RETROSPECTIVE STUDY OF CAUSES OF FAILURE OF LCP DISTAL FEMUR IN SUPRACONYLAR FEMUR FRACTURES AND TO PROPOSE PROTOCOL TO AVOID SUCH FAILURES

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Abstract

Aims and objective:

To identify the causes for failure of LCP in supracondylar distal femur fractures.
To propose protocol to avoid such implant failures

Methodology: This is a retrospective study of 20 patients with failed distal femur fractures at Raichur institute of medical sciences, Raichur and Suraksha Hospital, Raichur and also the cases which were operated in other hospitals from January 2012 to July 2023. All the patients selected for the study were examined according to protocol, clinical examination and radiological investigations were done.

Results:

In our study total 20 cases of failed distal femoral fractures treated with DFLCP were retrospectively analysed out of which 12 cases were operated outside and 8 cases were operated in RIMS hospital and Suraksha hospital Raichur. Out of these 20 cases in 9 cases revision surgery were performed, so out of 9 revision cases in 7 cases fracture has united, 1 case we lost the follow up and in 2 cases there were non union.

In 15 cases there was breach of AO priciples, among them 4 cases there is combination of absolute and relative stability, in 8 cases osteosynthesis in unreduced fractures, in 1 case there is multifactorial breech of AO principle, in 2 cases biology management was a problem.

In all cases there were implant related issues, in 12 cases small plate was used, in 4 cases there was implant selection issues, in 1 case dual platting was required, in 6 cases screws were in the fracture site, in 2 cases there was decreased screw hole density and in 1 case there was decreased working length.

In one patient, the patient insisted for implant removal and patient developed refracture after implant removal and refixation after refracture also failed.

Conclusion: Although DFLCP fixation is an established method of treatment of distal femoral fractures, yet the procedure is not free from complications. Considering the causes of failures in our study, in most of our cases causes of failure of the procedure are due to breach in AO principles and due to implant related issues. The important technical aspects are attaining good reduction with acceptable valgus angle, making correct rotation, achieving the stability, soft tissue handling, selecting the implant with proper implant size, placing plate properly with precise placement of number, location of screws with aseptic protocols. In sight of the findings of our study along with existing literature we propose for creating a fixation construct that is conducive for fracture healing by following AO principles of locking compression plates. Double fixation either with 2 plates (Medial and lateral) or retrograde IMIL nail with lateral plate with or without bone grafting is important to achieve satisfactory outcomes in cases where there is long metaphysial communition.

Keywords: Failed DFLCP in distal femur fractures

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BACKGROUND

The treatment of comminuted, intra-articular distal femoral fractures is challenging. Many of these injuries are the result of high-energy trauma, which generates severe soft-tissue damage and articular and metaphyseal comminution. Bone loss resulting from open fracture and poor bone quality may decrease the stability of fixation. Traditional devices for internal fixation have included the 95° condylar blade-plate, the dynamic condylar screw with a 95° side-plate, and intramedullary nails. However, coronal fractures or extensive distal comminution may preclude the use of these devices. In such cases, a lateral buttress or neutralization plate may be used. The condylar buttress plate was the first implant designed to serve this function. Unfortunately, when this device is applied in the presence of medial comminution or bone loss, failure of fixation and varus collapse may eventually result.

Recent advances in technology for the treatment of distal femoral fractures include the Less Invasive Stabilization System (LISS) and the Locking Compression Plate (LCP) condylar plate. Each of these implants offers multiple points of fixed-angle contact between the plate and screws in the distal part of the femur, theoretically reducing the tendency for varus collapse that is seen with traditional lateral plates. The purposes of this study is to describe causes of failure of the LCP condylar plate and to propose protocols to avoid such failures.

