

Treatment of Periprosthetic Femoral Fractures Vancouver Type B2: Revision Arthroplasty Versus Open Reduction and Internal Fixation With Locking Compression Plate

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Geriatric Orthopaedic Surgery
& Rehabilitation
Volume 10: 1-9
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DOI: 10.1177/2151459319876859
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Abstract

Introduction: The Vancouver algorithm recommends revision arthroplasty (RA) for Vancouver type B2 (VTB2) fractures. However, open reduction and internal fixation (ORIF) using locking compression plates (LCP) may be a valid and less invasive alternative treatment. **Materials and Methods:** Between January 2007 and March 2017, we retrospectively recruited all patients treated with either ORIF with LCP or RA for VTB2 fractures in our clinic. All of the following were reviewed: the length of hospital stay, the operating time, the need for blood transfusions during and/or after surgery, implant-related and patient-related complications, need for revision surgery, and the radiological outcome. Additionally, the functional outcome was investigated. **Results:** Fifty-nine patients were recruited. Thirty-five (59.3%) patients underwent RA, while 24 (40.7%) patients received ORIF with LCP. The median surgical time was 137.50 minutes in the LCP group compared to 160.00 minutes in the RA group ($P = .051$). Three (12.5%) patients in the LCP group and 10 (28.6%) patients in the RA group experienced an implant-associated complication ($P = .131$). Patient-related complications occurred in 3 (12.5%) patients in the LCP group versus 6 (17.1%) patients in the RA group ($P = .628$). The mean preoperative Parker mobility score was 9 points in both groups and decreased in both groups to a mean of 5 points in the LCP and 7 points in the RA group. **Discussion:** Open reduction and internal fixation with LCP seems to be a less invasive procedure for VTB2 fractures in comparison to RA. It is a bone-sparing procedure that can be advantageous for further revision operations. Moreover, some fractures can only be anatomically reduced by ORIF with LCP, whereas for proximal fractures with a radiologically unambiguously loosened stem RA might be advantageous. **Conclusion:** In line with previously published studies, our data suggest that ORIF using LCP is a valid treatment option for VTB2 fractures.

Keywords

total hip arthroplasty (THA), periprosthetic fractures, Vancouver B2, locking compression plate (LCP), femoral stem loosening

Submitted March 12, 2019. Revised June 25, 2019. Accepted August 15, 2019.

Introduction

With an increasing aging population, the incidence of patients undergoing total hip arthroplasty (THA) and hemiarthroplasty has constantly been rising in the past decades.^{1,2} This tendency is expected to continue, leading to a likewise increase in periprosthetic femoral fractures as it may occur in 0.07% to 18% after hip arthroplasty.³⁻⁵ Risk factors for postoperative periprosthetic femoral fractures are advanced age, osteoporosis, rheumatoid arthritis, proximal femur deformities, previous hip surgery, stems implanted without the use of cement and press-fit implantation, cortical perforation during surgery, stem loosening, and revision arthroplasty (RA).^{4,6}

The Vancouver classification introduced by Duncan and Masri is currently the most widely used classification system for periprosthetic femoral fractures.^{7,8} The classification includes the anatomical location of the fracture in relation to the stem, the

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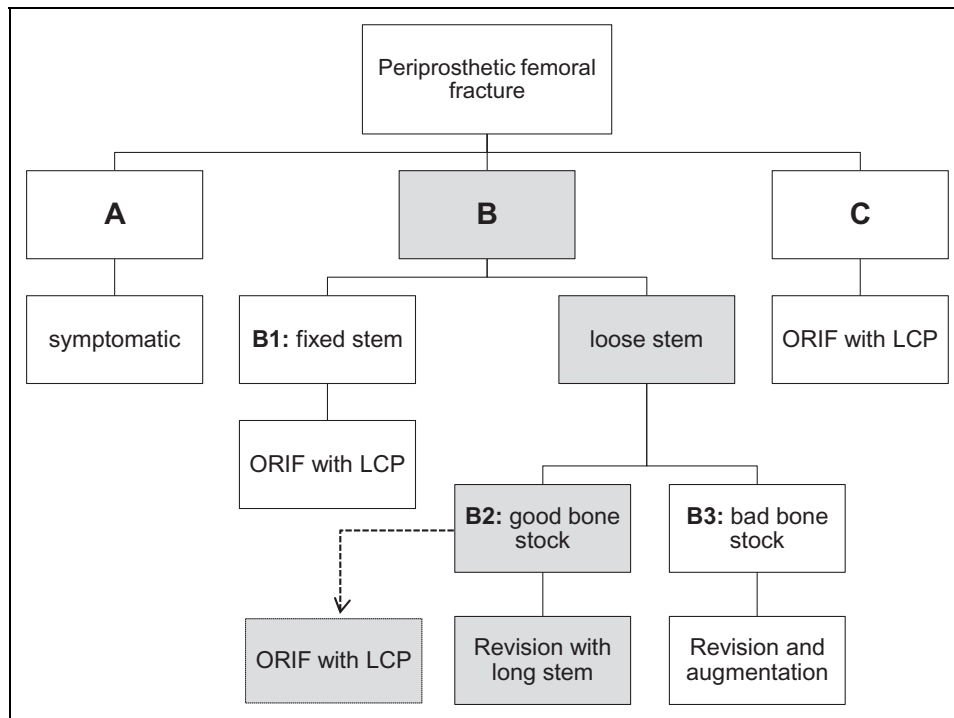


