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RETROSPECTIVE ANALYSIS OF COMPLICATIONS IN A SERIES OF SUBTROCHANTERIC FRACTURES TREATED WITH PROXIMAL FEMORAL NAIL

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ABSTRACT: The indication of the proximal femoral nails in the proximal femoral fractures seems to have narrowed down to the Subtrochanteric fractures in recent times. However, it still remains to be validated by properly conducted large prospective controlled trials. In 2010, The Cochrane Database of Systematic Reviews suggested that further studies are required in this category. Proponents of this technique are usually motivated by references to biomechanical advantages and minimal exposure during surgery. However there are also numerous difficulties and complications that are encountered and these have not received due consideration apart from implicating the learning curve for these problems. This small series conducted after due considerations to all these aspects reveals that the numerous problems may actually not be surgeon related alone but due to the inherent peculiar biomechanics of this region and the deficiencies of the IM nails to effectively control this fracture environment.

KEYWORDS: Subtrochanteric fracture-PFN-difficulties-complications.

INTRODUCTION: Management of Proximal femoral fractures has remained debatable for over 2 decades. While it has been clearly proven that operative treatment is associated with a reduced length of hospital stay and improved rehabilitation compared with non-operative treatment,^[1] the jury is still out on what the ideal mode of fixation is. Over the last 20-30 years, numerous modifications of fixation devices have been tried and the fact that till now no single implant (or class) has proven its clear superiority, points to the difficulties inherent to these fractures as well as the problems with our approach to the subject.

BACKGROUND: Regarding the various modifications of IM devices being tried out, a significant meta-analysis from Cochrane database of systematic reviews gave the opinion in 2006 that, 'Given the evidence of superiority of the sliding hip screw compared with intramedullary nails for extracapsular hip fractures, further studies comparing different designs of intramedullary nails are not a priority. Any new design should be evaluated in a randomized comparison with the dynamic hip screw.'^[2]

The Cochrane Database of Systematic Reviews 2010, Issue 9, contained another meta-analysis of 43 randomized and quasi-randomized controlled trials comparing cephalocondylar nails with extramedullary implants for extracapsular hip fractures. The authors' conclusions were – 'with its lower complication rate in comparison with intramedullary nails, and absence of functional outcome data to the contrary, the SHS appears superior for trochanteric fractures. Further studies are required to confirm whether more recently developed designs of

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intramedullary nail avoid the complications of previous nails. Intramedullary nails may have advantages over fixed angle plates for subtrochanteric and some unstable trochanteric fractures, but further studies are required.^[3]

This is one vital fact that has been ignored. It is ultimately the clinical results that finally matters. And when all the theoretical advantages do not translate into favorable results, it is imperative to review the subject again from the beginning. Many a time the explanations given are the lack of properly conducted trials and the poor results of 'the learning phase' of the operators. Surely these arguments do not hold ground after 2-3 decades of their use. So till the very recent times we still have many reports that indicate the same things. 'Poor reduction and coxavara caused by insertion of the nail could not be completely avoided, and the design of the distal part of the nail had the potential to cause femoral shaft fracture.'^[4] And in the Indian context also, 'an overall complication rate of 19% does not indicate a significant improvement over the previous IM devices'.^[5]

MATERIALS AND METHODS: With this background a series of subtrochanteric fractures were treated with the proximal femoral nail in this institute from 01/02/2012 to 01/02/2013. The Surgeons were experienced in intramedullary nailing of femur fractures and also in using implants with femoral neck purchase like the CBP, DCS, DHS, PFLCP and Cancellous screw fixation of femoral neck fractures and the adaptation to the Cephalomedullary nails was not difficult.

An extensive review of literature was carried out before undertaking this series. From the reports of earlier workers, we were aware of the potential complications and difficulties and discussed all possible eventualities and the necessary corrective steps. In spite of that, we encountered all the described complications in our small series and found that they were not exactly surgeon dependent but inherent to the fracture situation itself and very hard to avoid.

