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Percutaneous screw placement in acetabular posterior column surgery: Gender differences in implant positioning

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ABSTRACT

Percutaneous reduction and periarticular screw implantation techniques have been successfully introduced in acetabular surgery. Image guided navigation techniques might be beneficial in increasing accuracy. However, a thorough understanding of standard values is needed to oversee pitfalls. This cadaver study was designed to identify reliable angulation values for screw implantation in the posterior acetabular column and to provide knowledge of the bony thickness for the periarticular corridor. Gender differences were specifically addressed.

27 embalmed cadaveric hemipelvic specimens (13 male, 14 female) were used. After soft-tissue removal posterior column acetabular screw placement was conducted by one experienced orthopaedic trauma surgeon under visibility. Radiographic verification of ideal screw placement was followed by radiographic assessment in three standard views and angulation values were assessed. Through bony dissection the maximal periarticular canal width was assessed.

Various angulation values with regard to anatomical landmarks could be determined in the anteroposterior radiograph, as well as in the iliac oblique and the obturator oblique view. Gender differences were significant for all reference points with the pubic rami involved. The minimal canal width was 1.1 cm in female and 1.6 cm in male specimen.

The findings provide standard values for safe passages in percutaneous posterior column acetabular surgery. Gender differences have to be taken in consideration when planning the drill corridor. By adherence to standard values, screw placement can be performed safely.

Introduction

While open reduction and internal fixation is the standard treatment for most displaced acetabular fractures [1], special indications might allow for percutaneous fixation [2,3]. These are mostly non- or minimally displaced fractures [4,5]. As dissection is limited, the risk of soft tissue complications is decreased. Therefore, elderly patients or polytraumatised patients, without recovery capacities from extensive open approaches, take advantages from these techniques [3,6,7]. Image guided navigation systems might be an advancement in this regard, allowing highly accurate implant placement [8].

However, these technically demanding procedures need a thorough understanding of the underlying anatomical structures to oversee pitfalls. Narrow safe bony corridors implicate a risk of neurovascular or articular damage [9]. Gender differences of morphologic values of the acetabular region are evident, as shown earlier by our study group [10]. Despite this fact numerous studies fail to address this clinical relevant issue.

To our knowledge, there are no studies in the English literature that measure the inclination for posterior column screw fixation with special regard of gender differences and with the use of conventional radiographic outcome parameter.

Methods

This is an Institutional Review Board-exempt study of 27 embalmed cadaveric hemipelvic specimens (13 male, 14 female, age not determinable). Specimens were obtained for the study in accordance with the rules and regulations of the University of Medicine, Regensburg. A standard embalmment process with

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internal application of formaldehyde, phenol, glycerine and alcohol, followed by a nine month long external application of glycerin and phenol was conducted. Prior to the main experiments the specimens were dissected free of the overlying soft tissues and the hip joints were exarticulated. The remaining bony and ligamentous structures were checked for integrity before each experiment. After soft tissue dissection all specimens showed intact bony and ligamentous structures. No signs of former fracture healing or obvious pathologies of the bone were seen.

Using a 2.5 mm × 200 mm drill bit, a drill-hole was made and one cannulated 6.5 mm lag screw was placed in the posterior column under visibility by one experienced orthopaedic trauma surgeon. Retrograde entry site was used as described by Starr et al. [11,12], within the centre of the inferior surface of the ischial tuberosity. After drilling along the centre of the posterior column, it exited in the iliac fossa.

Screw placement was possible in all pelvises. No iatrogenic fracture was induced. Optimal screw placement was achieved using direct visualisation and then immediately afterwards validated using C-arm image-intensified fluoroscopic imaging. Each specimen was therefore positioned on a radiolucent table and anteroposterior, iliac oblique, and obturator oblique views were obtained. No violation of articular joint surface was tolerated. The cortex was only penetrated at the antegrade and retrograde entry points.

