



Review of methods to quantify lag screw placement in hip fracture fixation

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This review considers methods used to quantify lag screw placement within the femoral head following proximal femoral fracture. Implants used for fixation of femoral neck fractures can lead to unwanted outcomes in some patients. Cutting out of the screw within the femoral head has been shown to be the commonest cause of failure and is related to lag screw placement within the femur. Until now, there have been two methods published which quantify lag screw position within the femoral head. These are the concepts of 'Tip Apex Distance' and Parker's ratio method of lag screw placement. We shall discuss each one in turn and their implications in terms of fracture fixation failure.

INTRODUCTION

Devices used for internal fixation of proximal femoral fractures can in some patients lead to unwanted outcomes. The main implant related complications are fixation failures. Failure of fracture fixation of a proximal femoral fracture has been reported to have an incidence of between 5.3% and 16.8% (6).

There have been numerous studies demonstrating the importance of lag screw placement in relation to cutting out of the lag screw within the femoral head (e.g. (1)). Not only is quantification of lag screw placement an indicator to predict future fixation failure following surgery, but it can easily be used for audit and research purposes.

Until now, there have been two methods proposed which quantify lag screw position within the femoral head. These are the concept of 'Tip Apex Distance' (TAD) and 'Parker's Ratio Method of Lag Screw Placement' (PRM). We shall discuss each one in turn and their implications in terms of fracture fixation failure.

Tip Apex Distance (TAD) as a method to measure lag screw placement

This method was first published by Baumgaertner *et al* in 1995 (1). They described TAD as '*the sum of the distance, in millimeters, from the tip of the lag screw to the apex of the femoral head, as measured on an anteroposterior radiograph and that distance as measured on a lateral radiograph, after correction has been made for magnification*' (1). TAD is therefore a measure

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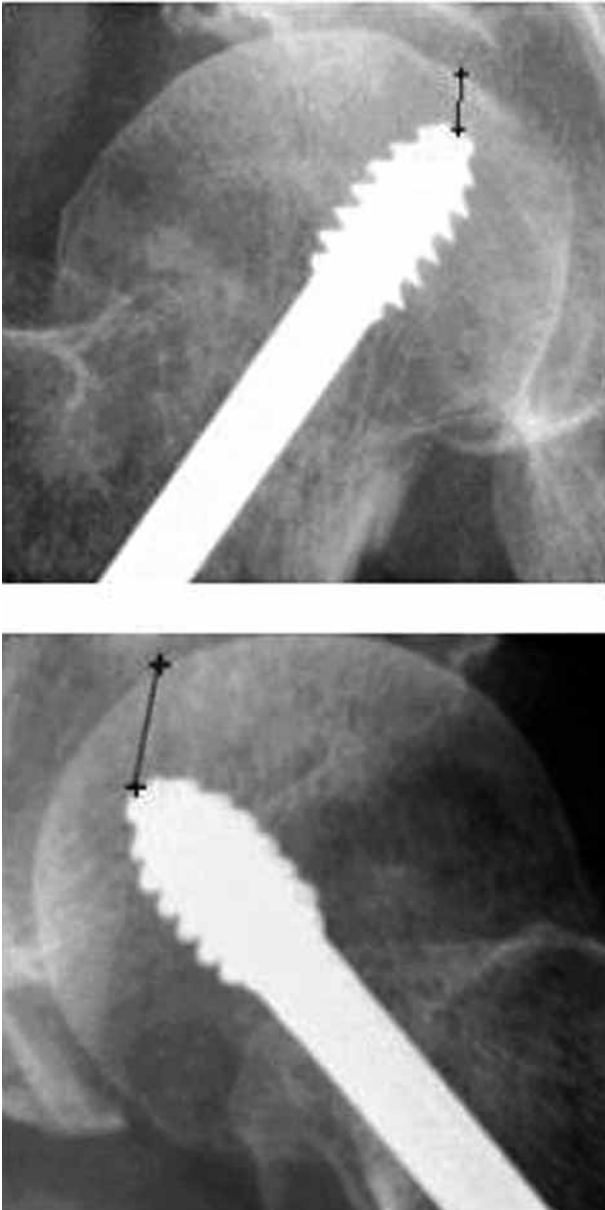


Fig. 1. — Measurement of the distance from the tip of the lag screw to the apex of the femoral head in the AP (top) and lateral (bottom) view in the calculation of TAD.

of how close the tip of the lag screw lies to the femoral apex. Figure 1 demonstrates this concept.

Correction of the radiological measurements for magnification is a simple process. It involves measuring the diameter of the lag screw on the radiograph and comparing this to the actual known

dimension of the implant, to produce a ratio (1). With this ratio, it is possible to correct each measurement for magnification to obtain accurate film readings. Parker has stated that correcting each measurement for magnification is usually not needed in routine clinical practice (6).