COMPLICATION	NUMBERS	REMARKS
Varus, procurvatum malreductions	3	Initially aligned fracture settled into varus procurvatum after removal from fracture table, 2 were with gross posteromedial comminutions and 1 spiral
Iatrogenic femur fractures	3	1 anterior cortex perforation in a curved femur and 2 displacements of comminution at fracture site when traction was reduced before distal locking to reduce fracture gap
Primary loss of reduction	1	
Proximal screw loosening with delayed union	1	Fracture had lateral wall combinations
Trochanteric pain and weakness	6	Almost all the other cases had varying amount of discomfort
Thigh pain restricting quadriceps rehabilitation	1	When using short PFN

Table 1: Complications encountered

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2 cases were salvaged using encirclage wiring over the nails. It was interesting to note that malreductions could be corrected even with the nail in-situ which suggested very poor and unstable fixation.

The series was initially designed as a prospective study to evaluate all the aspects of the use of PFN in subtrochanteric fractures, where it is still advocated. However after the initial difficulties during operation and the poor immediate postoperative outcomes, which naturally resulted in poor final outcomes, the series was stopped after 11 cases and individual cases were evaluated to determine the faults. Hence it is being presented as a pilot series with retrospective analysis and explanations of individual difficulties and failures to show how IM nails are fundamentally flawed in their application in subtrochanteric fractures.

DISCUSSION:

- A.** The inherent problems of the proximal femoral region have been well described and do not need further elaboration. However the problems with our approach to this fracture still leaves room for discussion.
1. There are numerous classifications of these fractures, mostly descriptive and without any bearing on the choice of treatment.^[6] This fact renders the analysis of the numerous trials very difficult and hence the lack of a clear consensus till date.
 2. The Proximal femoral fractures represent quite a heterogenous population of fractures with different indicated principles of fixation. Clumping them all together to evaluate an implant, results in application of improper fixation principles in some cases causing variable outcome in these trials. While principles of fracture compression and bridging with/ without bone grafting are indicated in different situations, any one implant may not be suitable to apply both principles with equal efficacy. Similarly we have many fracture subgroups that requires fixation principles like Buttress/ anti-glide(reverse oblique fractures), Neutralization (Spiral, long oblique fractures fixed with inter-fragmentary screws) and Tension band (compression) plating.
 3. We also have situations where we cannot be dogmatic about the surgical approach either. In case of transverse, oblique fractures which require accurate and anatomical reduction and fracture compression, it would be better to adopt an open reduction technique if percutaneous technique affords less than desirable reduction and fixation. On the other hand, comminuted fractures where accurate reduction is neither possible nor open reduction is desirable, or in fractures in the frail and elderly, it is certainly better to adopt a percutaneous technique.

However, it is rare to find literatures that have taken these variables into account.

More often we come across reports where the treatment groups have not been stratified and the fixation principles were being generally applied, whether suitable or not.

An ideal approach could be to concentrate on a homogenous population of fractures by a stratified randomized approach (e.g. Stable / Unstable or Osteoporotic/ Non- osteoporotic etc), evaluate an implant in such cases alone, or compare 2 implants that apply the same and indicated fixation principles. Finally when these mini-series are later compared it may be possible

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to find an implant that is the most versatile, which is able to apply all the fixation principles across the board in this heterogenous group of fractures.

B. The relevance of Biomechanical studies and their interpretations: For too long now, numerous biomechanical studies have been summarily quoted to explain the use of certain groups of implants in subtrochanteric fractures. However, there has been, glaring lapses in how these trials have been conducted (as admitted by these authors themselves) and in our interpretations of their results. The salient summarizing points can be mentioned.

- i) So far there are very few studies that have investigated the mechanical performance with a numerical model that has been validated by strain measurements on an implanted intramedullary nail.^[7,8]
- ii) Use of artificial bones and non-representative cadaver bones in many such studies.
- iii) It is very complex to accomplish experiments on a regular testing machine with more than one force acting on the bone.^[7]
- iv) The load scenario used focused solely on the hip force. Muscle forces were not considered. It is known that the resulting force of the muscle forces acting on the lateral side of the greater trochanter reduces the bending of the femur in the frontal plane.^[9,10]
- v) Using Gaps or medial wedges as unstable fracture models, which do not represent actual reductions where at least the tensile and hence non-comminuted antero-lateral cortices are reduced and held in contact.
- vi) Unrealistic high loading to failures, which are not exactly representative of an osteosynthesis.