Figure 1. Treatment algorithm for periprosthetic femoral fractures based on the Vancouver classification system with modification for Vancouver Type B2 (VTB2) fractures using open reduction and internal fixation (ORIF) with locking compression plates (LCP).

fixation status of the stem, and the quality of bone stock surrounding the stem. A valid and reliable judgment of this classification system is possible by plain conventional radiographs only.^{9,10} The majority of periprosthetic fractures are located around the stem and classified as Vancouver type B (VTB) with either a well-fixed (VTB1) or loose (VTB2/VTB3) stem.

Based on the Vancouver classification, a treatment algorithm was developed for fracture management (Figure 1).^{8,11,12} According to the Vancouver algorithm, open reduction and internal fixation (ORIF) using LCP is a widely accepted and established treatment option for VTB1 fractures.^{13,14} For the more technically challenging VTB2 fractures, RA with a long stem that bypasses the fracture remains the recommended procedure.^{15,16} However, ORIF using LCP is a less complex and a less invasive procedure, especially in the management of polymorbid elderly patients.^{17,18} We hypothesized that the ORIF with LCP could be a valid alternative if not a superior alternative to RA for the treatment of VTB2 fractures.

Materials and Methods

Patients

In accordance with local ethical committee approval, the medical records of all patients receiving hip arthroplasty between January 2007 and March 2017 in the Department of General, Hand and Trauma Surgery at our clinic were retrospectively reviewed. Patients diagnosed with a periprosthetic femoral fracture and classified at hospital admission as VTB2

according to the Vancouver classification system were included into the study. The fracture classification was then reassessed based on the X-ray pictures and intraoperative findings described in the surgical records. Patients with an intraoperative finding of poor bone quality described in the surgical report, for example, due to severe osteoporosis or severe comminution, were classified as VTB3. All fractures retrospectively assessed other than VTB2 were excluded. Other treatment options such as treatment using cerclage wires only, conservative treatment, or a combination of ORIF using LCP and RA were excluded as well. No distinctions were made between hemi and total hip prosthesis. The implant was selected depending on the team that was on call when the patient was admitted to the hospital. Our team consists of arthroplasty surgeons and trauma surgeons. If an arthroplasty surgeon was on call, RA was performed by a dedicated senior consultant arthroplasty surgeon immediately or in the later course. If a trauma surgeon was on call, ORIF with LCP was performed by a dedicated trauma surgeon immediately or in the later course.

The clinical data of all patients were retrospectively reviewed to record age, the time from primary surgery to revision operation, average operation time, the number of units of blood given during and/or after surgery, the length of hospital stay, the type of surgical procedure, implant- as well as patient-related complications, the need for revision surgery, and the follow-up time. All mortalities, which occurred following surgery, were recorded including the time until death.

