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The "Down the PC" view – A new tool to assess screw positioning in the posterior column of the acetabulum

G. Osterhoff *, S. Amiri, F. Unno, A. Dodd, P. Guy, P.J. O'Brien, K.A. Lefaivre

Department of Orthopaedics, Division of Orthopaedic Trauma, University of British Columbia, 3114 – 910 West 10th Avenue, Vancouver, British Columbia V5Z 1M9, Canada

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ABSTRACT

Introduction: Minimal-invasive placement of screws into the posterior column of the acetabulum (PC) is challenging. Due to the saddle-shaped curvature of the medial cortical border of the PC, the standard fluoroscopic views of the pelvis cannot provide the desired safety during screw insertion. The aim of this study was to define a view tangentially to the medial cortex of the PC and to evaluate its accuracy and inter-observer reproducibility.

Methods: Radio-dense markers on the medial cortex of the PC along the axis of a PC screw were brought in line and landmarks of the new "Down the PC" view were determined. Kirschner wires were placed into the PC of a pelvis composite model and five pelvic cadaver specimens in a total of 34 different correct and incorrect positions. Based on either only the "Down the PC" view, only the standard views, or a combination of both, three fellowship-trained orthopaedic surgeons had to decide if the inserted wires were in bone in the posterior column or had exited cortex, and if they penetrated the acetabulum. Sensitivity, specificity, and the intra-class correlation coefficient were calculated.

Results: A view using three radiographic landmarks (pelvic brim, medial cortical wall of the body of the ischium, ischial spine) was found. Sensitivity and specificity to detect perforation out of the bone were 1.00 and 0.97 for the "Down the PC" view, 0.46 and 0.97 if only the standard views were used, and 1.00 and 0.95 for a combination of both. Sensitivity and specificity to detect intra-articular wire placement were 1.00 and 0.96 for the "Down the PC" view, 0.72 and 0.95 if only the standard views were used, and 0.94 and 0.99 for a combination of both. Inter-observer agreement using only the "Down the PC" view was excellent with an ICC of 0.92 for perforation and ICC of 0.82 for intra-articular wire placement.

Conclusions: The "Down the PC" view is a useful addendum in the orthopaedic trauma surgeon's tool box. Using simple landmarks, it is easily to reproduce and thereby shows excellent accuracy and inter-observer agreement in order to detect medial perforation or intra-articular implant position.

Introduction

Limited open reduction and percutaneous screw fixation of acetabular fractures has been well described [1–4]. However, placement of screws into the posterior column of the acetabulum (PC) remains challenging. The bony corridor is narrow and in close vicinity to the hip joint and to neurovascular and visceral structures [5,6]. Due to the characteristic hyperbolic paraboloid (saddle-shaped) curvature of the medial cortical border of the PC, the standard intraoperative fluoroscopic antero-posterior, iliac oblique and obturator oblique views of the pelvis cannot provide the desired safety during screw insertion [7]. Although the literature reports averaged angles for potential fluoroscopic views along the medial cortical border of the PC of the acetabulum [8], these angles might not resemble the anatomy in the actual patient undergoing surgery and they are prone to errors secondary to positioning on the operating table.

The aim of this study was to (1) define the optimal view tangentially to the medial cortex of the PC, to (2) determine the radiographic landmarks that enable the surgeon to easily reproduce the view during an intervention, and to (3) evaluate the accuracy and inter-observer reproducibility of the use of the view in placement of fixation in the posterior column.

* Corresponding author. Tel.: +1 604 875 5239; fax: +1 604 875 5812.
E-mail address: g.osterhoff@gmx.de (G. Osterhoff).

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Methods

The study was approved by the institutional review board (University of British Columbia, CREB H15-00387).

Radio-dense markers were applied onto the medial cortex of the PC of a pelvis composite model along the axis of a standard PC screw. These markers were brought in line under fluoroscopy in order to produce a radiographic "Down the PC" view along the medial cortex of the PC parallel to the desired axis of a PC screw. Easy identifiable and reproducible bony landmarks of this "Down the PC" view were identified.

Kirschner wires were placed into the PC of a pelvis composite model and five pelvic cadaver specimens that were planned to be used for a different biomechanical study performed at our institution. The wires were placed in a total of 34 different correct (wire placed in the posterior column) and incorrect positions (i.e. either tip out of bone or wire perforates joint or both). Fluoroscopic "Down the PC", antero-posterior, iliac oblique and obturator oblique views were taken of each wire position. Based on either only the "Down the PC" view, only the standard views, or a combination of both, three fellowship-trained orthopaedic surgeons had to decide if the inserted wires perforated through the bony borders of the posterior column ("tip in bone?"), and if they penetrated the acetabulum ("wire in joint?").

The observers were blinded for the true wire position (as photographically documented during wire insertion and fluoroscopy by the first author) and started rating 34 "Down the PC" views. They then rated 34 combinations of the antero-posterior, the iliac and the obturator oblique (standard) view first alone and then in combination with the corresponding "Down the PC" view. Therefore, each of the three mentioned views or combination of views was rated for each wire position by each of the three observers resulting in 102 observations per observer and a total number of 306 observations.