Association of TAD with fracture fixation failure

In Baumgaertner's study of 198 patients, the average TAD for successfully treated fractures was 24 mm compared to 38 mm for those in which cut-out of the lag screw had occurred (1). No lag screw had cut out when the TAD was less than 27 mm. Lag-screw cut-out increased to 60% when the TAD was more than 45 mm. Baumgaertner *et al* concluded that screw position as measured by TAD was a strong independent predictor for lag screw cut-out (1). An interpretation of this study has shown that if during hip fracture surgery, the guide pin location yields a TAD of more than 25 mm, the surgeon should reassess the fracture reduction and reposition the guide pin (2).

Pervez *et al* (7) have also conducted a comparative study of TAD between 23 patients whose lag screw cut-out and 77 patients with uneventful fracture healing. TAD was found to significantly differ between patients with cut-out (average TAD = 38 mm) versus those without (average TAD = 24 mm) ($p = 0.001$).

Parker's Ratio Method to measure Implant Placement

Although TAD can be used as a form of assessment of lag screw placement, another method has been studied by Parker (which we have called Parker's ratio method) (6). This method involves recording the superior, inferior, anterior and posterior borders of the femoral head (fig 2). A is considered to be a point on the inferior (in the AP view) and posterior (in the lateral view) border of the femoral head. B is the mid-point of the lag screw. C is considered to be a point on the superior (in the AP view) and anterior (in the lateral view) border of the femur. The distances AB and AC are measured and the position of the centre of the lag

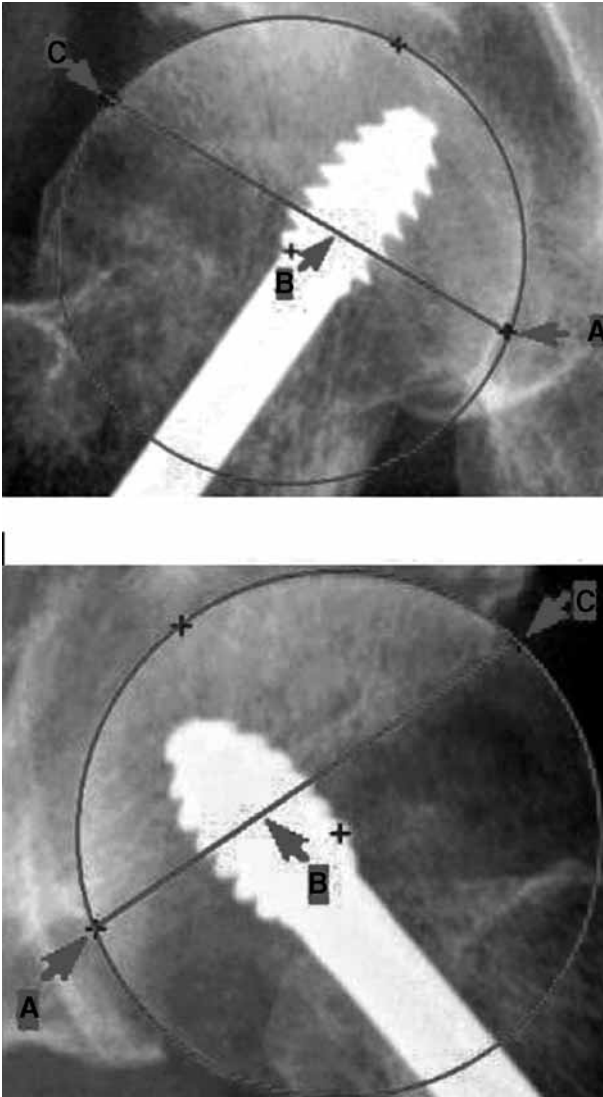


Fig. 2. — Positions of 'A', 'B' and 'C' to determine 'AB' and 'AC' to quantify lag screw position in the AP (top) and lateral (bottom) planes.

screw in relation to the femoral head is calculated by the ratio of AB and AC multiplied by 100.

The ratio is calculated in both the AP and lateral views to give a value within a range of 0 to 100 for each view. In the AP view, 0 is considered to be the most inferior screw placement and 100 is considered to be the most superior pin placement. In the lateral view, 0 is considered to be the most posterior screw placement and 100 is considered to be the most anterior pin placement.