Three standard radiographic views were obtained and different angulation measurements were assessed in relation to numerous via radiographic identifiable anatomical structures. Afterwards the posterior wall dimensions were measured at height of the greater sciatic notch. Therefore specimens were cut into 1 cm sections and different measurements were obtained: The distances between the screw holes and numerous bony landmarks were assessed. Additionally five areas were defined as shown in Fig. 1.

Statistical analysis was performed using the descriptive methods of SPSS v.19 for Windows (SPSS Inc., Chicago, IL). The Mann–Whitney U test was used to evaluate gender-specific differences in measured parameters. Results were considered to be significant when the p value was <0.05.

Results

Screw placement into the posterior column was possible in all pelves. No iatrogenic fracture was induced during experiments.

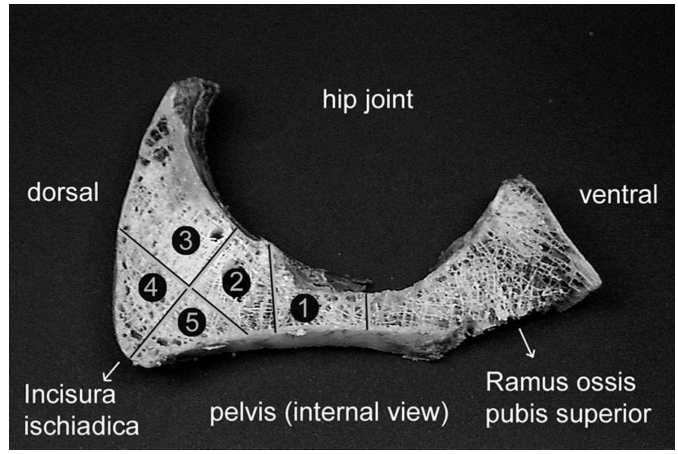

Fig. 1. A section through the hip joint to analyse the bony structure and the position of the screw. Five bony areas were defined. One line was drawn between the bony borders of the greater ischiadic notch and the articular surface and divided area 3 and 4 from 2 and 5. A perpendicular line to this divided area 3 from 4 and 2 from 5. A perpendicular line from the facies lunata to the medial side divided area 1 from 2.

Inclination angles with regard to the different anatomical landmarks are described in detail in Tables 1–3. Each table presents data from one of the three standard radiographic views (anterior–posterior, iliac oblique and obturator view). Values showed only minor differences between genders. Involvement of the pubic rami lead more often to significant differences between male and female specimens.

There were significant differences between gender when analysing the bony corridor as well as the distances between drill hole and bony borders (Tables 4 and 5).

71% of the drill holes were located in area 1 or 2, 29% in areas 4 or 5. Area 3 was never involved in our specimens (Fig. 1).

Discussion

Percutaneous stabilisation of acetabular fractures is a technically demanding procedure. Indication spectrum are non- or mild displaced fractures, but even displaced fractures have been addressed without the need for extensile approaches [2].

Image-guided techniques are spreading and promise a highly accurate placement of implants into the narrow bony corridors in

Table 1
Different angulation measurements visible on ap radiograph.

Angle between posterior column screw and…	Male specimen Mean [°] (Range) standard deviation	Female specimen	p
…tangent to pubic tubercle (108)[a]	33.1 (24.5–49.6) 9.05	32.6 (22.7–43.0) 7.75	0.886
…vertical plane (109)[a]	13.0 (10.0–19.0) 3.10	11.7 (8.0–17.4) 3.42	0.346
…horizontal plane (110)[a]	77.0 (71.0–80.0) 3.10	78.3 (72.6–82.0) 3.42	0.346
…caudal border of superior pubic ramus (111a)[a]	68.3 (55.0–94.7) 14.38	67.6 (53.5–92.5) 15.48	0.667
…tangent to acetabular rim (112)[a]	22.6 (20.0–27.0) 3.20	21.9 (15.0–28.5) 4.38	0.667
…linea ilioischiadica (116)[a]	2.4 (0.0–5.0) 1.83	2.6 (0.0–5.7) 1.77	0.720

[a] See also Fig. 3 for description.
[b] Significant values.