Quantitative anatomic characterisation of the pelvic brim to facilitate internal fixation through an anterior approach

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ABSTRACT

Purpose. To define the centre of the hip joint and the bone stock around the hip joint from the supraacetabular portion or pelvic brim so as to avoid penetration of guidewire into the hip joint when performing internal fixation using the anterior approach.

Methods. A total of 42 cadavers were utilised. Measurements were completed before and after cutting the pelvis into 4 pieces. Before cutting the pelvis, the centre of the hip joint was measured on the pelvic brim. After cutting the pelvis, the bone stock around the hip joint was measured in each section. The pelvic brim and the anteroinferior iliac spine were utilised as guide points in the measurements, because these parameters could be determined during an anterior surgical procedure.

Results. On the pelvic brim, the reflected centre of the hip joint centre was located approximately 3.2 mm anterior to the distal edge of the anteroinferior iliac spine. The mean minimum bone stock of the pelvic brim was 14.0 mm in the centre of the hip joint section.

Conclusion. This study described the anatomical reference points around the hip joint, and the ways in which they can be utilised to increase the safety of the anterior approach for internal fixation. It is important to define the centre of the hip joint from the supraacetabular portion or pelvic brim, given that it is not visualised during surgery using an anterior approach.

Key words: fracture fixation, internal; hip joint

INTRODUCTION

The anterior approach to performing fixation of the pelvis was developed predominantly to treat anterior column and anterior wall fractures of the pelvis. This intrapelvic anterior approach made exposure of the inner surface of the pelvis from the sacroiliac joint to the pubic symphysis possible, and several reports providing evidence of its clinical utility have been
However, direct visualisation of the hip joint is impossible using this approach, and careful attention is required when the guidewire is inserted around the hip joint.

The purpose of this cadaveric study was to estimate the reflected point of the centre of the hip joint on the pelvic brim, and the area of bone stock around the hip joint from the intrapelvic aspect, in order to reduce the risk of intra-articular penetration of a guidewire during surgery.

METHODS

A total of 42 hemipelves, from 22 male and 20 female cadavers, were utilised in this study. Cadavers that showed obvious bony deformities were excluded. Each hemipelvis was resected in the sagittal plane. The femur was removed so that the entire acetabular surface could be viewed. The diameter of each femoral head was measured, and an acetabular cup of the same diameter was selected for trial. The mean diameter of the femoral head was 46.1 mm (range, 40–52 mm).

The acetabular cup was placed on the acetabulum such that its orifice was parallel to the quadrilateral surface. After placing the acetabular cup in this position, a 1.5 mm K-wire was inserted from the top hole of the trial cup with the drill guide, and the wire inserted vertically through to the quadrilateral surface (Fig. 1). We utilised the outlet of the K-wire as a guidepoint for the centre of the hip joint, and measured the diameter line parallel to the pelvic brim on the quadrilateral surface. The diameter line was divided into quarters. The dividing points, including the centre of the hip joint (the outlet of the K-wire), were marked on the line. Three perpendicular lines from these dividing points and 2 extra-perpendicular lines, one from the anterior and the other from the posterior margin of the hip to the pelvic brim, were measured. These 5 lines were extended to the supra-acetabular portion. The first 3 perpendicular lines were utilised as pelvic cut lines in this study (Fig. 2). A perpendicular line from the distal edge of the anteroinferior iliac spine to the pelvic brim was also drawn. We defined the points of intersection of the perpendicular lines described above and the pelvic brim as reflected points, which were used for measurements taken before and after cutting the pelvis. The distance from the reflected point of the distal edge of the anteroinferior iliac spine to the reflected points of the centre of the hip joint was measured before cutting the pelvis (Fig. 3), and after cutting (Fig. 4). The minimum bone stock from the pelvic brim to the margin of the hip joint was also measured before and after cutting the pelvis. The thickness of the articular cartilage was disregarded in the measurements. The results were analysed statistically, by Student’s t test, to determine the differences in the measurements between males and females.
RESULTS

The results of the measurements are shown in the Table. The schema illustrating each measurement is shown in Fig. 5. The reflected point of the centre of the hip joint was 3.2±3.3 mm anterior to the reflected point of the distal edge of the anteroinferior iliac spine on the pelvic brim. The minimum bone stock from the pelvic brim to the margin of the hip joint was 14.0±3.6 mm in the cross-section passing through the centre of the hip joint (i.e. section 2), and this section had smaller measurement than the other 2 sections i.e. 18.5±4.6 mm in posterior (i.e. section 1), and 17.2±3.5 mm in anterior half of the hip joint (i.e. section 3). There were no statistically significant differences between measurements from males and those from females.

DISCUSSION

When performing fixation of the pelvis around the hip joint through an anterior approach, direct visualisation of the hip joint is impossible. It is sometimes also difficult to confirm the location of the guidewire using an image intensifier. One method of confirming the extra-articular placement of the guidewire is to move the hip joint through a full range of motion and to verify that there is no palpable or audible joint crepitus.2,6
Although screw penetration of the hip joint after fixation of the pelvis is a relatively uncommon complication during the procedure,\(^7\) the hazard of guidewire penetration remains a concern. Such penetration might be a cause of future chondrolysis or osteoarthritis. Previous reports have described the anatomical information needed for screw fixation.\(^7,8\) Further, basic instructions for screw fixation have been provided in the report by Letournel and Judet.\(^1,2\) The purpose of this cadaveric study was to measure the bone stock around the hip joint precisely, in order to provide anatomical information useful to aid safe insertion of the guidewire.

The technical reason why perpendicular lines were selected for each measurement was that, the right angle to the curved pelvic brim appeared to be the most appropriate in relation to the surgical procedure. Utilising these perpendicular lines, the location of the hip joint could be reflected on the pelvic brim if the guidewire was inserted vertically to the pelvic brim. Dividing the diameter line of the hip joint into quarters also had a technical purpose. If the pelvis had been resected into a greater number of smaller pieces, it would have been possible to obtain more detailed measurements. However, this would constitute complex anatomical information that would ultimately prove of no use during the surgical procedure.

The mean minimum bone stock from the pelvic brim to the margin of the hip joint was 14.0 mm, and was the smallest at the pelvic cut plane passing through the centre of the hip joint. The data are useful for determining the appropriate length of guidewire to insert in this area.\(^2\) Differences between males and females in anatomical morphology must also be considered. Because these differences did not significantly influence the measurements (\(p>0.05\)), the data from this study appear to be applicable to both males and females.

Almost all cases of anterior column and anterior wall fractures of the pelvis are caused by high-energy trauma. The classification of the fracture is complex and the fracture line can be located in any area of the pelvis. Sometimes fracture lines are complex, and screw insertion around the hip joint is necessary to achieve stable reconstruction and fixation. The authors believe that the results of this study provide useful anatomical data for the safe insertion of a guidewire in the hip joint, using an anterior approach.

### REFERENCES