Distal femoral fractures represent less than 1% of all fractures and 4-6% of all femoral fractures.[1,2] These fractures have a tendency of being unstable [AO type 33A2, 33A3, 33C2 and 33C3] with intra-articular comminution.[3-5]

Regardless of the immense advancements in implant designs and surgical techniques for treating these fractures, the difficulties in fracture healing and high rate of complications with subsequent poor outcomes are still encountered.[5, 6] Currently there is no consensus regarding optimal treatment for these fractures.[7, 8] DFLCP is helpful in the management of unstable fractures by virtue of offering multiple points of fixation and ability to resist varus collapse.[9] As high as 32% of these patients may require revision surgery to achieve satisfactory outcomes.[10,11] The causes and risk factors for these revision surgeries remain ambiguous. Few studies mention comminution, fracture type, osteoporosis, poor quality of reduction and unstable fixation due to poor application of the principles of locked plating system as the risk factors for poor outcome.[1, 6, 12-15]

Moreover, options for revision surgeries following failure of index operation are limited (ORIF revision with single/dual plates, retrograde intramedullary nail with or without bone grafting) with variable healing rates.[16-19]

AIMS AND OBJECTIVE

To identify the causes for failure of LCP in supracondylar distal femur fractures. To propose protocol to avoid such implant failures

MATERIALS AND METHODS

This is a retrospective study of 20 patients with failed LCP distal femur in supracondylar femur fracture at Raichur institute of medical sciences , Raichur and Suraksha Hospital, Raichur also the cases which were operated in other hospitals from January 2012 to July 2023 and were followed up with using there previous data. Informed written consent was taken from all patients. Ethical committee clearance was obtained.

Inclusion criteria:

1. All failed distal femur fractures primarily treated with LCP
2. Patients with age 18-75yrs

Exclusion criteria:

1. Failed distal femur open fractures
2. Patients with age less than 18yrs and more than 75yrs
3. Periprosthetic distal femur fractures
4. Pathological fractures

Methodology:

This is a retrospective study of causes of failure of LCP distal femur in supracondylar femur fractures and to propose protocol to avoid such failures. The study was conducted at Raichur institute of medical sciences, Raichur and Suraksha Hospital, Raichur also the cases which were operated in other hospitals from January 2012 to July 2023. Fractures were classified using AO classification system. The study was approved by the institutional ethical committee. Informed consent was obtained from all the patients.

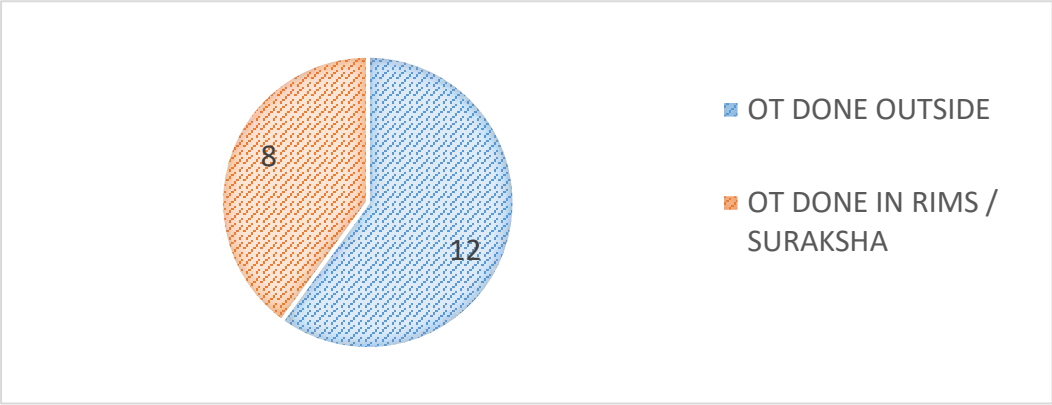
The anteroposterior (AP) and lateral radiographs of the distal femur with knee were performed. Computerized tomography scan was done in selected cases where fracture geometry was not clear on plain radiographs. All X-rays were assessed to define whether inclusion criteria were met, followed by a detailed case sheet evaluation to check for exclusion criteria. Baseline characteristics and outcome measures were collected using operation notes, day-to-day progress reports from case sheets, discharge card and follow-up evaluation, pre and postoperative radiographs, blood investigations including microbiological evaluation. Immediate post-operative AP & lateral radiographs were assessed for quality of reduction, posteromedial comminution or gap, plate length, working length (measured by the number of empty holes between the two screws closest to the fracture) and number of screws in proximal and distal fragment. Regular clinic-radiological assessment was done to check for any loss of alignment and to progress of union. Radiographically union was defined as bridging callus on at least three of four cortices on AP and lateral radiographs.

