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# Management of Vancouver type B1 periprosthetic femoral shaft fracture by reversed contralateral distal femur locking plate

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**Abstract**
**Background:** Vancouver B1 periprosthetic femoral fractures are described as fractures occurring around the stem tip in which the prosthesis is stable. Treatment options include Mennen plates (CMW Laboratories, Ex-eter, England), the Dall-Miles plate and cable system (Stryker Howmedica, Ruth-erford, New Jersey), dynamic compression plates, conventional plates, cerclage cables, locking compression plates, and strut allografts with or without plating. The aim of this study was to describe the efficacy of contralateral distal femur locking plate used in reverse for the management of type B1 periprosthetic femur fracture when used in conjunction with intra-operative demonstration of prosthesis stability and correct classification of these fractures.
**Methods:** Total 9 patients with Vancouver Type B1 periprosthetic fractures were enrolled in the study. Average age of all patients was 57.6 years with 8 male and 1 female. All patients were managed by open reduction and internal fixation by reversed contralateral distal femur locking plate and cables/circlage wiring and followed up for a minimum of 12 months. Patients were evaluated both clinically and radiologically.
**Results:** All fractures were united at an average of 14.5 weeks. Harris hip score at final follow-up was 86. One patient had superficial wound infection. The infection was successfully treated by irrigation and debridement of wound and intravenous antibiotics.
**Conclusion:** We observed good functional outcome in patient treated with reversed contralateral distal femur locking plate. We conclude that reversed contralateral distal femur locking plate is a reliable, effective and relatively cheaper option for management of Vancouver B1 periprosthetic femoral shaft fracture.

**Keywords:** Vancouver B1 fracture, locking plate, total hip arthroplatsy

## Introduction
Periprosthetic femoral fractures on the hip implant are relatively rare [1-2]. The incidence of periprosthetic fracture is roughly about 1% after primary Total Hip Arthroplasty (THA) and about 4% after revision THA [3-4]. However, increase in aging population and number of THA is contributing to an increase in incidence of these fractures. The management of these fractures is challenging as it requires understanding of principles of arthroplasty as well as Osteosynthesis. These fractures are classified by using the Vancouver classification System for periprosthetic fracture of Duncan and Masri [5]. The site of fracture, stability of implant and quality of bone stock are the three most important parameters to guide the surgeon for management of these fractures [6]. For type B1 periprosthetic fracture, where the femoral component is well fixed, open reduction and internal fixation is the treatment of choice. Treatment options available for these fractures include use of cable system, dynamic compression plates, locking compression plate, and strut allograft with or without plating. However, no single treatment has been proved to be superior to others.
Distal femur locking plate is used to fix the fractures involving the distal femur. It has a combination of locking and non-locking holes. Type B1 Periprosthetic Femur fractures have been treated by applying contralateral distal femur plate in reverse i.e. right side distal femur plate is used for Left side periprosthetic fracture and distal end of the plate (racket shaped) is placed proximally. The advantage of using this locking plate is that the racket shaped part of the plate accurately matches the contour of greater trochanter and it has multiple holes for

trochanteric fixation as compared to proximal femoral plate which has limited options for proximal fixation that is few proximal screws [7]. Locking screws used in locking plates allow unicortical fixation along the length of femoral stem without violating the implant-cement, implant-bone and cement- bone interface [8]. Distal to the tip of stem locking screws allow Bicortical fixation [8].

Confirming prosthesis stability on radiograph alone is difficult and as many as 20% of loose femoral stems go unnoticed. Intra-operative checking of the prosthesis stability has been recommended by several authors [3, 9]. Fixing these fractures without intra-operatively ascertaining the prosthesis stability has the potential to fix type B2 fracture with consequent failure requiring revision surgery.

The aim of this study was to describe the results of using contralateral distal femur locking plate used in reverse for the management of type B1 peri-prosthetic fracture when combined with per-operative demonstration of prosthesis stability

**Material & methods:** This prospective cohort study was conducted at the Department of Orthopedic Surgery, King George's Medical University (KGMU), Lucknow. Patients were recruited for a period of one year starting from January 2016 to 2017. Total 10 patients with Vancouver Type B1 periprosthetic fractures were enrolled in the study. One patient was found to be B2 intra-operatively and was excluded from the study. Pre-operative radiological classification of the fracture was done by operating surgeon. Written informed consent was taken from all the cases before enrollment.