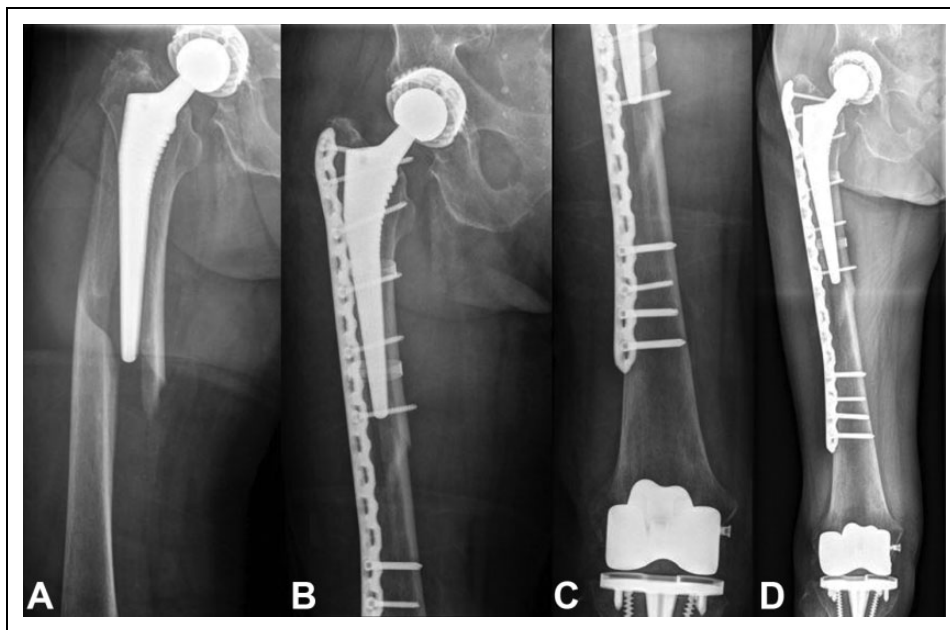


Figure 2. Case 1: A, Anteroposterior radiograph of a 91-year-old woman who sustained a Vancouver type B2 periprosthetic femoral fracture 8 years after primary total hip replacement. B/C, Postoperative anteroposterior radiographs of the right hip following revision surgery with open reduction and internal fixation with a locking compression plate and cerclage wires. D, Anteroposterior radiograph showing clinical and radiographic fracture healing at 1 year postoperatively.

Postoperative radiographs were reviewed by 2 experienced blinded orthopedic surgeons for evidence of radiographic fracture healing, defined as the bridging of the fracture site with callus/bone/trabeculae or osseous bone according to the most commonly used criteria described by Corrales et al.^{19,20} Implant subsidence was measured from the superolateral corner of the femoral stem to the superior tip of the greater trochanter. An initial subsidence of the implant by a few millimeters was assessed as normal, but progression after 2 years or subsidence >5 mm was considered pathological for both uncemented and cemented components.^{21,22} A progression of the subsidence and persisting pain was defined as clinically relevant subsidence.

Functional outcome was assessed in a postoperative study visit using a standard questionnaire including questions regarding pain, walking distance, ability to climb stairs, pre- and postoperative need of walking aids, and pre- and postoperative accommodation. The Parker Mobility Score was also recorded pre- and postoperatively.²³ In a standardized clinical examination gait pattern, level of power, range of motion of hip and knee joints, scar conditions, pressure pain over the great trochanter as well as over the fracture site, and the timed up-and-go test were investigated and recorded. The timed up-and-go test measures the seconds spent when a patient rises from an armchair, walks 3 meters, turns around, walks back to the armchair, and sits down.²⁴ If patients were unable to come to the consultation for the final follow-up, they were visited in their residences.

Surgical technique

Locking compression plate. A lateral subvastus approach was performed on the fracture site and proximal femur. The fracture

was reduced anatomically and fixed using cerclage wires. A large fragment 4.5-mm broad LCP (DePuy Synthes; Johnson-Johnson, Zimmer GmbH Sulzer allee, Winterthur, Switzerland) was contoured, applied, and fixed using conventional and locking head screws. The plate was chosen as long as possible (16-22 holes). The distal part of the plate was inserted using the minimally invasive technique (MIPO). Internal plate fixation was completed using 3.5-mm Locking Attachment Plate (DePuy Synthes; Johnson-Johnson, Zimmer GmbH Sulzer allee, Winterthur, Switzerland) and/or additional cerclage wires. Small fragments of the greater trochanter were not grasped. Large fragments may have been framed with an additional plate or cerclage wire. This was decided intraoperatively by the surgeon. (Figure 2) The operated leg was partially loaded for 6 weeks. If this was not possible for coordinative reasons, the patient was mobilized into the wheelchair.

Revision arthroplasty. In majority of cases, a lateral approach was performed. Thereafter, the femoral head was dislocated, and the stem, with all remaining cement, was completely removed. The fracture was exposed, as far as possible anatomically reduced, and fixed using cerclage wires. The femur was then reamed to allow the insertion of an either cemented or uncemented longer stem. For RA, the following stems were used: Weber Shaft (AlloPro, Zimmer GmbH Sulzer allee, Winterthur, Switzerland), Alloclassic Zweymüller Stem (Zimmer Biomet, Zimmer GmbH Sulzer allee, Winterthur, Switzerland), Revitan Revision Hip System (Zimmer Biomet, Zimmer GmbH Sulzer allee, Winterthur, Switzerland), and Avenir Hip System (Zimmer Biomet, Zimmer GmbH Sulzer allee, Winterthur, Switzerland). Small fragments of the greater trochanter

