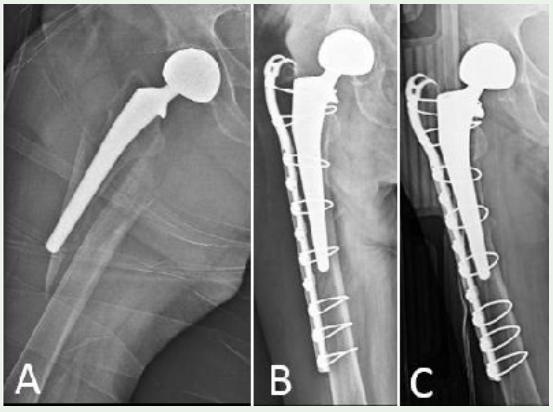

Figure 2: Clinical case of ORIF surgery.
Anteroposterior radiography (A) of a right total hip arthroplasty in a ninety-four years old woman with a Vancouver B2 fracture. The trauma was minor and occurred 10 years after the primary arthroplasty. (B) Anteroposterior radiography of the same hip after ORIF at 6 months and (C) 4 years.

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Table 1: Comparison of demographic, pre and perioperative data in each group.

	Revision (n=16) Mean ± Standard error	ORIF (n=10) Mean ± Standard error	P-value
Age (years)	76.3 ± 9.1	74.4 ± 12.9	0.66
Height (m)	1.63 ± 0.008	1.63 ± 0.01	0.98
Weight (kg)	70.6 ± 16.1	69.2 ± 12.5	0.82
Gender: women/men	14/2	7/3	Chi-square: 1.21 NS
Death/No death	2/14	2/8	Chi-square: 0.27 NS
Duration of surgery (min)	224.9 ± 75.4	152 ± 38.5	**0.04**
Length of hospital stay (days)	18.0 [11.5-23.5] $	15.0 [8.8-18] $	0.09
Follow up (months)	23.9 ± 32.2	27.9 ± 20.5	0.46
AmbulatoryScore (/4)	0 [0- 1] $	1.5 [0 - 3] $	0.16
Parker Score (/9)	6 [4 - 9] $	3.5 [1 - 9] $	0.3
FAC Score (/8)	6 [5 - 8] $	5 [1.75 - 8] $	0.27

$ Median[1st-3nd quartile]

Significant value are in bold

Complications (Table 4) and mortality were assessed for all patients and bone-related complications were classified as dislocation or re-fracture. The rate of complications was reported as well as the number of deaths in each group.

Statistical analysis

The homogeneity between groups in pre or perioperative was tested using a t-test for quantitative variables and chi-square test for qualitative variables.

Primary outcomes analyzed by different statistical analysis. Only no parametric analyses were used, all scores being categorical. A Rank Sum Test was used to compare postoperative scores (early and late) between groups. As no difference was observed between groups, all scores from both 2 groups were combined. Then, the Wilcoxon Signed Rank Test was used to assess the difference between the pre- and post-fracture (early and late) on functional status including the Ambulatory status, the Parker and FAC scores.

Secondary outcomes were assessed by Chi-square or Fisher Exact tests to compare the rate of proportions between groups.

Moreover, to test the influence of cement *vs.* cementless stems on postoperative scores, we used a rank sum test.

All the statistical analyses were performed using Sigmaplot v13 (SPSS) and p-values were considered to be significant when <0.05.

Table 2: Comparison of postoperative (early and late) scores between groups (Rank Sum Test).

	Revision (n=16) Median [1st- 3nd quartiles]	ORIF (n=10) Median [1st- 3nd quartiles]	P- value
Ambulatory Score (early)	3 [2 -3]	3 [2 - 3.5]	0.66
Parker Score (early)	3 [1.5 - 4]	1.5 [0 - 4]	0.28
Parker Score (late)	5 [3 - 6]	4 [1 - 9]	0.79
FAC Score (early)	2 [1 - 4]	3 [0 - 5.75]	0.97
FAC Score (late)	6 [5 - 7]	6 [1 - 7]	0.54

Results

Twenty six patients fulfilled the inclusion criteria consisting of a complete bone union on radiography and at least 6 months of follow-up. In overall, the mean follow-up time was 26.3 months (± 25.1). We reported 16 patients undergoing revision surgery and 10 patients in ORIF group.

Primary outcomes

The functional scores were equal in the pre-operative stage in each group (Table 1).

In the postoperative stage (early and late), no differences were found between groups (Table 2). So, the scores of 2 groups were combined.