There are no gold standard representatives of IM and EM groups- designs of both groups are constantly evolving. This particular factor renders these comparative studies redundant after each modification. Hence, head to head biomechanical trials of representatives of EM and IM devices are not possible in the near future. While among the EM devices, recently it seems that we have a winner in the form of the PFLCP,^[11] the IM group is still evolving with newer and newer modifications.

C. Analysis of our findings and supporting literature;

1. Varus procurvatum reduction is inevitable: This phenomenon has nothing to do with the entry point or learning curve; this step can be quickly learnt and it would not have been so persistently seen for decades. The real problem is that the bone at the entry point is not that strong to counteract the deforming forces of the muscles and the body weight and the purchase of the proximal fragment, both of the nail in the wide medullary canal as well that of the proximal screws are not very secure. The IM nail ultimately has to 'lean on' the posteromedial cortex (broken most of the time) to resist the varus procurvatum tendency. Thus it is more commonly seen in the fractures with posteromedial comminutions than with intact posteromedial walls. [Fig.1] Even in these medial side-supported fractures, the lateral wall is distracted by the forces rather than compressed. If an implant was put lateral to this intact lateral wall, the fracture, or

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whatever was brought into contact would have been subjected to tension band forces for better stability, load sharing effect and consequently better healing. This deficiency of the IM nails exposes it to the body's greatest deforming forces at the fracture site with the comminuted posteromedial wall unable to support it and the intact lateral wall simply leaning and distracting on the implant.

2. Difficulty in obtaining and maintaining a closed reduction has been described by many authors: Limited exposure offer a technical challenge to obtain a good reduction and restore axial rotational and angular alignment and restore length. There is difficulty in finding the appropriate starting point and being able to pass a reamer in the appropriate direction down the intramedullary canal.^[12]

Unlike a more distal femoral shaft fracture, where the proximal fragment can be aligned to the distal fragment by simply adducting the fractured limb across the midline on the fracture table, in the subtrochanteric region this does not work. Adducting the limb does not affect the short proximal fragment and causes the fracture to fall into further varus. The abducted and flexed position of the proximal fragment can be aligned to the distal fragment by actually abducting the distal limb. However, in this position, the entry point is very deep and even if the entry point is somehow made by percutaneously controlling the fragment with a Steinmann pin, reaming into the canal in the proper direction is very difficult. The reamer continues to have an inclination to damage the medial wall and holding the proximal fragment adducted to the distal fragment during this entire period of reaming, followed by nailing till the end of the proximal fixations, with a percutaneous pin or clamp is easier said than done inside the bulky soft tissues and jigs. It also defeats the purpose of closed nailing if the fracture has to be opened routinely. ILei-Sheng Jiang, et al. reported 39% cerclage wiring.^[13]

We have tried to bring the proximal fragment into better alignment by increasing the traction in neutral or slight adduction, thereby managing this step without opening the fracture site. However, this also unacceptably distracts the fracture. Distraction at the fracture was corrected by reducing the traction prior to distal locking. In at least 3 of our cases, after this step, when we checked the final reductions, we found that the initially aligned fractures settled into varus- procurvatum malreduction confirming the observation that the precarious hold of the implant in the proximal fragment does not control the deforming forces. [Fig 2] The control of rotational alignment is also more difficult with intramedullary implants and frequently is not mentioned in reports with such devices.^[14] Adjunct reduction techniques are often required to achieve fracture reductions and prevent varusmalunions.^[15] and it has been proved both in clinical and biomechanical studies. While ILei-Sheng Jiang, et al. reported 39% cerclage wiring^[13] [Fig. 4], Müller et. al experimentally proved that 'additional wire cerclage could significantly decrease the failure of osteosynthesis (100 vs 10%) after intramedullary nailing of subtrochanteric fractures (p<0.05).^[16]