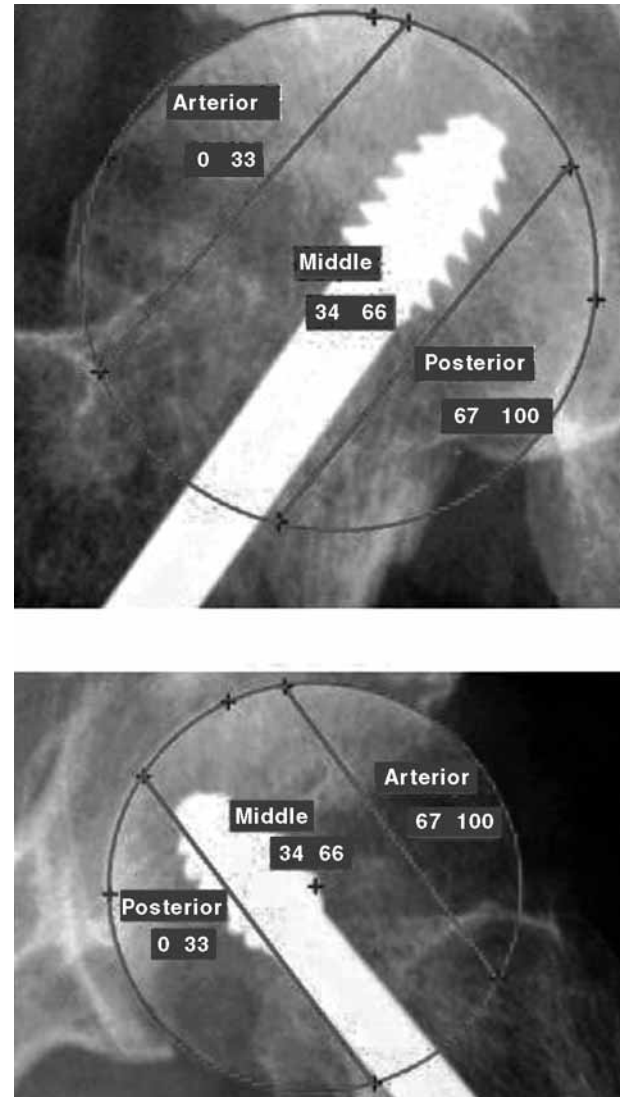


Fig. 3. — Categorising lag screw position in the AP (top) and lateral (bottom) planes.

We modified Parker's method categorising the values into three positions on the AP plane and three positions on the lateral plane (fig 3). On the AP view, the measurements are split into inferior, middle and superior positions of lag screw placement. The inferior portion can be classified as between the values of 0 and 33, the middle portion can be classified as between 34 and 66 and the superior portion can be classified as being within 67 and 100. A similar method can be used for the

Table I. – Summary of studies conducted on lag screw placement in relation to cutting out of the implant

Study author and year	Position(s) concluded to have increased cut-out
Pervez <i>et al</i> , 2004 (7)	<i>Superior, anterior</i>
Gundle <i>et al</i> , 1995 (4)	<i>Superior, posterior</i>
Parker, 1992 (6)	<i>Superior, posterior</i>
Davis <i>et al</i> , 1990 (3)	<i>Posterior</i>
Mainds and Newman, 1989 (5)	<i>Superior</i>

measurements from the lateral view. The posterior portion can be classified as between the values of 0 and 33, the middle portion can be classified as between 34 and 66 and the anterior portion can be classified as being within 67 and 100.

Association of lag screw placement with fracture fixation failure

Parker compared lag screw placement of DHS implants using the above method in those fractures treated successfully (200 cases) with those fractures in which cut-out had occurred (25 cases) (6). On AP radiographs, Parker found that the average position of the screw was 45 for uneventful union and 58 for those in which cut-out had occurred. This difference was found to be statistically significant ($p < 0.001$). On the lateral radiograph measurements, the average position was 45 for uneventful union and 36 for cutting-out. This was also found to be statistically significant ($p = 0.02$). Parker concluded from this study that cutting-out was more frequent when screws were placed more superiorly or posteriorly (6).

Davis *et al* (3) have also conducted a study of femoral screw placement in 230 intertrochanteric femoral fractures treated with either a DHS or a Küntscher Y nail. Davis *et al* (3) found that lag screws placed posteriorly in the femoral head had a significantly higher rate of cut-out than those lag screws placed centrally ($p < 0.001$). These findings were for both the Küntscher Y nail and the sliding hip screw.

Adding to the interest, lag screw placement in the femoral head has been most recently studied by Pervez *et al* (7). In addition to measurements of TAD, Pervez *et al* (7) assessed if there were any significant differences in lag screw position in the femoral head between 23 cases of cut-out compared with 77 cases of uneventful fracture healing. Their methodology to determine lag screw position was by Parker's Ratio Method. An increased occurrence of cut-out was associated with superiorly or anteriorly placed screws.

The above studies, summarised in table I, suggest strong evidence that inappropriate screw placement is associated with increased cut-out which could subsequently lead to implant failure. The general trend is that cut-out is associated with superior screw placement on the AP radiograph or peripheral placement of the lag screw (both anterior and posterior) on the lateral radiograph. Screw placement is therefore favoured towards aiming the lag screw centrally or inferiorly on the AP view and centrally on the lateral view (6).

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