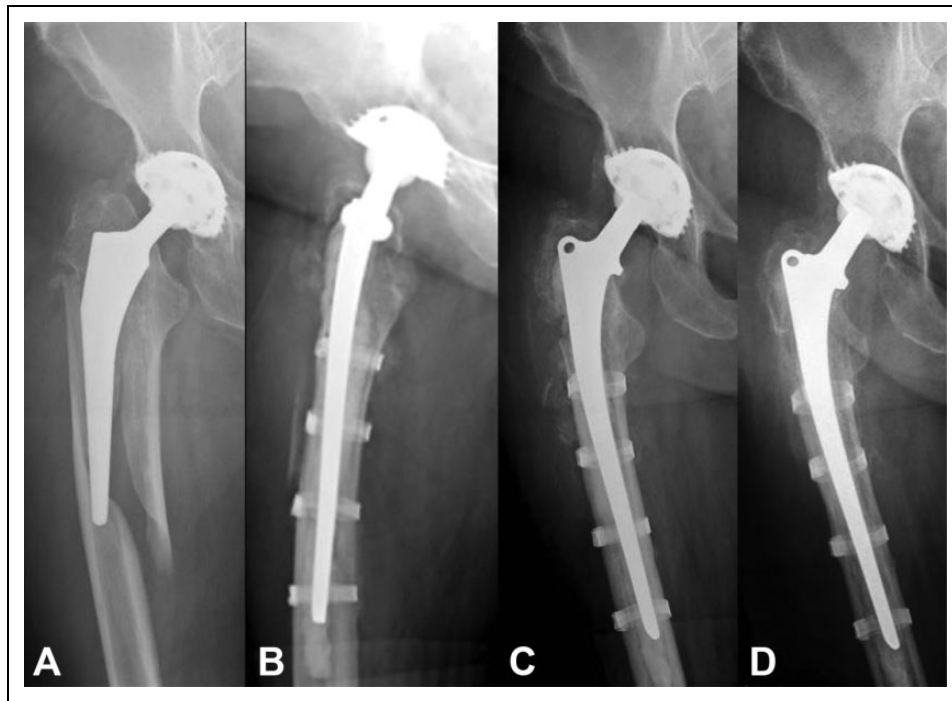


Figure 3. Case 2: A, Anteroposterior radiograph of a 71-year-old woman who sustained a Vancouver type B2 periprosthetic femoral fracture 4 years after primary total hip replacement. B/C, Postoperative anteroposterior and lateral radiographs of the right hip following revision with a revision stem and cerclage wires. D, Anteroposterior radiograph showing clinical and radiographic fracture healing at 1 year postoperatively.

were not grasped. Large fragments may have been framed with an additional plate or cerclage wire. This was decided intraoperatively by the surgeon (Figure 3). The operated leg was partially loaded for 6 weeks. If this was not possible for coordinative reasons, the patient was mobilized into the wheelchair.

There were 2 dedicated senior consultant arthroplasty surgeons performing RA and 3 dedicated trauma surgeons performing ORIF with LCP.

Statistics

All analyses were performed in the R programming language (version 3.3.3).²⁵ Continuous data were checked for normal distribution and equal variances. Demographic and baseline data were compared between the treatment groups with a Wilcoxon rank-sum test for continuous data and a χ^2 test (with continuity correction) or a Fisher exact test for categorical data. A log-rank test was performed to compare time-to-event data between LCP and RA. The results of the statistical tests were considered as statistically significant for $P < .05$. For P values between .05 and .10, a trend toward significance was identified.

Results

Between January 2007 and March 2017, a total of 2805 patients underwent THP or HHP at our department. Thereof, 113 (4.02%) patients had a periprosthetic femoral fracture VTB, including 75 (2.67%) patients with a VTB2 fracture.

Fifty-nine patients met inclusion criteria and were eligible for data analysis. Five patients were excluded because of the use of surgical techniques other than ORIF using LCP or RA. These were cerclage wires only in 3 patients and RA combined with ORIF and LCP in 2 patients. One patient was treated conservatively because of comorbidities. Ten patients were excluded because they were reclassified other than VTB2 fractures after review of the X-ray images and the intraoperative findings. The X-ray pictures of 6 patients were reclassified as stable and therefore as VTB1 fractures. Four patients were reclassified as VTB3 based on the bone quality found intraoperatively (Figure 4).

Demographic and Clinical Baseline Data

Twenty-four of the patients were treated with ORIF utilizing a 4.5-mm LCP. In 11 (45.8%) patients, 1 or more locking attachment plates were added. In 21 (87.5%) patients, 1 or more cerclage wires were added. Thirty-five patients underwent RA. In 14 (40.0%) patients, the RA was cemented, while in 21 (60.0%) patients the RA was uncemented. The median age at operation time was 84 years in both the groups. Nineteen (79.1%) patients were female in the LCP group versus 23 (65.7%) in the RA group. The fracture sides were almost equal in both groups with 14 (58.3%) fractures on the right leg in the LCP group and 16 (45.7%) in the RA group. The initial implant was in 22 (91.7%) patients in the LCP group and in 33 (94.3%) patients in the RA group with a THP. Median time from primary THP or HHP to periprosthetic fracture and subsequent

