AWARENESS OF TIP-APEX DISTANCE REDUCES FAILURE OF FIXATION OF TROCHANTERIC FRACTURES OF THE HIP

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We compared the results of the surgical treatment of trochanteric hip fractures before and after surgeons had been introduced to the tip-apex distance (TAD) as a method of evaluating screw position. There were 198 fractures evaluated retrospectively and 118 after instruction.

The TAD is the sum of the distance from the tip of the screw to the apex of the femoral head on anteroposterior and lateral views. This decreased from a mean of 25 mm in the control group to 20 mm in the study group (p = 0.0001). The number of mechanical failures by cut-out of the screw from the head decreased from 16 (8%) in the control group at a mean of 13 months to none in the study group at a mean of eight months (p = 0.0015). There were significantly fewer poor reductions in the study group.

Our study confirms the importance of good surgical technique in the treatment of trochanteric fractures and supports the concept of the TAD as a clinically useful way of describing the position of the screw.

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A sliding hip screw with a fixed angle is commonly used to fix trochanteric fractures of the hip, but has a reported failure rate of 8% to 13%. Mechanical failure is usually due to cut-out through the femoral head when the fracture collapses into varus. There is known to be an increased risk of cut-out in older or osteoporotic patients, those with unstable fractures, and after poor reduction or fixation. Accurate placement of the screw in the femoral head is essential, but there is no simple method of describing and documenting this position.

We have devised the use of the tip-apex distance (TAD) from anteroposterior (AP) and lateral radiographs to describe the position of the screw within the femoral head and have shown it to be highly predictive of failure by cut-out. We now report a prospective study to assess the effect of the introduction of this concept on the management of trochanteric fractures of the hip in one hospital.

PATIENTS AND METHODS

We included all patients with trochanteric hip fractures treated by a fixed-angle sliding hip screw and either a sideplate or an intramedullary nail who had complete radiological and clinical records and a minimum follow-up of three months. Of 146 consecutive patients treated after the TAD concept had been introduced, 118 (118 fractures) met these criteria. Our retrospective control group was a series of 198 fractures (193 patients) treated over the previous four years.

For both groups, we recorded the patients' age, gender and medical condition on the rating of the American Society of Anaesthesiologists. Fracture patterns were classified according to the systems of Müller et al and of Evans as modified by Kyle, Gustilo and Premer, and considered as stable (types I and II) or unstable (types III and IV). Reduction was assessed on the amount of displacement and neck-shaft alignment on immediate postoperative AP and lateral radiographs, being categorised as good, acceptable or poor. A good reduction had normal or slightly valgus neck-shaft alignment on the AP radiograph, under 20° of angulation on the lateral and displacement of less than 4 mm on either view. Acceptable reductions met the requirements as regards alignment or displacement, but not both. Poor reductions met neither criteria. Implant type and angle were recorded for both prospective and retrospective groups.

Tip-apex distance. The calculation of TAD (Fig. 1) has previously been reported in detail. It is the sum of the distances from the tip of the lag screw to the apex of the femoral head on AP and lateral radiographs. For research purposes we adjusted for radiological magnification using...
the known diameter of the hip screw, but for intraoperative use the TAD can easily be estimated from the fluoroscopic images after guide-pin insertion (Fig. 1). It does not differentiate between peripheral or shallow placement, but the smaller values confirm that the implant is more central and deeply located.

We recommended that the aim should be a TAD of under 25 mm, since we had no screw cut-out in our retrospective series when this had been achieved, regardless of any other fracture or patient variables. For purposes of comparison we also recorded the location of the tip of the screw as defined by Kyle et al.14 and Cleveland et al.15 In this method the femoral head is divided into superior, central and inferior thirds on the AP view, and into anterior, central and posterior thirds on the lateral view, giving a total of nine separate zones.

A total of 41 attending surgeons operated during both study periods. Seven were active only during the control period, 28 (68%) during both periods, and six operated only during the study period. At the end of the study, all were asked to complete a questionnaire about their perceptions of the fixation of trochanteric hip fractures. We used Student’s t-test for analysis of interval data, a chi-squared test for dichotomous variable data and contingency table analysis for multiple categorical data.