The primary outcome measure was defined as revision surgery due to implant failure with subsequent non-union. The various risk factors studied were AO fracture type, velocity of injury, closed vs open fracture, quality of fracture reduction, posteromedial comminution or gap, working length of plate and duration of surgery. The intra-operative characteristics studied were technical difficulties encountered in fixation with DFLCP. For better understanding of the principles of DFLCP fixation, the technical difficulties were classified into problems associated with:1) Breaches of AO principles 2) Implant related issues 3) Surgical team problems 4) Post operative management issues 5) Patient compliance issues 6) Failure recognition and timing (AO) [39]

1) Breaches of AO principles includes a) general considerations on violation of AO principles, b) osteosynthesis in unreduced fractures, c) principles of stability, selection of implants, and the combination of absolute and relative stability, d) biology management.
2) Implant related issues includes a) implant selection issues, b) type of implant related to biomechanical principles, c)implant size, d) failures due to guided targeting and implant assembly.
3) Surgical team problems includes a) determing factors for failures relating to surgical team, b) Insufficient preparatory planning c) lack of anatomical knowledge, d) insufficient asepsis protocols, e) proficiency and experience, f) accumulation of failures
4) Post operative management issues includes a) general considerations in postoperative management
b) physiotherapy c) implant removal
5) Patient compliance issues includes failures unrelated to healthcare team but related to patient compliance
6) Failure recognition and timing includes early recognition of failures

In our study total 20 cases of failed distal femoral fractures treated with DFLCP were retrospectively analysed out of which 12 cases were operated outside and 8 cases were operated in RIMS hospital and Suraksha hospital Raichur.

Chart showing distribution of selected cases



Out of these 20 cases in 9 cases revision surgery were performed, so out of 9 revision cases in 7 cases fracture has united, 1 case we lost the follow up and in 2 cases there were non union.

In 15 cases there was breach of AO priciples, among them 4 cases there is combination of absolute and relative stability, in 8 cases osteosynthesis in unreduced fractures, in 1 case there is multifactorial breech of AO principle, in 2 cases biology management was a problem.