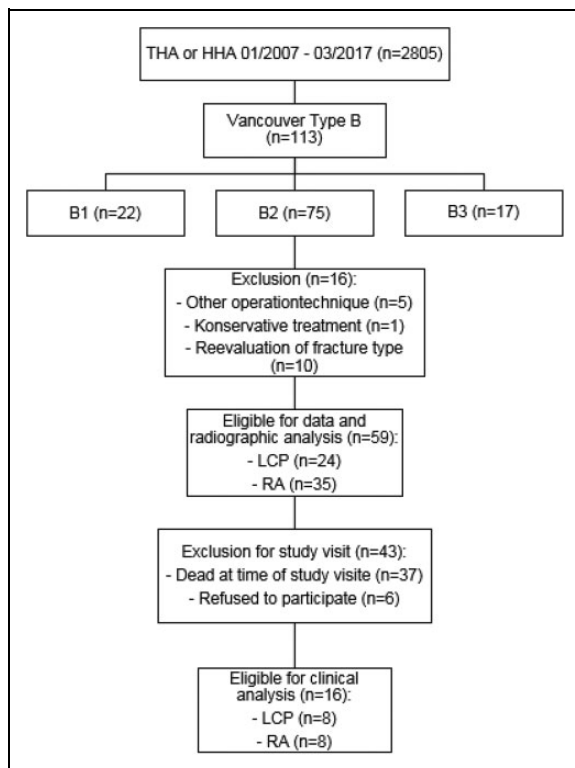


Figure 4. Clinical trial profile and patient flowchart.

Table 1. Patient Demographic Data.

Parameter	LCP	RA	P Value
n	24	35	
Median age, years (IQR)	84.00 (80.50-88.00)	84.00 (78.00-88.00)	.734
Median time from HA to RA/LCP (IQR)	137.50 (120.75-163.50)	160.00 (14.00-180.00)	.308
Gender			
Female	19 (79.2%)	23 (65.7%)	.408
Male	5 (20.8%)	12 (34.3%)	
Primary implant			
THA	22 (91.7%)	33 (94.3%)	1.000
HHA	2 (8.3%)	2 (5.7%)	
Fracture sight			
Right leg	14 (58.3%)	16 (45.7%)	.492
Left leg	10 (41.7%)	19 (54.3%)	

Abbreviations: HHA, hemiarthroplasty; IQR, interquartile range; LCP, locking compression plates; RA, revision arthroplasty; THA, total hip arthroplasty.

surgery was 124.5 months (interquartile range [IQR]: 46.00-201.25) in the LCP group and 85.00 months (IQR: 26.50-161.50) in the RA group ($P = .308$). None of the demographic or clinical baseline data differs significantly between the treatment groups (Table 1).

Surgical Time, Blood Transfusion, Hospital Stay, and Time to Surgery

The median surgical time was 137.50 minutes (IQR: 120.75-163.50) in the LCP group compared to 160.00 minutes (IQR: 140.00-180.00) in the RA group. Median surgical time seems higher for patients treated with RA, although only a trend toward significance can be seen ($P = .051$). Median time of hospital stay was similar in both groups with 16 days (IQR: 12-22) in the LCP group compared to 15 days (IQR: 12-22) in the RA group ($P = .621$). A total of 19 of 24 patients in the LCP group versus 24 of 35 patients in the RA group received blood units ($P = .548$). There was no relationship between number of units of blood and treatment group ($P = .667$).

The time from initial trauma until surgery varied in both groups but tended to be shorter in the ORIF group. The ORIF group showed a range of 0 to 4 days (median 1 day), whereas patients in the RA group waited 0 to 22 days (median 2 days) until surgery. In the ORIF group, 23 (95.8%) patients were operated within the first 72 hours compared to 23 (65.7%) patients in the RA group.

Complications

Implant-related complications include refracture, clinically relevant implant subsidence, clinically relevant displacement of the fracture, and hip dislocation. Patient-related complications include wound infection, pulmonary embolism, deep vein thrombosis, neurovascular injuries, and postoperative organized hematoma. Mortality and time to death after surgery were recorded separately.

Three (12.5%) patients in the LCP group and 10 (28.6%) patients in the RA group experienced an implant-related complication. All implant-related complications in the LCP group were refractures. Of these, one was a refracture at the same location and 2 were peri-implant fractures. The implant-related complications in the RA group were refractures in 2 patients (all peri-implant fractures), dislocation of the prosthesis in 5 patients, dislocation of the greater trochanter in 1 patient, and implant subsidence in 2 patients ($P = .131$). In the case of dislocation of the greater trochanter with resulting pain and functional impairment, the greater trochanter was initially grasped with cerclage wires. Implant-related complications occurred with equal frequency in uncemented and cemented RA. Patient-related complications occurred in 3 (12.5%) patients in the LCP group versus 6 (17.1%) patients in the RA group ($P = .628$). The reported complications in the LCP group were a wound infection in 1 patient and a postoperative hematoma in 2 patients. In the RA group, 4 patients had a wound infection, 1 patient had pulmonary embolism, and 1 patient had a postoperative hematoma. Four (16.7%) patients needed a secondary surgery in the LCP group and 6 (17.1%) patients in the RA group ($P = .746$) (Figure 5). The surgery included 2 revision ORIF with LCP and 2 wound revisions in the LCP group. While 3 RAs, because of complaints due to implant subsidence, recurrent hip joint dislocations and