**Table 1:** Showing patient characteristics and fracture characteristics

| **General characteristics of patients** | |
|---|---|
| Number of patients (N) | 9 |
| Mean Age | 57.6 years |
| Sex (Male/Female) | 8/1 |
| **Fracture characteristics** | |
| Affected side (Left/Right) | 3/6 |
| Fracture line (Oblique/Transverse) | 8/1 |
| Fracture classification (B1) | 9 |
| Union time (average) in weeks | 14.5 (13-16) |

We used contralateral Titanium distal femoral Locking Compression Plate (LCP) in reverse i.e. right side distal femoral locking plate was used for the left side Periprosthetic fracture. Surgery was performed in lateral decubitus position on a standard table. An incision was given on the previous scar mark with patient lying in lateral decubitus position. The stability of femoral component was tested by applying traction on the prosthesis, rotational force on the prosthesis and inspection of cement bone interface [9]. This helped us to differentiate type B1 fractures from type B2. Once the fractures were correctly classified intra-operatively contralateral reverse distal femur locking plate was used for type B1 fractures. The plate selected most frequently had 13-15 holes with the aim to extend the plate from tip greater trochanter up to lateral condyle femur to prevent stress riser. Reverse contralateral plate allowed the racket shaped portion of the distal femur plate to support the greater trochanter.

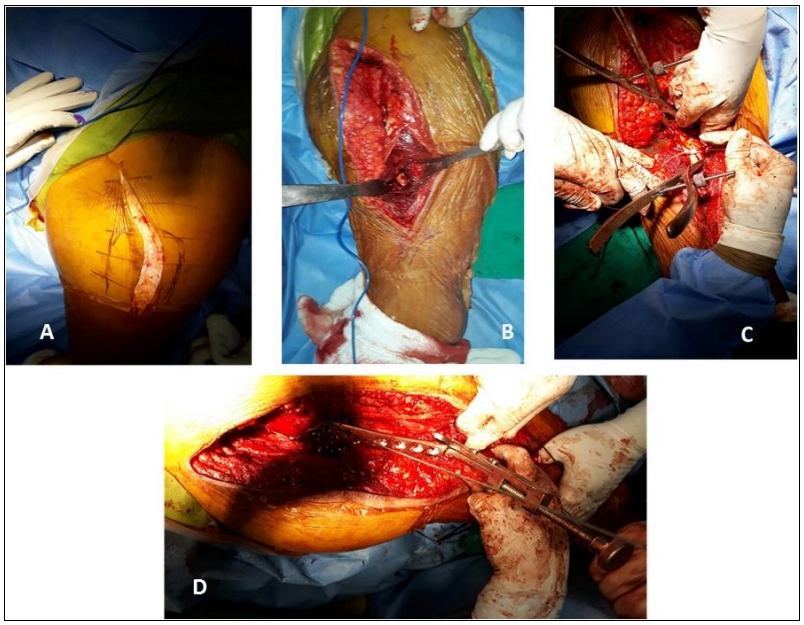


**Fig 1:** Surgical techniques
**Fig 1 A:** Posterolateral approach (Gibson's)
**Fig 1 B:** Exposed fracture site
**Fig 1 C:** Provisional fixation of fracture by cables.
**Fig 1 D:** Reverse distal femur locking plate placed on the lateral aspect of femur provisionally fixed with K wires.

Position of the plate was checked under image intensifier in both AP and lateral views. Bicortical locking screws were placed into the trochanter and into the femoral shaft distal to the tip of prosthesis. Unicortical locking screws were placed along the length of stem. To improve rotational stability of the proximal fragment cables were applied in the proximal fragment [22]. Average surgical time was 120 minutes (range, 90-160 minutes).