3. **Damage to the abductor mechanism:** The functional importance of this vital anatomical region has not received its due importance even after it was recognized long

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ago. Muscle forces acting on the lateral side of the major trochanter reduces the bending of the femur in the frontal plane.^[17]

Literature says that damage to this region is a very common phenomenon and we observed this in most of our cases. Abductor mechanism damage has been reported in upto 27% cases.^[18] Even the very simplest of cases were found to have a trendelenburg gait after 6 months and pain at the entry point. [Fig.3] We attribute this to the faulty restoration of the biomechanics at the hip joint besides the other obvious causes pointed out by various authors.^[19,20]

- 4. IM Buttressing of a reverse oblique fracture is not the best way to do it:** It is also stated that an IM device buttresses a reverse oblique fracture better than a DHS by resisting the medialisation of the shaft with its intramedullary location which a DHS cannot. This argument supports IM devices in relation to the DHS only, which is already an established contraindication in this situation. No proponents of EM devices would use a DHS in a reverse fracture. Anybody would choose a DCS, Blade plate or recently the PFLCP for such cases. These Buttress plates buttress the intact lateral cortex in the trochanteric region and resist any shaft medialization better than any IM device would. We see exactly the same application in the proximal humerus. Why should we think otherwise in case of a reverse oblique fracture? IM devices will always result in a cortical step before the buttressing effect sets in. And once distally locked, this small cortical step would cause a slight distraction laterally at the fracture from the bending strains.
- 5. Diaphyseal locking:** Diaphyses is not the traditional or ideal location for putting interlocking bolts. This region tolerates stress risers poorly. Contact areas of screws with the cortical bone is very less compared to the metaphyseal regions and this implies greater stress. When the entire body weight and the strong muscular forces concentrate on these screws and bone in contact, through short and hence stiff nails, breakage of these screws and fractures are always predictable. It is safer to use longer, more elastic nails with distal metaphyseal locking if one chooses to nail a subtrochanteric fracture. However we experienced one case of anterior cortex perforation in an osteoporotic and excessively curved femur after using a long PFN. [Fig. 5] The only case in our series where we used a short PFN after this accident, still complains of thigh pain after 7 months. High rates of this complication of 17% in the hands of experienced surgeons have been earlier reported by Zhao X et. al.^[10] Interestingly, the reason for this was apparent long ago. 'Nail unloaded both the medial and lateral cortex by stress transmission to a distal point of the medial shaft.'^[20]
- 6. The argument of being more biological also needs to be accepted with caution:** Besides the high rates of conversion to open reductions, IM devices in subtrochanteric fractures are not uniquely minimally invasive after the development of percutaneous plating techniques. In their prospective randomized study of 66 cases on

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IM nail Vs. Biologic plating, Lee PC et. al. concluded that DCS is a feasible device and IM (RTRN) nail revealed no advantages.

There are other pitfalls to consider when adopting IM devices in a biological approach-The relative importance of reaming's as grafts is unclear, the long-term importance of removing bone from the proximal femur in a young patient is unknown and reaming at the greater trochanter may have an effect on the abductor insertion.^[12]

CONCLUSION: Contrary to recent trends, instead of subtrochanteric fractures, it is the trochanteric fractures in the elderly frail patients who benefit more from PFN. We found it easier and quicker to put in the nail when the entry point is fractured, with very little dissections. There was no need to open and reduce grossly displaced fractures as in the subtrochanteric region, the varus of the trochanteric fractures can be indirectly reduced and pinned in place and due to the intact lateral cortex, while the IM nail complements the tensile forces in the intact lateral wall by itself transmitting the compressive forces only. Any fractures involving the lateral wall like the subtrochanteric fractures [Fig. 6] should however be considered a contraindication for IM nailing.

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Figure 1



Figure 2

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Figure 3



Figure 4



Figure 5



Figure 6

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