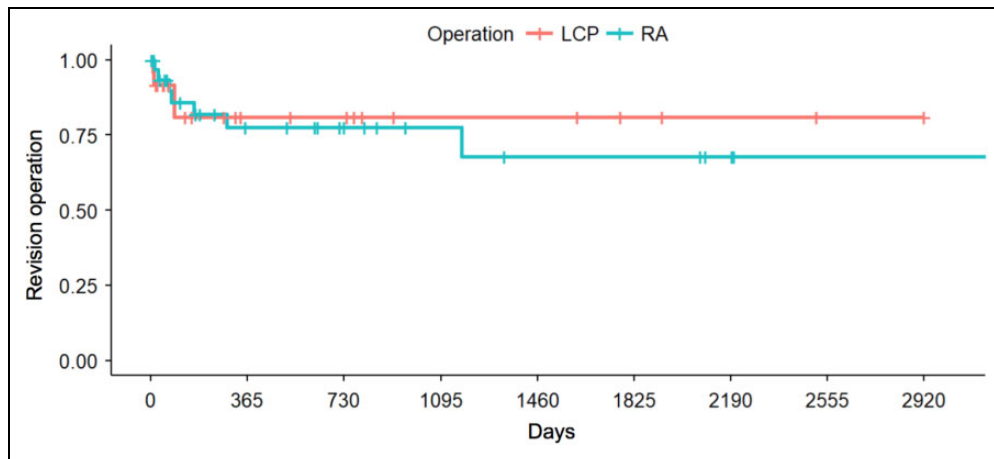


Figure 5. Kaplan-Meier plot of revision operation rate over 8 years (2920 days).

Table 2. Implant-Related Complications (Refracture, Clinically Relevant Implant Subsidence, Clinically Relevant Displacement of the Fracture and Hip Dislocation), Patient-Related Complications (Wound Infection, Pulmonary Embolism, Deep Vein Thrombosis, Neurovascular Injuries and Postoperative Organized Hematoma), and Need for Revision Surgery in Both Groups.

Parameter	LCP	RA, Cemented/ Uncemented	P Value
N	24	35	
Implant-related complications	3 (12.5%)	10 (28.6%), 5/5	.131
Refracture	2 (8.3%)	2 (5.7%), 2/0	
Clinically relevant implant subsidence	0 (0%)	2 (5.7%), 0/2	
Clinically relevant dislocation of Greater trochanter	0 (0%)	1 (2.9%), 1/0	
Hip dislocation	0 (0%)	5 (14.2%), 2/3	
Patient related complications	3 (12.5%)	6 (17.1%), 1/5	.628
Wound infection	1 (4.2%)	4 (11.4%), 1/3	
Neurovascular injuries	0 (0%)	0 (0%)	
Deep vein thrombosis/ pulmonary embolism	0 (0%)	1 (2.9%), 0/1	
Postoperative organized Hematoma	2 (8.3%)	1 (2.9%), 0/1	
Secondary surgery	4 (16.7%)	6 (17.1%), 3/3	.746

Abbreviations: LCP, locking compression plates; RA, revision arthroplasty.

repeated periprosthetic fracture, 1 ORIF with LCP as well as 2 wound debridements with inlay change were necessary in the RA group. Revision surgery was equally often necessary for uncemented and cemented RA (Table 2).

The median follow-up time was 1609 days (IQR: 619-3200) for all included patients. A total of 13 (54.2%) of 24 patients treated by ORIF with LCP and 23 (65.7%) of 35 patients treated by RA died during the follow-up period ($P = .781$). One patient died 4 days postoperatively in the RA group. The patient who died on the fourth postoperative day was a 97-year-old polymorbid patient. The suspected cause of death was a pulmonary embolism. The patient did

not undergo an autopsy. No death during hospital stay was observed in the LCP group. Two years postoperatively, the probability of survival was 62% in the LCP group and 54% in the RA group (Figure 6).

Radiographic Outcome

Two of 24 patients in the ORIF group and 5 of 35 patients in the RA group died within the first 6 months after surgery and could therefore not be conclusively assessed with regard to bone healing. Two patients in each group did not appear for radiographic follow-up due to their advanced age or cognitive impairment. In summary, the X-ray images of 20 patients in the LCP group and 28 patients in the RA group had an adequate follow-up time (>6 months) and were available for analysis. Two (10.0%) of the 20 patients in the LCP group showed nonunions during the course of the study. In comparison, 5 (17.9%) of the 28 patients in the RA group showed no sufficient bone healing.

