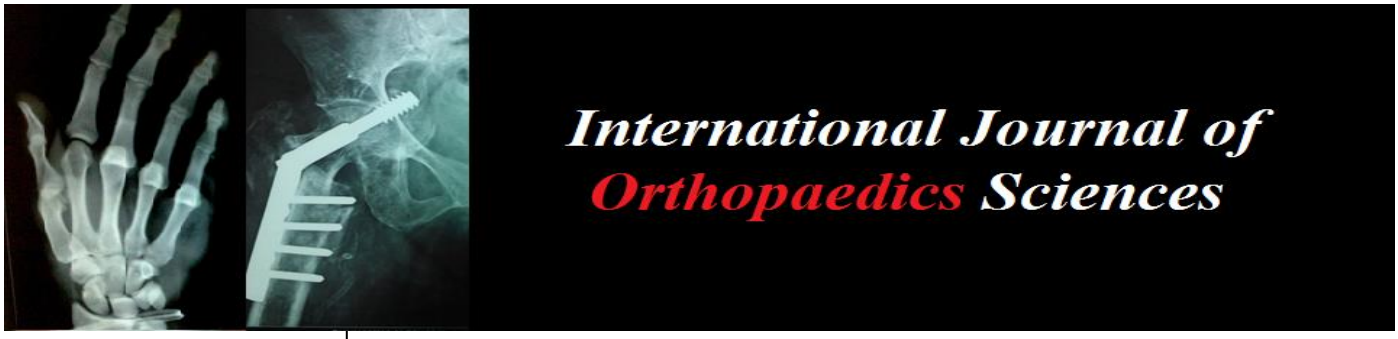

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Exchange nailing with Uni-cortical plate augmentation +/- bone grafting for proximal 2/3rd distal 1/3rd junction shaft non-union femur

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Abstract
The femur is prone to fracture when struck by strong external forces, such as in motor vehicle accidents, falling from height. Intramedullary nailing (IMN) has achieved good results in the treatment of adult femoral shaft fractures. However, poor blood supply and severe soft tissue damage often result from inappropriate surgical operations or deep infection, leading to delayed union or bone non-union. The incidence of non-union of femoral fractures after trauma is 5%–10%. The treatment options available to deal with NON-UNION include Exchange Nailing, removal of the nail, and Re-osteosynthesis with plating +/- Bone grafting, or Ilizarov fixation. We present our experience of plate augmentation with Exchange nailing +/- bone grafting for non-union at junction of proximal 2/3rd and distal 3rd of femoral fractures. It is an efficient technique, which provides additional rotational stability at the non-union site, the additional advantages of this technique are that it can be done with minimally invasive technique, allows early rehabilitation of the patient, and carries lesser morbidity.

Keywords: Uni-cortical, plate augmentation, bone grafting, non-union femur, intramedullary nailing

Introduction
The femur is the strongest long tubular bone in the human body, as well as the main weight-bearing bone of the lower extremities. The femur is prone to fracture when struck by strong external forces, such as in motor vehicle accidents, falling from height.[1] With the progress of social modernization, the incidence of femoral shaft fractures has increased dramatically in about 5 years. Intramedullary nailing (IMN) has achieved good results in the treatment of adult femoral shaft fractures. However, poor blood supply and severe soft tissue damage often result from inappropriate surgical operations or deep infection, leading to delayed union or bone non-union. The incidence of non-union of femoral fractures after trauma is 5%–10% [2]. Some studies have found that the incidence of non-union caused by IMN of the femoral shaft has even reached above 10% [3]. The occurrence of non-union can cause obvious pain and seriously affect the day-to-day life activities of patients.

The femoral shaft was divided into Isthmus and Non-isthmus section which includes Supra-isthmus and Infraisthmal section depending on the location of the fracture site [4-7].

The treatment options available to deal with NON-UNION include Exchange Nailing, removal of the nail, and Re-osteosynthesis with plating +/- Bone grafting, or Ilizarov fixation [8]. An exchange nailing is considered as the most accepted method for the non-union of femur shaft fractures However, the results with this technique are inconsistent as Exchange nailing lacks rotational stability, Also the removal of nail and re-osteosynthesis with the plate constitutes a well-known method but requires extensive soft tissue and vascular compromise, which hampers union [11]. The use of Ilizarov fixation is a cumbersome procedure and is not favored routinely especially in the thigh, by most surgeons.

We present our experience of plate augmentation with Exchange nailing +/- bone grafting for non-union at junction of proximal 2/3rd and distal 3rd of femoral fractures. It is an efficient technique, which provides additional rotational stability at the non-union site, the additional

advantages of this technique are that it can be done with minimally invasive technique, allows early rehabilitation of the patient, and carries lesser morbidity.

Materials and Methods

Between 2019 till PRESENT, 10 patients belonging to age group 30 to 65 with femoral non-union at the junction of proximal 2/3rd and distal 3rd after initial management received therapy with Exchange nailing with Uni-cortical augmentation plating +/- bone grafting at Deptt of Orthopaedics; Shri Mahant Indresh Hospital Patel Nagar Dehradun. A Non-union was defined as a radiolucent line without signs of callus formation around femoral shaft fracture treated by interlocking intramedullary nailing (IMN) OR plating for at least six months [12]. It was characterized as persistent pain at the fracture site which might get worse by weight-bearing.