For all patients (n=26), we observed a significant difference in pre *vs.* early post-operative scores with a decrease of functional status (Table 3) that worsened in both groups for those who were unable to return to their pre-injury levels of mobility, required a walking aid to move. At the later postoperative stage, no significant differences were observed in functional scores *vs.* preoperative status. Regarding the home' residence, 50% patients in the ORIF cohort and 56% in the revision cohort were able to go back home with home help.

Secondary outcomes

Demographic data, pre-operative scores and perioperative data are shown in Table 1. Only duration of surgery was significantly different (p=0.04) between groups (152 ± 38.6 minutes in ORIF group vs. 224.9 ± 75.4 minutes in revision group) with a significant difference. The mean age of patients at the time of injury was 74.4 ± 12.9 years in the ORIF group and 76.3 ± 9.1 years in the revision group, with a total of 5 men and 21 females' patients. The mean time from primary arthroplasty to fracture was 80.7 ± 77.6 months in ORIF group and 68.9 ± 72.8 months in revision group. With regard to co morbidities, 12 patients had a Charlson index score greater than or equal to 5; 5 in the ORIF group and 7 in the revision group with no statistical difference in the two groups (p=0.89).

As for bone, related complications leading to reoperation in the ORIF group: one patient suffered an irreducible dislocation and another dislocation followed by a re-fracture nine year after the previous surgery. In the revision group, we reported one superficial hematoma at 2 months followed by a re-fracture at 2 years and one recurrent dislocation started 3 weeks postoperatively.

Table 3: Comparison of scores in pre and postoperative for all patients (Wilcoxon Signed Rank Test).

	Preoperative (n=26) Median [1st- 3nd quartiles]	Postoperative (n=26) Early Median [1st- 3nd quartiles]	Postoperative (n=26) Late Median [1st- 3nd quartiles]	P-value
Parker Score	5 [2 - 9]	3 [1 - 4]		**0.001**
	5 [2 - 9]		4.5 [2 - 8.3]	0.43
FAC Score	6 [4 - 8]	2 [1 - 4.5]		**0.001**
	6 [4 - 8]		6 [3.5 - 7]	0.30
Ambulatory Score	0.5 [0 - 2]	3 [2 - 3]		**0.001**

Significant values are in bold

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Table 4: Number of early postoperative complications in each group.

	Revision N=16	ORIF N =10
None	6	4
Anemia	8	3
Urinary infection	2	2
Pulmonary embolism	0	1

Chi-square= 12 - P= 0.21

Table 5: Comparison of postoperative scores between cement *vs* cementless stems groups (Rank Sum Test).

	Cement stems (n=9) Median [1st- 3nd quartiles]	Cementless Stems (n=17) Median [1st- 3nd quartiles]	P- value
Ambulatory Score (early)	3 [2.3 -3]	2.5 [1.3 - 3]	0.27
Parker Score (early)	3 [2 - 4]	2 [1 - 4]	0.55
Parker Score (late)	4 [2.5 - 9]	5 [1.8 – 6.7]	0.87
FAC Score (early)	2.5 [2 - 4]	2 [0.5 - 5.5]	0.94
FAC Score (late)	6 [4 - 7]	6 [2 - 7]	0.77

Patient-related early postoperative complications are shown in Table 4. The frequency of complications is the same between the groups (Chi-square: 12 - P=0.21).

All except one of the patients needed to receive blood transfusions during the perioperative course. 20% of patients died after ORIF and 13% after revision (Fisher Test p=0.54) with a delay of 59.5 ± 19.1 months in the ORIF group and 37.5 ± 10.6 months in the revision group.

Cement *vs.* cementless stems

No significant difference was observed between scores of cement *vs* cementless stems (Table 5).

Discussion

The periprosthetic fractures after primary THA are a severe complication occurring in elderly patients. Due to the advanced age of population, there was a high prevalence of comorbidities. To highlight this fact, the Charlson score allows to evaluate the risk of death due to comorbid disease [18]. In our study on 26 patients, 12 presented a Charlson score greater or equal to 5 which predicts a year mortality approaching 85%. Not only has the risk of death had to be considered but also the quality of life and the functional outcome. This was the challenge of the present study. In early and late postoperative stages, we showed that there was no statistical difference on functional scores related to treatment strategy. Moreover, all patients in the early postoperative period presented deterioration of their functional status. Still, we could demonstrate that the two groups recovered their preoperative ambulatory status regardless of type of surgery after >6 months. A recent retrospective study of 67 patients showed no statistical influence on the outcome stemming from fracture type or treatment strategy. Comorbidities seem to influence functional outcome [19]. In addition, Moreta et al. found that the presence of previous local risk factors such as osteoporosis, osteolysis and loosening of the stem were associated with poorer ambulatory status and since then propose an adequate follow-up particularly in case of osteolysis and osteoporosis [20].