Postoperatively, patients were allowed non weight bearing walking with walker on postop day 2. Full weight bearing was allowed once there was evidence of clinical and radiological union. Patients were followed up at 6 weeks, 12 weeks and 24 weeks. The functional outcomes were assessed using Harris hip score at 6, 12 and 24 weeks.

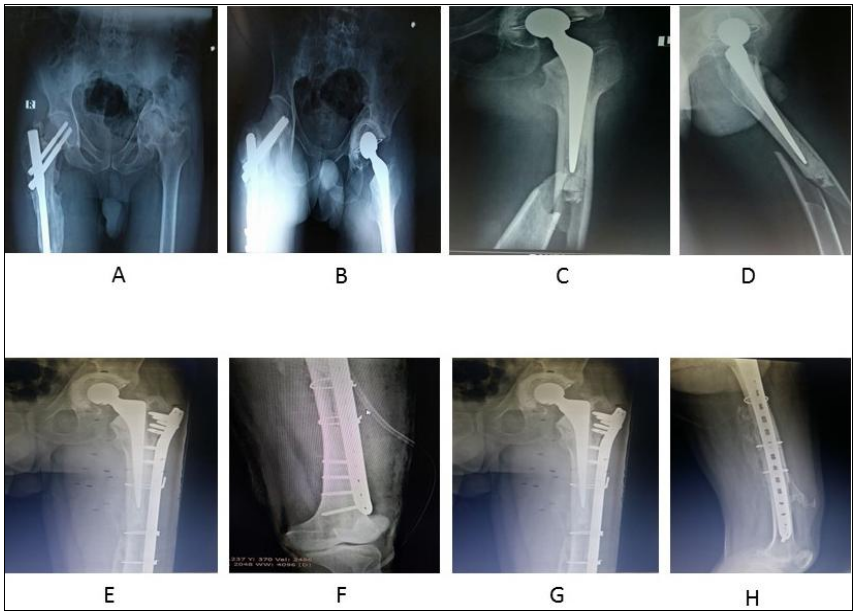


**Fig 2:** Radiological images
**Fig 2 A:** Post traumatic arthritis hip (Left) & united fracture sub trochanteric femur (Right) with implant in situ (PFN),
**Fig 2 B:** Immediate post-op showing cemented total hip arthroplasty (THA).
**Fig 2 C:** Peri prosthetic fracture type B1 (AP view)
**Fig 2 D:** Peri prosthetic fracture type B1 (Lateral view)
**Fig 2 E & F:** Immediate post-op (AP & Lat. radiograph) after fixation by reverse distal femur locking plate showing both Bicortical and Unicortical locking screws surrounding the prosthesis and spanning the femur from greater trochanter to supracondylar area.
**Fig 2 G & H:** AP & Lateral view showing evidence of union (After 6 months)

**Results**

All patients of type B1 periprosthetic fracture were underwent operative management. Demographic and fracture characteristics of the patients are described in table 1. Reverse Distal femoral locking plate was used in 9 patients found to be B1 intra-operatively. All fractures were united at an average of 14.5 weeks. Harris hip average score of all patients was 86 at final follow-up (6 months). Postoperatively one patient in the Osteosynthesis group developed superficial wound infection. The infection was successfully treated by irrigation and debridement of wound and intravenous antibiotics.

**Complications:** None observed

**Discussion:** Osteosynthesis is considered to be the treatment of choice for Vancouver type B1 periprosthetic fracture with retention of the implant. The techniques used to fix type B1 periprosthetic fracture include plate-cable system, locking plate, dynamic compression plate, and allograft with or without locking compression plate. However no single treatment has been proved to be superior [3]. Good results have been reported by treating type B1 periprosthetic fractures with transverse or short oblique fracture lines with Dynamic Compression Plates [10-11]. Buttaro *et al*. has recommended the use of allograft in combination with LCP for fractures at the tip of long stem as they found LCP alone to be insufficient for management of these fractures [12].