Patients who were included in the study were from the age group 30-65 yrs. old with an average gap of 9 months from the primary fixation of the fracture with no sign of healing at fracture site,

Patients who were excluded from the study are with open fractures at the initial injury, pathologic fracture, suspected latent infection, leg length discrepancy of more than 1.5 cm, severe cardiovascular disease, or a recent administration history of corticosteroids and immunosuppressive drugs. The cases of infected non-union and any fracture of less than one year duration were excluded from the study

All the patients had blood investigations including complete blood count (CBC), erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP), liver function test (LFT), renal function test (RFT), and RBS.

Pre-Op Skiagram of Patient in Ap and Lateral View After 9 Months of Primary Surgery

Post Op Skiagram of Same Patient Showing Union at The Fracture Site After Proper Follow Up and Rehabilation After 7 Months of Second Surgery.

Surgery and Follow Up

The patient shifted to the operating room after proper pre-anesthetic workup and then the position was made over the fracture table and then procedure started with implant removal (nail removal /plate removal) and then other Nail of larger diameter was introduced in the medullary canal after proper reaming which aid bone marrow from medullary cavity at fracture site along with this augmentation Unicortical plating along with bone grafting from the ipsilateral iliac crest site was fixed to provide rotational stability in the distal femur fracture (infra-isthmus as it has a broad medullary cavity), and then closure was done after proper drain placement.

On post-op day 2 drain was removed & Postoperative Rehabilitation was initiated with Knee Rom Exercises, Quadricep Strengthening Exercises, and NON-weight bearing assisted walking. Then the patient was regularly follow up clinically and radiographically at initial biweekly till 1 month and then monthly intervals till 9 months to see the callus formation and union at the fracture site.

Post Op Skiagram of Another Patient Treated with The Same Method as Dicussed in Text

Immediate Post Op Skiagram Of 3rd Patient Treated with Augmentation Exchange Nail and Bone Grafting

Table 1: Detail of Patients

Case no	Age of patient	Sex	Avg time between 1st & 2nd surgery (Months)	Avg time of union	Complications
1	34	M	10	7	NIL
2	64	F	12	10	NIL
3	65	F	15	9	NIL
4	44	M	11	7.5	NIL
5	56	M	9	6	NIL
6	39	M	12	9	NIL
7	48	F	15	6	NIL
8	62	F	12	8	NIL
9	33	F	9	6	NIL
10	59	F	10	9	NIL

Results

The average time of surgery between the primary surgery of interlocking nail fixation/plating and the exchange nailing with Unicortical plating +/- bone grafting was 13 months. Mean surgical time was 160 min. The average blood loss during the surgery was around 200 ml (range 120–300 ml). No neurovascular complications were noticed after the surgical procedure. The average duration of follow-up was 10 months (range 7–15 months). We could achieve union in all cases with an average time to radiographic union of 7.05 months (range 4–9 months). The average range of motion of the knee was 115° (range 100–135°). None of the implants showed a failure on follow-up radiographs.

Discussion

It is believed that instability of rotation is the dominant reason for non-union after intramedullary nails and other reason could be improper reduction or type of implant used and many more,

This Instability of rotation can be corrected either by exchanging the larger intramedullary nails or by plate fixation after removing the hardware or both along with bone grafting to provide better aid for fixation.

Augmentative Unicortical plate fixation in treating femoral nonunion after intramedullary nails have been reported with satisfactory efficacy [4-7]

Recently, Park *et al*. [13] retrospectively reviewed 39 patients with femoral shaft non-unions after intramedullary nails treated by Augmentation plating with Bone Grafting and illustrated that the absolute indications of such technique maybe include non-isthmus femoral shaft non-unions, isthmus femoral shaft non-unions with bone defects.

Mechanical instability and destruction of the biological environment are primarily responsible for bony nonunion and both sides often co-exist simultaneously. In our study, causes of non-union of all patients were analyzed in detail including inefficacy of distal locking screw or implant failure, bone Resorption, improper nail size or diameter; distraction of fracture site (improper reduction), Various methods of surgical treatment have been advocated for the treatment of femoral non-union. They are associated with various advantages and disadvantages. Exchange nailing is known to be the most acceptable method of treatment for femoral non-union.[14] The thicker nail provides better bending and rotational stability and also the reaming of the canal promotes Osteogenesis and its augmentation with plating with bone grafting provides better stability especially in infra-isthmus distal femur fracture.[15] Plate augmentation is equally effective for proximal, middle, and distal third femoral fractures. We have used a locking plate, as it gives a good purchase even with Unicortical screws. The plate holds the fragments in place thus preventing their macro motion.

We achieve bony union in all the cases with no significant complications and no implant failure. Very few studies have been done on plate augmentation with exchange nailing, and they have shown results comparable to the present study [16-20]. We believe that plate augmentation along with exchange nailing and bone grafting in the non-union femoral shaft fractures is a useful and easy technique to adopt with good results and is associated with only minimal complications.

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