With an aging population, the management of the comorbidity and its consequences are becoming a real challenge for the health care system. The cost-effectiveness ratio of surgical intervention and length of hospital stay could be improved with yearly or every-other-year x-ray surveillance to detect osteolytic lesions and propose an elective procedure of revision [21]. Moreover the system whose costs tended to decrease the length of follow up after total hip arthroplasty with the consequence that asymptomatic loosening is not identified in an early stage which increase subsequently the risk of fracture [3,6,21].

The Charlson-index score, the local risks factors and consequently the Vancouver classification can't be used independently without regard to the functional outcome. Indeed the diagnostic-therapeutic algorithm universally accepted and used for fracture classification, the Vancouver system [4,5], is actually not always helpful for surgical indication according to the surgeon's decision and with regard to the general health of the patients. That's why there is still debate among experts and the decision should be taken with respect to the evolution of surgical techniques and studies on this scopes will come up to a modified classification for periprosthetic fractures [22]. This classification could include the type of implant and implantation technique (cemented *vs* cementless), the mechanical quality of the bone stock and the time point of fracture occurrence [10]. To help choosing the adequate treatment, CT scans or scintigraphy should be performed in order to recognize signs of loosening because, the x-ray cannot determine the stability alone [23].

A recent study highlights the interest of considering the type of implant, in 12 patients treated with successful ORIF without revision of Vancouver B2 fractures according to the type of implant and compared to revision surgery. The type of implant explained the recovery of stability of the stem within its cement mantle. Rotational stability is ensured by the geometry of the cemented collarless polished tapered stem. Their results were statistically significant in term of total fracture healing with shorter surgical time and less blood transfusions compare to the revision group. Our results confirm that the surgical duration was also lesser in the ORIF group (Table 1). Moreover Spina et al. in his retrospective study of 61 patients undergoing surgery for periprothetic fracture concluded that the revision surgery with or without internal fixation is more aggressive in term of increased surgery time and additional blood loss, and therefore associated with an increased risk of death in the short- and medium-term [14]. That fact can also lead to a different approach for adapted treatment dependent on the condition of the patient. However, in our study, we did not observe more blood loss in revision group. The difference of hemoglobin (pre minus post-surgery) was 3.77 ± 1.8 g/dl in revision *vs.* 2.97 ± 1.3 g/dl in ORIF (p=0.2) not confirming the study of Spina, et al.

Another important point concerns the problem of cemented *vs.* cementless stem. Our study included 26 cases of periprosthetic femoral fracture Vancouver B2 consolidated and only 9 were cemented (40% in ORIF *vs.* 30% in revision group). It is important to mention the relevant result of Abdel, et al. who reported a significant greater risk of post-operative femoral fractures with cementless femoral stems [2]. About the cementless stem, Spina, et al. observed that the cementless straight stems can reach new stable position by the press fit concept after ORIF [14]. Therefore, the treatment of periprosthetic femoral fractures requires particular attention and planning because safe fixation is difficult compared to other fractures. Revision with

a long stem has been the preferred treatment with or without plate in B2 fracture but this surgery is costly, technically difficult, time-consuming, and can lead to considerable bone loss. This justifies why different ways to obtain a secure montage were approached with no general consensus.

In our ORIF group, half of patients' beneficiate of osteosynthesis with cable ready trochanteric plate or cable plate system with supplementary bicortical screws and grip on the greater trochanter. Kamineni, et al. treated a series of 13 patients with loose prostheses obtaining radiological union and recommends as an alternative treatment the use of a plate and cable fixation with supplementary screws. They regard that procedure to be more adequately achieved using internal fixation alone with plate and cable, thus allowing bone union followed by an elective revision, instead of a primary revision first in order to avoid hip exposure and complications linked to more extensive surgery. Benefits include a procedure not technically demanding, immediate fracture stability and early mobilization [24].