Chart showing the causes of DFLCP failures in distal femur fractures

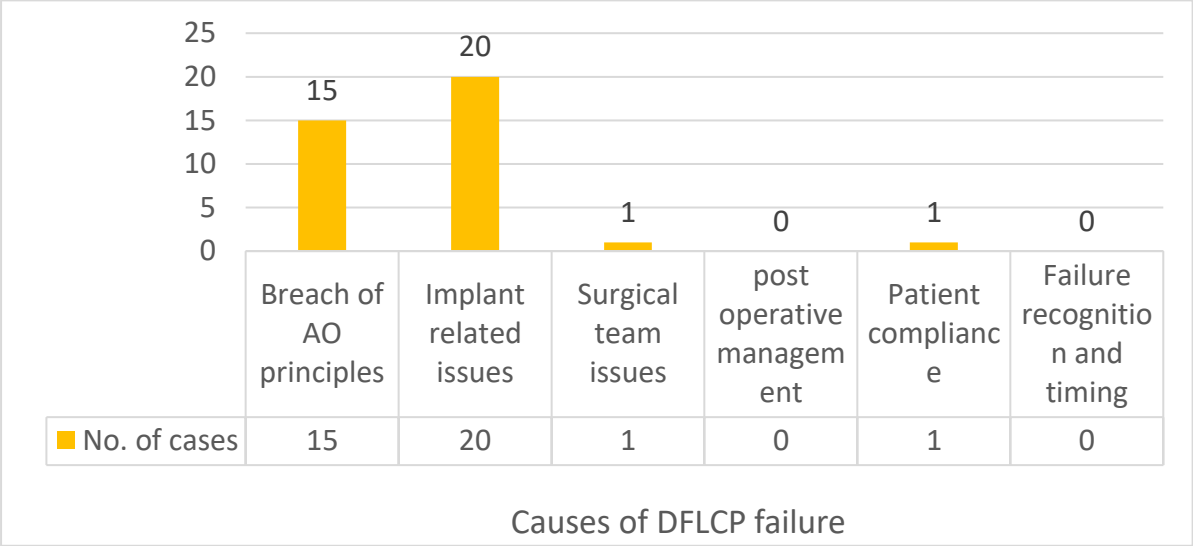
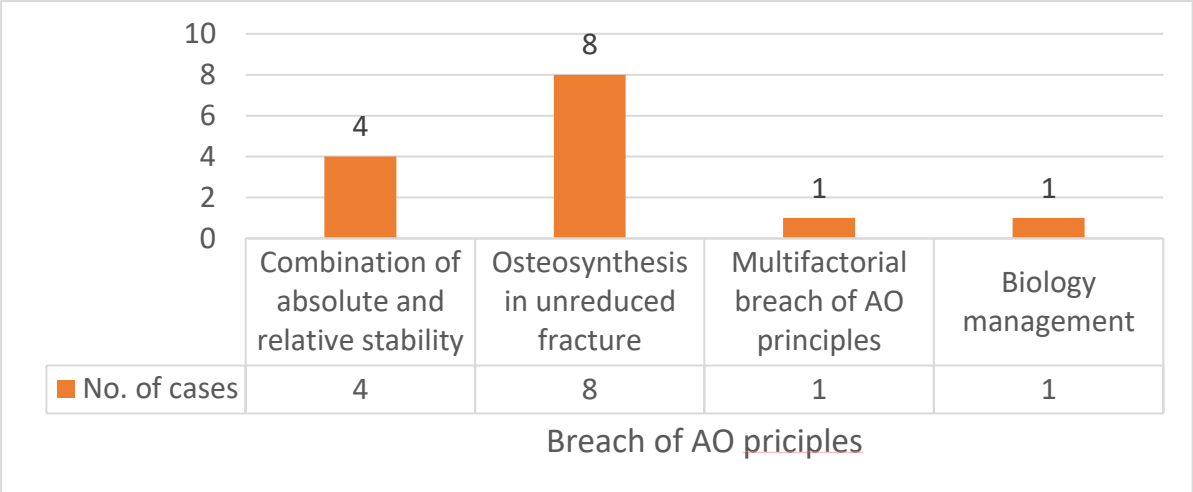
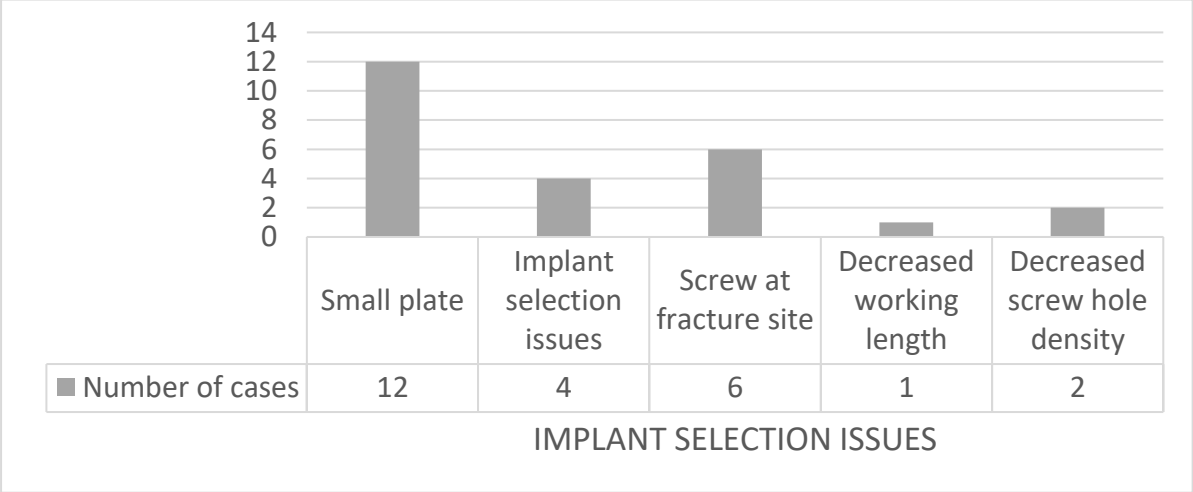


Chart showing the different causes of Breach of AO principles in our study cases



In all cases there were implant related issues, in 12 cases small plate was used, in 4 cases there was implant selection issues, in 1 case dual platting was required, in 6 cases screws were in the fracture site, in 2 cases there was decreased screw hole density and in 1 case there was decreased working length.