Clinical Outcome

At the time of clinical follow-up, 37 of the 59 patients were dead, and 6 patients refused to participate in this study, so 16 patients were eligible for our study visit and clinical analysis. Of these, 8 patients were treated by ORIF with LCP and 8 patients with RA. Five patients in the LCP group and 4 patients in the RA group reported persistent pain in the hip. One patient in each group was found to have a subsidence of the prosthesis, which led to impingement as the cause of the pain. No irritations of scars were detected. In the RA group, 2 patients limped compared to 3 patients in the ORIF group. One patient who underwent ORIF with LCP was not able to walk at all. Level of power of the affected leg was M5/5 in all patients with RA. Half of the patients in the LCP group had a level of M4/5.

Scores

Mean preoperative Parker mobility score was 9 points in both groups and decreased in both cohorts to 5 points in the LCP

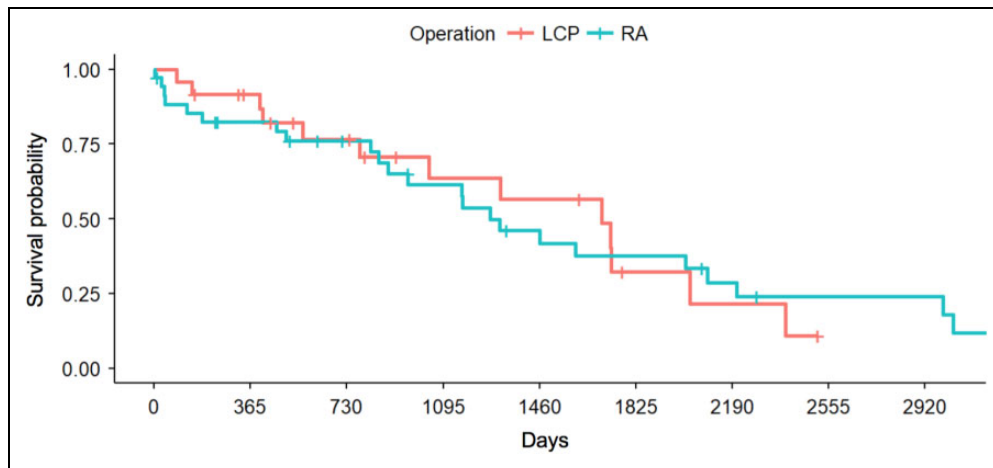


Figure 6. Kaplan-Meier plot of overall survival rate over 8 years (2920 days).

group and 7 points in the RA group. Four patients in the RA group returned to their preinjury level of mobility. In the ORIF group, 2 patients had the same Parker mobility score pre- and postoperatively. Those patients who were not able to return to their preinjury mobility level needed either walking aids or a wheel chair.

Median time needed for the Timed Up and Go Test was 17 seconds (9-38) in the LCP group compared to 12 seconds (10-21) in the RA group. One patient in the LCP group could not perform the test due to immobilization.

Discussion

Revision surgery after VTB2 fractures remains technically challenging even for experienced surgeons. Besides aseptic loosening and sepsis, periprosthetic femoral fractures are among the 3 most frequent complications after hip arthroplasty and also the second most common reason for RA.²⁶ The increasing incidence of this pathology can partially be attributed to older patients with poorer bone quality as well as to younger patients with higher activity demands. Thus, a very heterogeneous patient collective with different functional demands is affected. A surgical procedure adapted to the patient's individual demands is therefore indispensable.

Although the Vancouver classification system has been established and proven for decades, important clinical factors such as patient physiology, fracture pattern, age, and comorbidities are not considered in this algorithm. Previous studies have already criticized the choice of surgical procedure based on this classification alone.^{27,28} Niikura et al suggested that decisions regarding the treatment of periprosthetic femoral fractures should take into account not only the approach of the Vancouver algorithm but also an assessment of each patient's physical status and activity level.²⁹ Pavone et al suggest plate osteosynthesis in all patients with an American Society Physical Status Classification System score of 3 or greater, regardless of the fracture type.³⁰ Several attempts have been made to

develop a new treatment algorithm; however, none of them has been successfully implemented in clinical practice so far.^{26,28}

The Vancouver classification relies on 3 radiographic criteria to characterize periprosthetic femoral fractures and help guide management decisions. These are fracture location, prosthesis stability, and quality of the surrounding bone stock.⁷ Even experienced radiologists cannot always clearly distinguish between a loose and a well-fixed prosthesis to identify the VTB1 and VTB2 subgroups.⁹ It is therefore possible that a radiologically diagnosed loose stem turns out to be well fixed during surgery, which means that RA is not mandatory.³⁰ This situation should not be neglected, as RA itself is a technically challenging procedure that can lead to iatrogenic bone fragmentation, even in the hands of experienced surgeons. Vice versa, it is not uncommon for VTB2 fractures to be mistaken for VTB1 fractures, which turns out during surgery. In unclear cases, the treatment of VTB1 and VTB2 fractures with the same surgical procedure seems to be advantageous.