With the Dall-Miles cable and plate system, Haddad, et al. use autogenous graft at the fracture site, strengthened by a cortical strut allograft and feel that could accelerate the bone union, therefore allowing rapid mobilization [25]. This graft is described as an additional stability procedure, inevitable in order to avoid failure and providing a strong construct [26]. However the detrimental effects of soft tissue stripping for application of the strut graft cannot be ignored as it may cause a deep infection and require increased time to bind the bone elements. Therefore it must be used with caution [27]. Likewise, to get optimized stability, these plates should be bypassed by two shaft diameters at the distal extremity of the stem [28]. At the opposite, the minimally invasive fixation option with LCP plate has also been described as a valid alternative in case of B2 fractures borderline for conservative treatment with preservation of hematoma and respect of periosteal blood supply and soft tissue surrounding [11]. Finally, a biomechanical study rests on utilization of a locking attachment plate construct (LAP-LCP), as compared to a cerclage-LCP construct. The LAP-LCP construct allows the placement of bicortical screws laterally to the prosthesis stem and offers a multidirectional stability with improved proximal fixation compared to LCP-construct [29] (Figure 3).

Figure 3: Decision tree in geriatric patients with fracture mechanism on low-energy trauma.
Decision tree to help the surgeon in geriatric patients with Vancouver type B2 periprosthetic femoral fracture after total hip arthroplasty. The choice of surgical technique should consider the Charlson score and the early mobilization was possible or not.

The main limitations of this retrospective study are the small number of patients, the samples were not balanced and the variability in length of the follow up (from 6 to 110 months). Furthermore, the sample was heterogeneous due to various differences related to prior implants, variation in the number and position of cables and screws with plates and finally the number of surgeons. Our series is short by our choice to limit to Vancouver B2, therefore a criticism but also an advantage. Our results should be taken with caution but the p value was not close to the significance level. However large series are difficult to obtain when only a small fraction of B2 fractures were treated by ORIF in our hospital.

For these reasons, the study has a low power of detecting statistically significant variances and thenceforth further studies with larger numbers of appropriate patients are required to define the specific indications of the ORIF treatment for Vancouver B2 femoral periprosthetic fractures.

Conclusions

In revision option, cooperation of a trauma surgeon and hip joint surgeon is recommended but not necessary in ORIF option treatment. Moreover, the choice of treatment should not solely be based on an algorithmic classification. We have to customize the treatment of this fracture with regard to the evaluation of each patient's condition and functional status [12], the socioeconomic status, the configuration of the fracture but also the stem design cemented or not to avoid a scheme of routine [15]. This should be added with the early identification of loosening of the prosthesis stem with radiography and CT-scan or scintigraphy follow-up.

Furthermore, this study tends to prove that the correct classification is crucial for selecting the treatment, which can be non-operative or consist in an osteosynthesis or in a revision arthroplasty, depending on the patient's general medical condition and the local status and therefore conclude that osteosynthesis with a plate is a valid option with some substantial advantages like reduced surgery time, diminution of perioperative blood loss and transfusions [13,16], diminution of surgical costs, the recourse of less experienced surgeons, the avoidance of hip exposure and complications linked to more extensive surgery, the potential to perform minimal invasive percutaneous osteosynthesis, and finally the possibility with younger patients to avoid a long stem implant at the time of fracture if further revisions are required in the future [16]. From our results, we propose an algorithm in order to help the surgeon about therapeutic decision (Figure 3).

References

1. Singh JA, Jensen M, Harmsen S, Lewallen D. Are Gender, Comorbidity and Obesity Risk factors for Postoperative Periprosthetic Fractures Following Primary Total Hip Replacement? J Arthroplasty. 2013; 28: 126-131.
2. Abdel MP, Watts CD, Houdek MT, Lewallen DG, Berry DJ. Epidemiology of periprosthetic fracture of the femur in 32 644 primary total hip arthroplasties: A 40-year experience. Bone Joint J. 2016; 98-B: 461- 467.
3. Lindahl H, Malchau H, Herberts P, Garellick G. Periprosthetic femoral fractures: Classification and demographics of 1049 periprosthetic femoral fractures from the Swedish National Hip Arthroplasty Register. J Arthroplasty. 2005; 20: 857-865.
4. Brady OH, Garbuz DS, Masri BA, Duncan CP. The reliability of validity of the Vancouver classification of femoral fractures after hip replacement. J Arthroplasty. 2000; 15: 59-62.

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https://dx.doi.org/10.36876/smggr.1006

5. Naqvi GA, Baig SA, Awan N. Interobserver and Intraobserver Reliability and Validity of the Vancouver Classification System of Periprosthetic Femoral Fractures after Hip Arthroplasty. J Arthroplasty. 2012; 27: 1047-1050.

