The complications of displaced intracapsular fractures of the hip

THE EFFECT OF SCREW POSITIONING AND ANGULATION ON FRACTURE HEALING

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We have studied the placement of three screws within the femoral head and the degree of angulation of the screws in 395 patients with displaced intracapsular fracture of the hip to see if either was related to the risk of failure of the fracture to unite. No relationship between nonunion of the fracture was found regarding the position of the screws on the anteroposterior radiograph. However, we found that a reduced spread of the screws on the lateral view was associated with an increased risk of nonunion of the fracture.

One of the most common methods for internal fixation of intracapsular femoral neck fractures is the use of multiple screws. Generally the screws are cannulated to aid their placement. Three screws are usually used, although some surgeons prefer using two and some four. Traditionally, it has been advised that the screws be inserted parallel to each other to provide compression across the fracture site and allow for some collapse to occur as the fracture heals. Previous reports have made recommendations on the positioning of the screws relative to each other within the femoral head, but few have been based on clinical studies.

Patients and Methods

Between July 1989 and July 2003, we treated 607 patients with displaced intracapsular fractures of the hip by internal fixation in our unit. We excluded from the study group those treated by methods other than three screws (17 cases); pathological fractures (16 cases); those with less than 100 days radiographic follow-up (67 cases); those who died within 100 days of fracture (62 cases) and those in whom the radiographs were not available for review (50 cases). A total of 395 patients was included in the study. The mean age was 73.9 years (22 to 96); 86 (21.8%) were male and 327 (82.8%) came from their own homes. The mean time between the injury and surgery was 37 hours (3 to 1776) and between admission and surgery was 20.9 hours (1 to 78). All patients were treated by closed reduction and internal fixation with three cannulated 7-mm cancellous AO screws (Stratec Medical, Hertfordshire, UK). All patients had a minimum of 100 days radiographic follow-up or radiographic evidence of nonunion. Those cases of redisplacement of the fracture requiring revision surgery were included as nonunion, as were fractures which failed to show radiographic evidence of healing at one year from surgery. Union was defined as clear evidence of obliteration of the fracture line on both the anteroposterior (AP) and lateral radiographs at a minimum of 100 days from fracture. The mean time between surgery and the final radiograph for those showing union of the fracture, was 454 days (100 to 1898).

Radiological factors were measured from the images taken at the time of surgery. The position of each of the screws in the AP and lateral radiographs expressed as percentage of the maximum diameter of the femoral head (Figs 1 and 2). A higher number equates to a more superior placed screw on the AP or a more anterior screw on the lateral film. The spread of the screws was the difference between the two most peripherally placed screws on the AP or lateral films. The angle between the screws was measured to the nearest 5˚, but undertaken only for the last 310 cases. Furthermore in a sub-group of 62 cases, the distance from each screw tip to the joint line was measured on the AP and lateral radiographs.

In order to check for interobserver agreement, we scrutinised 50 radiographs using Kappa values which were 0.5 and 0.65 for AP and lateral angle measurements. These represent moderate and good agreement respectively. For continuous measurements, agreement plots were drawn and more than 90% of values were within the 95% confidence interval.
GraphPad software (GraphPad InStat version 3.0 for Windows 95, GraphPad Software, San Diego, California) was used to analyse the data. The Mann-Whitney U test was used for distributions which did not follow the Gaussian (Normal) distribution and an unpaired t-test with Welsh correction was used for distributions which did follow Gaussian distribution. In order to determine the statistical significance for the angles the chi-squared test was used. A p value of < 0.05 was considered statistically significant.

**Results**

Nonunion developed in 153 of the 395 fractures. The median time at which nonunion was deemed to have occurred was 68 days (mean 137). Table I shows the results for the position of each of the screws, on the AP and lateral radiographs, related to the occurrence of nonunion and the spread of the screws. Table II details the relationship in degrees of angulation between the screws either on the AP or lateral radiographs or a combination of both. In addition the number of patients in whom the screws were deemed to be parallel on the AP radiograph, on the lateral radiograph or on both views is detailed. The mean distance of the screws from the hip joint was 12.1 mm and 12.5 mm on the AP radiographs for the cases of union and nonunion (p value = 0.37) respectively and 14.2 mm and 13.3 mm respectively on the lateral radiograph (p = 0.18). For the subgroup of 62 patients, the sum of the mean distances on the AP and lateral were 26.2 mm and 25.8 mm (p = 0.18) respectively. Because of these findings, measurements of screw position were not undertaken on later patients in this study.

**Discussion**

The findings suggest that neither the position of the screws in the AP view nor the angle between the screws had any affect on the prospect of fracture union. However, the position of the middle and anterior screws and the distance between the most anterior and the most posterior screws on the lateral views altered the outcome significantly. Essentially a greater spread of screws on the lateral film reduced the risk on nonunion. The middle screw was found to be
higher in the femoral head on the lateral radiographs in fractures that healed as compared with those that did not.

We were not able to differentiate those cases of nonunion that were due to mechanical failure of fixation from those which were related to the biological causes of failure to heal. Such a differentiation can only be speculative. We feel that mechanical failure of fixation should be blamed for most nonunions. The length of follow-up for our cases was not long enough to consider the complication of avascular necrosis.

Although the position of the lag screw of a sliding hip device has been critically studied, particularly in the treatment of trochanteric fractures, this is not the case for internal fixation of intracapsular fractures with multiple parallel screws. Most authors describe their personal preference, such as placement of the lower screw on the calcar femorale or central placement of the screws on the lateral view. Others have recommended a spread of screws on the lateral radiograph. In a clinical investigation of screw position, Lindequeist reported a lower rate of nonunion for a two-screw system in his study of 87 fractures if the distal screw was placed inferiorly in the femoral head and neck and the superior screw placed posteriorly. These findings have been supported by cadaver studies. Von Bahr, Syk and Walheim reported a higher failure rate if the screws were placed anteriorly. Lagerby et al. reported a higher failure rate in those fractures fixed with calcar support for the distal screw. Booth, Donaldson and Dai reported improved stability for those femora fixed with a screw placed adjacent to the calcaneus. Conversely, Saito, Miyasaka and Toriumi reported no difference in the occurrence of fracture healing complications in relation to the position of the screws.

Various authors have suggested that screws should be parallel without presenting data to support this recommendation. In clinical studies, Spangler et al. reported no relationship between the angulation of the screws and the occurrence of fracture healing complications. Within our study, we did not consider in detail the distance of the screws from the joint line. It was our unit’s policy that all the screws should be placed less than 10 mm from the joint line and ideally at 3 to 5 mm. Our limited study of the distance of the implant from the joint confirmed that this was not a significant factor for this study and, therefore, we did not record this for the full series. The lower risk of fracture healing complications with placement of the implant close to the joint line has been previously demonstrated in a number of studies on intracapsular fractures.

We conclude that the most important factor in the positioning of screws during the internal fixation of an intracapsular fracture, is that there should be spread of screws in the lateral view. We found the degree of angulation between the screws had no measurable effect on the risk of nonunion.

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References