RESULTS

The two groups were similar with respect to gender and ASA medical rating, but the mean age of the study group was 81 years as against 77 years for the control group (p = 0.001). There were more stable fractures in the study group (56%) than in the control group (45%) (p > 0.005).

There were 169 (85%) good or acceptable reductions and 29 (15%) poor reductions in the control group, as against 111 (94%) good or acceptable and 7 (6%) poor reductions in the study group (p = 0.0002). Intramedullary implants were used in 26% of the control group and 39% of the study group (p = 0.05); the use of 135° sideplates had increased, with significantly fewer 145° and 150° devices being used in the study group (p = 0.001).

There were no cut-out failures in the 118 fractures of the study group at a mean follow-up of eight months (3 to 19), compared with 16 of 198 (8%) in the control group at a mean follow-up of 13 months (3 to 48) (p = 0.0015). In the study group, one patient had delayed union in a varus position after fractures of the sideplate screws and another had deep infection which required removal of the implant. There were three non-cut-out failures in the control group.

For the study group the mean TAD was 20 mm (6 to 40), significantly less than the mean of 25 mm (9 to 63) for the control group (p = 0.0001). The TAD was less than the 970 M. R. BAUMGAERTNER, B. D. SOLBERG

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Fig. 1

The TAD can be estimated during operation by measuring the distance from the tip of the guide-pin to the apex of the femoral head on both the AP and lateral fluoroscopic images.

Fig. 2

The distribution of TAD for the study group of 118 fractures (white) and for the retrospective control group of 182 fractures, showing those which did not cut-out (grey) and those which did (black). The shift to smaller TAD values, implying more central and deep screw placement, is well shown.

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recommended maximum of 25 mm in 87% of the study group and in 75% of the control group (p = 0.006; Fig. 2), and the proportion of screws in the central zone was 64% and 43%, respectively (p = 0.0002).

To reduce bias due to changes in surgeons and their skill we specifically reviewed the results for the 28 attending surgeons working throughout both periods. For this group the average TAD fell from 26 to 20 mm and cut-out failures from 7% to zero. Only 62% of the questionnaires were returned. The perception was that improved technique was responsible for the decrease in the rate of cut-out. Of those who felt that better technique was the cause for improvement, 80% highlighted the importance of better screw position, often using the term “central and deep”, but only 20% used the term TAD in their answer, and only 25% mentioned improved quality of reduction.

DISCUSSION
We have shown a significant improvement in surgical technique and results after surgeons had been made aware of the current local failure rate and were introduced to intraoperative estimation of the TAD. Many previous reports on the treatment of hip fracture have focused on variables associated with the patient or the implants, but our study has shown that continuing education and increased interest in technique can improve results. Johansson et al. showed significant improvement in reduction and position of implants when fixation was performed by a small number of interested surgeons. They did not report outcomes, and it was not clear whether the smaller group of surgeons had improved, or had been selected because they were better technicians. Our questionnaire showed that surgeons had not specifically measured the TAD during operation, but that the increased emphasis on central and deep placement had led to improved screw positions.

Other factors not related to improved surgical technique could have influenced the results. Although not significantly different, there were more stable fractures in the study group, and this would be expected to decrease the rate of cut-out. There was a shift away from the use of high-angle plate fixation, possibly because the initial study had identified the use of a 150° device as an independent predictor of cut-out, but the study group was older. An increase in intramedullary fixation did occur, but such devices have not been shown to influence the rate of cut-out. As this was a prospective study, the surgeons were aware of data collection, and the so-called Hawthorne effect must apply: the outcome will have been influenced by the study itself. During the duration of both treatment periods there was no change in imaging technology or implant availability.

We believe that our results confirm that surgical technique is an important factor in the outcome of treatment for intertrochanteric hip fracture, and that it can be influenced by education and improved methods of assessment.

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