Chart showing the different causes of implant selection issues in our study cases



In one patient, the patient insisted for implant removal and patient developed refracture after implant removal and refixation after refracture also failed.

DISCUSSION

Although DFLCP is technically demanding procedure, however; with proper application of technique it gives outstanding results even in unstable distal femoral fractures. The important technical aspects are attaining good reduction with acceptable valgus angle, making correct rotation, placing plate properly with precise placement of screws. The technical problems encountered in our study can be summarized under the following headings:

Osteosynthesis in unreduced fractures

The importance of anatomical fracture reduction while treating intra-articular distal femur fractures cannot be overemphasized. Choice of an appropriate surgical approach and technique (conventional direct open reduction vs indirect reduction) should be dictated by the fracture geometry, severity of soft tissue injury, patient factors, implant selection, and surgical skills of the operating surgeon. We aimed at achieving anatomical reduction of articular area, restoring length and alignment of the metaphysis to articular block. In our study reduction technique failed in 8 patients. Buckley in 2011 reported statistically significant incidence (38.5%) of femoral malrotation following fixation of distal femoral fractures using indirect reduction technique.[18] Outcome of distal femoral fractures is closely associated with the quality of fracture reduction. [18-21] Therefore, in case of an unacceptable indirect metaphyseal reduction one should not hesitate to do an open reduction to prevent subsequent failure.

Radiograph image showing DFLCP application in unreduced fracture

Problems associated with plate positioning and guide wire placement

When anatomically contoured plate is placed properly, it assists fracture reduction by restoring normal length and alignment. Contrary to this improper positioning of the plate causes mal-reduction of the already reduced fracture (primary loss of reduction). Cory recommends positioning of the plate within a centimeter of anterior edge of the lateral condyle and 1 to 1.5 centimeter above the joint line.[6] Accurate positioning of plate ensures the placement of guide wire nearly parallel to articular surface of the femoral condyles, thus ensuring the restoration of desired normal valgus alignment.[6]

Radiograph and CT picture showing improper positioning of the screws and screws are not holding the medial fragment, in this case revision surgery was performed by application of bone graft and medial plate and CC screws

Problems of combination of absolute and relative stability

Anatomical reduction and absolute stability is recommended in articular surface and in metaphysical and diaphysial fractures the aim of reduction is to restoration of length of the bone, correct alignment axis and rotation, which should be maintained during mobilization.

Radiograph images showing mixing of absolute and relative stability, leading to failure of the implant in subsequent follow up

Implant related issues

A moderate axial motion and minimal shear movement between fractured bone fragments is desirable for fracture healing, too much or too little can delay or inhibit fracture healing.[22-25] The axial micromotion produced by locked plating system are often altered by variables viz plate length, working length, the offset distance between the bone and plate, screw spacing and the material properties of the plate.[23, 26-28] Biomechanics of locked plating system is closely associated with the modulation of the mechanical environment in favor of fracture healing with appropriate level of axial micromotion. Failure to do so may result in fixation failure . Although, it is generally agreed upon that the plate length forcomminuted fractures should be 2 to 3 times longer than the fracture length, however the optimal screw position and type of screw on the proximal side of the locking plate are currently debated.[26, 29-31] Gautier recommends that ≥ 3 empty holes should be left around the fracture site, whereas Stoffel recommends that the screws should be placed as close to the fracture site as possible [26, 31] for comminuted distal femoral fractures. The working length of a locking plate is defined as the distance between the two closest screws across the fracture site and it is influenced not only by plate length but also by type of screws placement.[32] However, location and number of locking screws are commonly chosen by surgeon experience instead of scientific evidences.[6, 9] Although we agree with the Hoffman's recommendation to put at least three bi-cortical screws on either side of the fracture[19], but we recommend minimum 4 screws across the fracture site for unstable fracture pattern.