Furthermore, the Vancouver classification system does not distinguish between different fracture patterns. This fact seems important because fractures with more than 1 fragment, especially in the trochanteric region, can only be anatomically reduced by plate osteosynthesis. In comparison, in RA, the fracture parts can often only be approximated. In case of RA of fractures that run out far distally, the stem can only be anchored in solid bone over a short distance. The stability is therefore largely based on the previously inserted cerclage wires. Thus, the supposed advantage of postoperative full weight bearing after RA is not given with these fracture patterns. In contrast, in cases where there is a simple, proximal fracture with a radiologically unambiguously loosened stem, this might be an advantage of RA, especially in older patients. Patients treated with ORIF using LCP have to walk on crutches for 6 weeks with partial weight bearing. However, with improved implants and fixation devices, a more stable construct can be achieved allowing full weight bearing in some cases.

There are only few studies in the recent literature with heterogeneous results and conclusions to the use of ORIF with LCP for VTB2 fractures. Fousek and Vasek compared ORIF with LCP for VTB1 and VTB2 fractures in 19 patients. They found that VTB2 fractures show poorer outcome after ORIF with LCP than VTB1 fractures, which is hardly surprising. They conclude plate osteosynthesis can only be carried out in VTB2 fractures as a palliative procedure in immobile and severely ill old patients.³¹ Spina et al performed ORIF with LCP in 7 cases of VTB2 fractures of which 4 cases recovered walking ability without pain and good radiographic results and 3 cases showed poor clinical and radiographic outcome. They conclude from their findings that in VTB2 fractures, the stem can reach a new stable position after ORIF with LCP, sometimes with a secondary slight subsidence.³²

A subsidence of the prosthesis can occasionally be observed in both surgical procedures and only leads to persistent complaints in severe cases in our opinion. Park et al measured the stem subsidence after ORIF with LCP in VTB2 fractures and found in their cohort of 27 patients an average distance of stem sinking of 2.5 mm. However, there was no case with loss of reduction or loss of fixation requiring revision surgery.³³ We presume that with fixation devices such as locking attachment plates and cerclage wires, the osteosynthesis gets further rigidity, and the stem regains stability. Severe subsidence of the prosthesis that leads to persistent pain and revision operations can thereby be avoided in the majority of cases.

In the study by Solomon et al, the results of 12 VTB2 fractures treated by ORIF with LCP were compared to those treated by RA similar to our study. In the ORIF cohort, all fractures healed, and all stems were found to be stable. Further, a significantly shorter surgical time was observed in the ORIF group. There were more complications reported in the RA cohort compared to patients who were treated with ORIF.¹⁸ This confirms our findings that ORIF with LCP seems to be a less invasive and a technically less demanding procedure and might therefore be advantageous in already compromised patients with a high risk of perioperative mortality and a pre-existing low level of activity. A shorter operation time in comparison to RA and an uneventful bone healing after ORIF with LCP for VTB2 fractures could also be shown by Joestl et al.¹⁷

In addition, the risk of recurrent dislocation of the hip was higher after RA in our cohort, which we attribute to a weakening of the capsule and muscles around the hip by repeated surgery through the same or a different approach. In contrast, the subvastus approach to the lateral femur used for ORIF with LCP leaves the capsule and trochanteric muscles as far as possible untouched.

Thus, if a revision of the prosthesis should become necessary in the patient's further course, it can be performed minimally invasive via direct anterior approach (AMIS), and a shorter stem can be applied. In younger patients, it is very likely that one or more changes in the prosthesis are necessary in their lifetime, which makes a bone-sparing operation as achieved by ORIF with LCP generally desirable.

Comparing our study with previous reports, a generally poor functional outcome in patients with VTB2 fractures can be found. Patients with periprosthetic femoral fractures are generally frail and elderly with a high level of comorbidities, and thus high 1-year mortality rates are quoted at 13% to 17%.^{34,35} Long-term outcome seems to play a subordinate role, as most of the patients die during the first decade after operation. A thorough economic analysis is beyond the scope of this study, but it should be mentioned that the LCP is the more cost-effective implant.

The limitations of this study include the retrospective study design, the variability in different implants used for RA, the different surgeons performing the procedures, and the relatively small sample size with low power to detect statistically significant differences. In addition, our data show that the time from initial fracture to surgical restoration of patients differs in the 2 groups, which can lead to a potential bias of outcome comparability. Also, a large number of RAs were cemented which is shown to have inferior outcome in some studies. Further prospective studies should be implemented.

Conclusion

Our data are in line with previous similar studies and support the hypothesis that ORIF using LCP is an alternative treatment option to RA in the management of patients with VTB2 fractures. Nevertheless, it should be noted that functional outcome is poor for both operation techniques and mortality rate is high.

Authors' Note

C. Baum and M. Leimbacher contributed equally.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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