Although anatomical locking compression plates for proximal femoral fracture fixation have been developed, proximal trochanteric fixation is difficult, especially when the fracture line extends proximally as these plates lack in the number of screw options. In contrast to these plates, the racket shaped portion of reverse distal femur locking plate allows the surgeon to put multiple unicortical and bicortical screws in proximal fragment despite the metaphyseal presence of implant [7]. Contralateral LCP anatomic Distal Femoral Less Invasive Stabilization system (LISS) locking compression plates used in reverse have been used to fix these fractures [8]. Good results have been reported by using contralateral distal femoral LCP used in reverse by Ebraheim *et al*, who reported hundred percent union rates at 14 weeks in 13 patients using open technique [13].

Confirming prosthesis stability on preoperative radiographs alone is difficult, and as many as 20% of loose femoral stems go unnoticed [9]. In a study of 321 fractures, the surgeon's classification of type B1 fractures (based upon the preoperative radiograph and operation notes) was in agreement with radiologist's classification in only 34% of cases [15]. Validity assessment of type B fractures has been reported to be 81%, with a K value of 0.68, indicating substantial agreement [14] but still leaving a 19% chance of wrongly classifying the fracture preoperatively and consequentially fixing type B2 fractures. Several studies comparing radiographic and intraoperative assessment of stability have reported the radiographic sensitivity to be limited [14-15]. It has been postulated that underestimation of stem loosening might be the reason for high failure rates seen with open reduction and internal fixation of these fractures, as revision arthroplasty would have been a more appropriate option [16].

However, in none of the studies using the LISS technique, femoral implant stability was assessed per-operatively which is critical to discerning B1 fractures from B2 fractures. A study on 14 patients using the LISS technique reported loss of fixation and early loosening in 2 cases that were subsequently classified as B2 [8]. In our series of 10 patients, we checked the implant stability and correctly classified the fracture as B1 or B2 intraoperatively. This enabled us to detect one case classified B1 radiologically in preoperative assessment to be actually B2 intraoperatively and managed the patient with long femoral stem rather than osteosynthesis. We did not encounter loosening or implant failure in our series.

Limitations of using contralateral LCP anatomic distal femoral Less Invasive Stabilization system (LISS) locking compression plates used in reverse include difficult positioning of the plate on proximal femur and sagittal curve of the plate as it is designed for the slightly more incurved distal femur [7]. Using the open technique helped us to offset these problems. The bone around the tip of femoral stem is under considerable stress therefore it is important to eliminate the stress riser effect of femoral stem. This can be obtained by sufficient distribution of stress by spanning of femur from greater trochanter to supracondylar region [17]. In our series of patients we have spanned the whole length of femur extending from greater trochanter to supracondylar area.

Another concern is screw pullout that occurs due to dynamic loading, especially in patients with osteoporotic bones. In comparison with unicortical screws, bicortical screws provide better rotational stability and are less likely to pull out. It is postulated that they may jeopardize the stability of the stem or the integrity of the cement mantle when aimed proximally [18]. However, most reports suggest that that despite violation of cement mantle with proximal screws, it does not result in premature loosening of the femoral stem [19-21]. The proximal femoral fixation can be supplemented with cables to prevent rotation of the fragment [9]. We used cables in the proximal fragment as biomechanically unicortical screws with cables in the proximal portion are reported to provide additional stability in compression, lateral bending and torsion as compared to proximal cables alone [22].

Using these plates, LISS technique has the advantage of smaller incision and preservation of fracture haematoma [8]. Open technique combined with per-operative classification of fracture as B1 or B2 has the advantage of correctly classifying fractures and choosing the right treatment but it has the disadvantages of a bigger incision and loss of fracture hematoma.

## Conclusion

We observed good functional outcome in patient treated with Reversed contralateral distal femur locking plate. Reversed contralateral distal femur locking plate is a reliable, effective and relatively cheaper option for management of Vancouver type B1 periprosthetic femoral fractures. Confirming prosthesis stability on preoperative radiographs alone is difficult, and has the potential to wrongly classify B2 fractures as B1 which may result in subsequent implant failure and necessitating revision surgery. Further, surgical exploration of the joint and assessment of stability of the femoral component should be recommended for all type B1 fractures. The major limitation of our study was small sample size. In future, a study with larger sample size will validate these findings.

**Clinical Relevance:** It's a cheaper and efficacious modality of treatment for periprosthetic fracture.

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