Author's reply

Sir,

Thank you for your interest[1] in the article[2] and bringing out the questions that usually nag the surgeon's mind after seeing a case of fracture neck of femur (FNF).

1) We have taken the presence of primary compressile trabeculae in AP radiograph and independently active community ambulation, mobility without any aid as inclusion criteria. We give more importance to patient preoperative functional activity level (qualitative) rather than DEXA scan (quantitative) while selecting the patients. Patients with posterior comminution require little more precaution at the time of surgery.[3]
2) The fundamental concept of fixation area and stability hold true for all fracture fixations: Plating, nailing, screw fixation and K wiring at all levels diaphyseal, metaphyseal and epiphyseal. Fixation of FNF works on lag screw concept where the screws give excellent stability by passing through the fracture site.

I. In tibial condyle fracture fixation, the lag screw should extend to the far cortex for good stable fixation. In femoral head where far cortex fixation is not possible, the screws should be long enough to have sufficient fixation in the strong subchondral bone. This is true for hip screw in DHS fixation, screws in FNF and proximal locking screws in proximal femoral nail or reconstruction nail.
II. In IM nailing of long bone shaft fratures, there should be sufficient length of nail on either side of the fracture to negate the angular forces with locking bolts to negate the rotational forces.
III. In femoral supracondylar (metaphyseal) fracture, plate fixation stability in distal fragment is better with 3 to 5 screws through a buttress plate rather than one or two screws with a DCP.
IV. In paediatric supracondylar humerus fracture K wire fixation, for better stability and to prevent reduction loss, the wires on medial and lateral side should spread out, i.e. cross above the fracture site.

The best way to prevent various forces (angular, shear and rotational forces) acting at the fracture site and hence to avoid malunion or nonunion is to improve the area covered by the fixation device.

3) While few surgeons advocate two screws,[4,5] majority[6-9] advise three screws for better stability and good outcome. We are not aware of any randomized clinical study in displaced FNF in elderly or adult patients, which say that two screws fixation give good functional results like three screws. In biomechanical study, Swiontowski *et al.*,[10] found three screws or pins offered enough stability in FNF, but also said that bone density correlated with fixation stability. However Kauffman *et al.*,[11] found that fourth screw was beneficial in cases with posterior comminution. The fixation strength of any implant for any fracture ultimately relies on bone quality. While three screws may suffice in younger patients with good bone quality, fourth screw can offer more fixation stability in older patients with poor bone quality. Several studies include all age groups under the umbrella of fixation, but it will be better to make a distinction between the two groups–young and old. We advocate placing four screws in four quadrants of head; inferior anterior, inferior posterior, superior anterior and superior posterior. If four screws are placed in diamond fashion, even then the middle two screws will be "crowded" and create a "stress area" albeit at a slightly higher level. Crowding or width between the screws is variable depending on the width of the lateral proximal femur. While diamond configuration will occupy same area like rectangular configuration, orientation and screw positioning may be technically more difficult, as three screws will be seen in AP or lateral view of fluoroscopy.[12] Technical errors like making multiple drill holes in the lateral cortex and inadvertent entry into the medial cortex can result in subtrochanteric fracture especially in severely osteoporotic bone. We have not encountered any such fracture. Irrespective of diamond or rectangular configuration at the entry site, the screws should be parallel to one another and as much peripheral as possible inside the neck head of femur.
4) The "level or degree" of anatomic reduction required in FNF fixation itself has not been defined clearly in the literature.[13] While we agree that nonanatomical reduction can be associated with nonunion, we challenge that it is not the sole culprit. We disagree with studies that say that anatomical reduction is essential to prevent AVN and nonunion. No biomechanical reason can be offered for malreductions leading to AVN and nonunion.

AVN femoral head is determined by residual vascular supply that remains after primary trauma and surgical trauma rather than by nonanatomical reduction. As we have said in our paper, the risk of AVN in elderly patients is less. In an excellent study, Liu *et al.*,[14] classified femoral head circulation into three types based on super selective digital subtraction angiographic method, in patients undergoing screw fixation for FNF. After sustaining FNF, elderly patients still had good vascular bands in angiography compared to that of the middle aged and young patients. The rates of AVN for elderly, middle-aged and youth were 10.53, 45.45 and 66.67%, respectively and the rates of fracture nonunion were 0, 0 and 6.67%, respectively.

Union (Nonunion) is determined by the stability (instability) achieved after fracture fixation and the presence (absence) of blood circulation to fracture fragments. In younger patients anatomic reduction may offer better stability than nonanatomical reductions. Here, the fracture is transcervical with spikes and troughs that can match with anatomical reduction and bone quality is good. In elderly patients the fracture is subcapital, often with transverse configuration and bone quality is poor. Anatomic reduction may not offer more stability but better fixation can provide more stability here.

Many "proved" facts in the FNF study are evolved over years from observational studies. We need not carry the "myths" of the past into future unless a scientific (biological or mechanical or both) rational explanation can be offered for the same.

Accurate reduction is not necessary for any fracture to heal: we need accurate reduction in intraarticular fracture (even here 2 mm step or gap is accepted) to prevent posttraumatic pain, arthritis and stiffness. If the two factors i.e. stability and vascularity are present, all the malreduced fractures will go for malunion rather than nonunion. Malreductions are generally accepted by orthopedic community in several

places like proximal humerus, distal radius, clavicle and comminuted shaft fractures etc., for they do not lead to poor functional outcome. We feel the discrepancy in the tolerance levels for malreductions between the above said fractures and FNF is huge and unjustified. We are not against anatomical reduction; we are against unstable fixation which is the single most important factor that promotes nonunion in FNF. The focus should be on perfect fixation rather than on perfect reduction at the cost of fixation. In FNF, whatever good reduction is achieved, with poor fixation the reduction will be lost within a short period of time even if the patient is doing NWB.

Has it been proved that synovial fluid (enzymes) prevents fracture union in femoral neck fracture? To the best of our knowledge, the answer is no. It was simply a hypothesis passed on from generation to generation in medical colleges and ingrained in our thinking. Any author who says that enzymes in the synovial fluid prevent FNF healing owes an explanation on how it does not affect intraarticular fracture healing involving other synovial joints e.g. displaced lateral tibial condyle fracture will go for malunion not nonunion after splinting.

We do not think that we have solved all the problems associated with this "unsolved fracture," but yes, after understanding the key rational concepts, we are very comfortable in dealing with these uncomfortable fractures.

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