Statistical analysis

Sensitivity and specificity and 95% confidence intervals (CI) were determined for the "Down the PC" view alone, the standard views alone, and the combination of both (Excel 2007, Office, Microsoft, Redmond, WA, USA).

The intra-class correlation coefficients (ICC) and 95% CIs (two-way mixed, single measure, absolute agreement) were calculated to assess inter-observer agreement with regard to wire "perforation through the bony borders of the posterior column" and "penetration of the joint" (SPSS for Windows 22.0, IBM, Chicago, IL, USA).

Results

"Down the PC" view

A view that is easily to reproduce using three radiographic landmarks (pelvic brim, medial cortical wall of the body of the ischium, ischial spine) was developed (Figs. 1 and 2).

Starting from a standard "pelvic inlet" or even a "Down the iliac wing" position, the C-arm is further rotated over the patient towards the side of the affected hemipelvis until the pelvic brim and the medial cortical wall of the body of the ischium are brought in line. Then the C-arm is tilted further towards the patient's head until the ischial spine is aligned under the body of the ischium. In some cases, repeat alignment of the pelvic brim and the medial border of the ischium might be necessary after tilting the C-arm in order to shoot along the medial cortical wall of the PC.

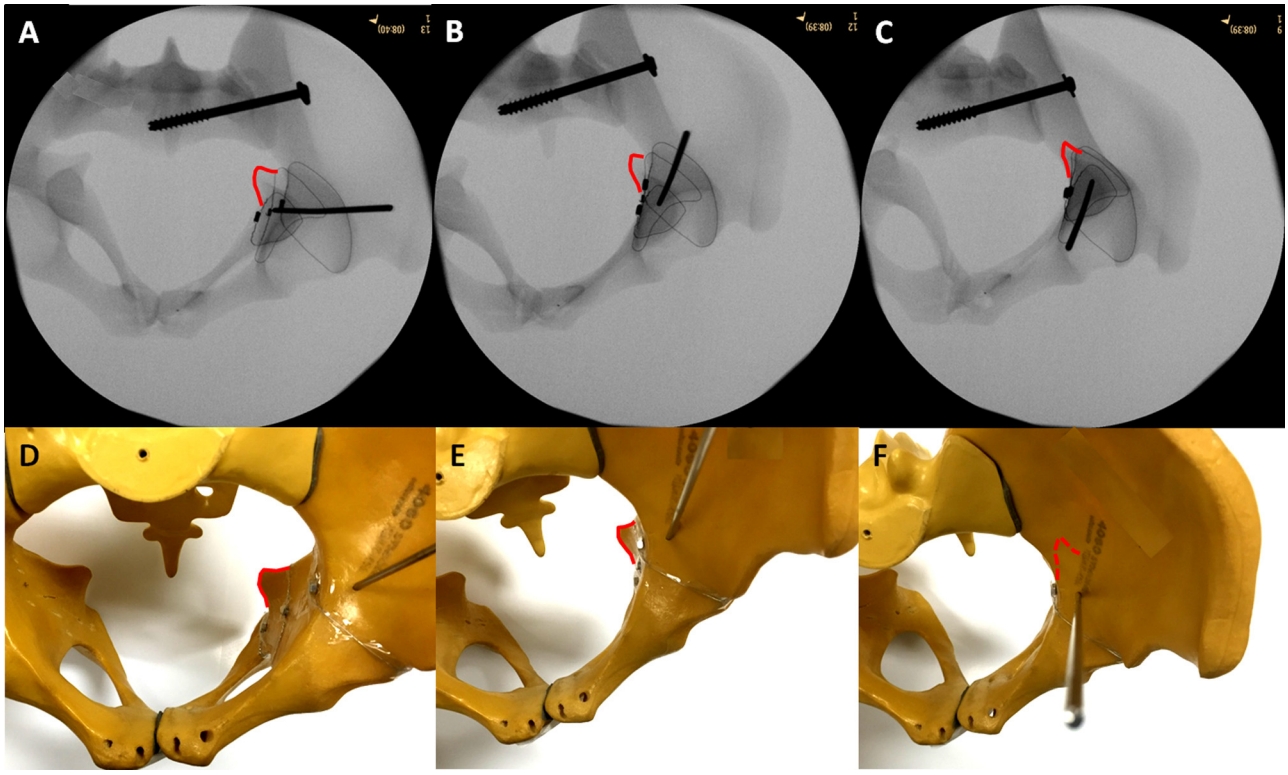

Fig. 1. The "Down the PC" view. Starting from a combined standard "pelvic inlet" position (A+D), the C-arm is further rotated over the patient towards the side of the affected hemipelvis until the pelvic brim and the medial cortical wall of the body of the ischium are brought in line (B+E). Then the C-arm is tilted further towards the patient's head until the ischial spine is centred under the body of the ischium (C+F). The red lines represent the ischial spine. Note how it is positioned under the body of the ischium in the "Down the PC" view. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)