Author's reply

Sir,

We thank the authors[1] for their interest in our article[2] entitled "Four quadrant parallel peripheral screw fixation for displaced femoral neck fractures in elderly patients" and raising some critical points. The authors have quoted several biomechanical studies[3-8] in their queries, which in general have got the following limitations:

1. Even though termed as biomechanical studies, they are essentially mechanical studies without any biology (live tissues/blood perfusion) involved. Fracture healing requires both mechanical stability and blood circulation of the fractured bones.
2. The end point in several of these studies, "failure under loading conditions," is not clearly defined. Whether the "failure" means loss of fixation and separation of induced fracture (if so, how much gap) or perforation of head by screws (cut through) or breakage/bending of one screw/several screws or fracture of the tested bone at another place, etc., is often not mentioned. All the above-mentioned scenarios can result in clinical failures.
3. While normal hip is subjected to various loading moments, i.e. axial/bending/rotational strains in combination, most of the biomechanical studies test either one or more loading moments separately. The complex dynamic muscular forces acting on a normal biological hip (e.g. combined hip flexion, abduction, and external rotation required for chair sitting) cannot be mimicked in a cadaveric mechanical hip.
4. The number of hips tested is generally small.
5. The age and bone quality of the cadaveric bones are not known. In some studies, synthetic bones are used.
6. While the fixation device and the quantity of the implants may be the same, the quality of fixation (technique of device fixation) in the cadaver setting is different from the clinical setting. While in the clinical setting, femoral neck fracture (FNF) fixation is generally done under C arm control with accurate positioning of the implants inside the head and neck, implants are simply "placed" in the femoral neck in cadaveric studies. In case of multiple screws, they are generally crowded in the central portion of the head.

Cadaveric studies can give broad outlines regarding treatment options. Improved mechanical strength, as determined by these studies, by itself is not a guarantee for fracture healing or good functional outcome, as biology is not involved. We feel that clinical studies with clear criteria, guidelines, and results have got more practical relevance than vague cadaveric "biomechanical" studies where several confounding variables are involved.

The point wise answers to the issues raised by the authors are given below:

I. In the study mentioned,[3] four patterns of triangular configurations (three screws) and two patterns of horizontal configurations (two or three screws) were tested in synthetic bone models. Four-screw configurations (rectangle/diamond patterns) were not tested. Use of fourth screw has been shown to have advantage in FNF with comminution.[9] Since we did not possess settings for biomechanical testing, we could not do the same. However, there can be no denial that four-screw pattern offers more area of coverage in the head and neck of femur than three-screw pattern [Figure 1]. More area of coverage, especially in osteoporotic bones, provides more stability.

II. Basicervical fractures are uncommon in elderly population, where the fracture pattern is predominantly subcapital. In our case series, we did not have any basicervical fracture pattern.

III. The most important issue in this cadaveric study[8] is the positioning of screws. While the diameter (7 mm) and length of the screws (95 mm) were mentioned, the spacing of the screws (distance between one screw and another) in either group has not been mentioned. The three screws were positioned very close to each other as shown in the line diagram [Figure 2]. Placing screws this close can precipitate a fracture with horizontal pattern, as the cortical width is small. In four quadrant parallel peripheral fixation (FQPP) pattern, the superior screws are placed as farther as possible from the inferior screws. As said in our earlier reply,[10] repeated drilling at the same level with multiple holes can increase the risk of subtrochanteric fracture. The authors of the above-mentioned cadaveric study have themselves admitted the weaknesses in their study: No reproduction of the trabecular architecture and, hence, morphology and strength variations in cadaveric bones and testing of the specimens in only one mode, i.e. direct weight bearing; torsion and transverse stress application were not tested. Only 20 "saw bone" femora were tested. With 64 patients of FNF completing 2 years of followup in our study[2] and performing the same in more than 200 cases in the past 6 years without any subtrochanteric fracture, we justify FQPP screw fixation pattern.

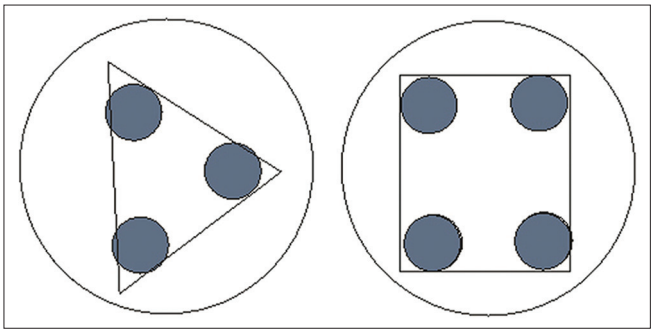

Figure 1: A line diagram showing screw positions inside the head of femur and the corresponding area occupied

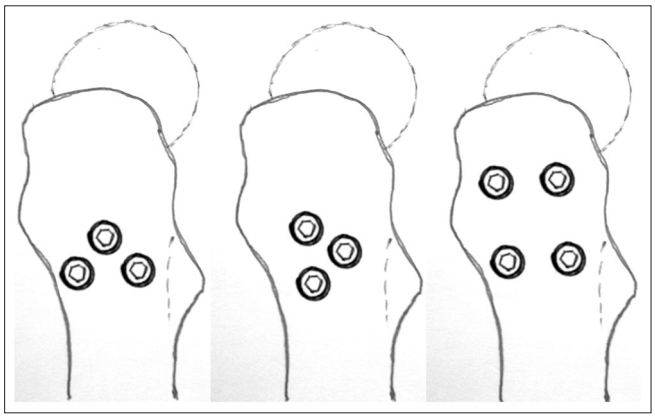

Figure 2: A line diagram showing screw head positions at the entry site for different configurations. The first picture shows horizontal configuration of three screws in cadaver settings (note the closeness of the screws; they are almost in horizontal line). The second picture shows vertical configuration of three screws in cadaver settings; in clinical settings, the three screws should further spread out. The third picture shows the four-screw FQPP configuration which we advocate

IV. We advocate nonanatomical reduction, not malreductions in FQPP fixation for FNF. With the fracture site's cross-sectional contact area is >75%, four screws can be placed in four quadrants of the femoral head. With excellent stability, the minor malreduction is not detrimental for healing. The degree of intolerance for nonanatomical reduction is unjustified in FNF cases, compared to the degree of tolerance for the same in several other fracture scenarios. Similarly, the high degree of tolerance for imperfect fixation in FNF is unjustified.

V. We have addressed the "washers" issue earlier.[10] According to us, the conclusion in that study[11] was derived from a pure statistical association. How can washers increase fracture stability or blood circulation at fracture site and, hence, reduce fixation failure and improve union rate? If it is so, can usage of washers with cancellous screws provide better union rate in medial malleolus fractures or tibial condyle fractures compared to nonusage of washers? We could not trace any other clinical study in literature which says that washers will improve clinical union in FNF or any other fracture setting.

According to us, there is nothing called "stable fracture reduction" in low-energy FNF, where the fracture pattern is almost always transverse. It is an inherently unstable fracture even after reduction; stability depends purely on fixation quality and bone quality. While bone quality cannot be managed immediately by the surgeon, fixation quality can be improved by covering more area of fixation and adopting adequate precautions at the time of surgery, as mentioned in our study.

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