In our study in all cases there were implant related issues, in 12 cases small plate was used, in 4 cases there was implant selection issues, in 1 case dual platting was requires, in 6 cases screws were in the fracture site, in 2 cases there was decreased screw hole density and in 1 case there was decreased working length

Radiographs showing use of small plate and decreased working length which lead to implant failure


Radiograph showing revision surgery using long plate

Radiograph showing screw at fracture site

Radiograph showing application of more number of screws to proximal fragment leading to implant breakage

DUAL PLATE Holzman recommended addition of a medial plate and autogenous bone graft for aseptic non-unions with stable lateral construct as was in our case.[33] The addition of a medial plate along with bone graft enhances both mechanical and biological environment for bone healing to prevent subsequent late failure. Therefore, in patients lacking signs of progressive union in two consecutive orthogonal radiographs, we

recommend an early application of medial plate and bone grafting rather than to wait for the development of an established non-union.

Peschiera also reported high failure rates with poor medial alignment and discontinuity, and recommended for medial column reconstruction either with graft or medial buttress plate when a medial defect of 2 cm or more is observed in order to prevent fixation failure.[34] Prayson also recommends supplementation with medial column plating in similar fracture patterns.[35] Steinberg suggested double plate fixation for A3 and C3 type comminuted fractures to improve the rate of fracture healing.[36] Metwaly advocated double plating for intra-articular fractures of distal femur in elderly population to improve the stability of fixation.[37] We also believe that unsupported medial column lead to healing issues, necessitating medial column reconstruction in unstable distal femoral fractures with posteromedial comminution or gap.

Healing complications

Henderson in 2011, classified the implant failures into early (≤ 3 months) and late failures (≥ 3 months) following index surgery. Early implant failure is due to mechanical instability secondary to either surgical technique or implant design, and late failure is likely related to healing issues where the implant experiences loading cycles that exceed its fatigue limit [10]. In one of our cases (plastic deformation of plate and en-bloc pulling out of distal screws) early failure was observed, which was related to mechanical instability due to technical errors. The early failures in our study emphasizes the need of refining the surgical techniques and proper application of principles of biomechanics of locked plating system. Toro also opined healing issues are more likely due to technical errors and stressed on improving the techniques.[9] Hsu reported early failure in 13.6% of his patients with complex distal femoral fractures treated by locked plating emphasizing mechanical instability as a possible risk factor for early fixation failure.[38]

Radiograph showing early failure due to plastic deformation of plate and enbloc pulling out of distal screws

Radiographs of revision surgery done in above case with bone graft and longer plate

Radiographs showing early implant failure

Our study attempts to highlight the technical difficulties and mechanical failure of DFLCP in distal femoral fractures following index surgery.

LIMITATIONS OF THE STUDY

However, retrospective design, small sample size and lack of comparative groups are the limitations of current study. Future studies are required aiming improvement in the surgical techniques and augmenting stability of fixation in unstable distal femoral fracture.

CONCLUSION

Although DFLCP fixation is an established method of treatment of distal femoral fractures, yet the procedure is not free from complications. Considering the causes of failures in our study, in most of the cases causes of failure of the procedure are due to breach in AO principles and due to implant related issues. The important technical aspects are attaining good reduction with acceptable valgus angle, making correct rotation, achieving the stability,

soft tissue handling, selecting the implant with proper implant size, placing plate properly with precise placement of screws with aseptic protocols. In sight of the findings of our study along with existing literature we propose for creating a fixation construct that is conducive for fracture healing by following AO principles of locking compression plates. Double fixation either with 2 plates (Medial and lateral) or retrograde IMIL nail with lateral plate with or without bone grafting is important to achieve satisfactory outcomes in cases where there is long metaphysial communition. To follow all guidelines for the clinical application of LCP as given by gautier and sommer.[40]

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