6. Rayan F, Dodd M, Haddad FS. European validation of the Vancouver classification of periprosthetic proximal femoral fractures. J Bone Joint Surg Br. 2008; 90: 1576-1579.

7. Ohly NE, Whitehouse MR, Duncan CP. Periprosthetic femoral fractures in total hip arthroplasty. HIP Int. 2014; 24: 555-665.

8. Misur PN, Duncan CP, Masri BA. The Treatment of Periprosthetic Femoral Fractures After Total Hip Arthroplasty: A Critical Analysis Review. JBJS Rev. 2014; 2.

9. Niikura T, Sakurai A, Oe K, Shibanuma N, Tsunoda M, Maruo A, et al. Clinical and radiological results of locking plate fixation for periprosthetic femoral fractures around hip arthroplasties: a retrospective multi-center study. J Orthop Sci. 2014; 19: 984-990.

10. Frenzel S, Vécsei V, Negrin L. Periprosthetic femoral fractures, incidence, classification problems and the proposal of a modified classification scheme. Int Orthop. 2015; 39: 1909-1920.

11. Ehlinger M, Bonnomet F, Adam P. Periprosthetic femoral fractures: The minimally invasive fixation option. Orthop Traumatol Surg Res. 2010; 96: 304-309.

12. 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: 138-145.

13. Joestl Md J, Hofbauer M, Lang N, Tiefenboeck T, Hajdu S. Locking compression plate versus revision-prosthesis for Vancouver type B2 periprosthetic femoral fractures after total hip arthroplasty. Injury. 2016; 47: 939-943.

14. 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: S85–92.

15. Park SK, Kim YG, Kim SY. Treatment of Periprosthetic Femoral Fractures in Hip Arthroplasty. Clin Orthop Surg. 2011; 3: 101-106.

16. 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: 169-173.

17. Parker MJ, Palmer CR. A new mobility score for predicting mortality after hip fracture. J Bone Joint Surg Br. 1993; 75: 797-798.

18. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. J Chronic Dis. 1987; 40: 373-383.

19. Märdian S, Schaser KD, Gruner J, Scheel F, Perka C, Schwabe P. Adequate surgical treatment of periprosthetic femoral fractures following hip arthroplasty does not correlate with functional outcome and quality of life. Int Orthop. 2015: 39: 1071-1078.

20. Moreta J, Aguirre U, de Ugarte OS, Jauregui I, Mozos JL. Functional and radiological outcome of periprosthetic femoral fractures after hip arthroplasty. Injury. 2015; 46: 292-298.

21. Lavernia CJ. Cost-effectiveness of early surgical intervention in silent osteolysis. J Arthroplasty. 1998; 13: 277-279.

22. Duncan CP, Haddad FS. The Unified Classification System (UCS): Improving our understanding of periprosthetic fractures. Bone Joint J. 2014; 96-B: 713-716.

23. Lindahl H, Malchau H, Odén a, Garellick G. Risk factors for failure after treatment of a periprosthetic fracture of the femur. J Bone Joint Surg Br. 2006; 88: 26-30.

24. Kamineni S, Vindlacheruvu R, Ware HE. Peri-prosthetic femoral shaft fractures treated with plate and cable fixation. Injury. 1999; 30: 261-268.

25. Haddad FS, Marston RA. The Dali-Miles periprosthetic cable and plate system for femoral fractures. Injury. 1997; 28: 445-447.

26. Tsiridis E, Haddad FS, Gie GA. Dall-Miles plates for periprosthetic femoral fractures: A critical review of 16 cases. Injury. 2003; 34: 107-110.

27. Moore RE, Baldwin K, Austin MS, Mehta S. A systematic review of open reduction and internal fixation of periprosthetic femur fractures with or without allograft strut, cerclage, and locked plates. J Arthroplasty. 2014; 29: 872-876.

28. Dargan D, Jenkinson MJ, Acton JD. A retrospective review of the Dall-Miles plate for periprosthetic femoral fractures: Twenty-seven cases and a review of the literature. Injury. 2014; 45: 1958-1963.

29. Lenz M, Windolf M, Mückley T, Hofmann GO, Wagner M, Richards RG, et al. The locking attachment plate for proximal fixation of periprosthetic femur fractures - A biomechanical comparison of two techniques. Int Orthop. 2012; 36: 1915-1921.

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