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Ultrasound-guided supra-acetabular pin placement in pelvic external fixation: description of a surgical technique and results

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KEYWORDS

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ABSTRACT

Introduction: Pelvic fracture in trauma patients can lead to hemodynamic instability. External fixation is a treatment capable of stabilizing these injuries in the context of damage control surgery. Supra-acetabular pin offers the greater biomechanical stability but requires the use of intraoperative fluoroscopy. The aim of this study was to analyze our results for an ultrasound-guided supra-acetabular pinning.
Material and methods: Cross-sectional study with cadaveric specimens. Ultrasound-guided pin placement assessed by fluoroscopy and dissection.
Results: Fourteen ultrasound-guided supra-acetabular pins were placed in seven cadaveric specimens. Excellent placement in all cases, evaluated with radiological control. Good qualitative bone fixation after dissection. One femoral cutaneous nerve was not found during anatomic dissection and was assumed injured.
Conclusion: Ultrasound-guided supra-acetabular pin placement is a feasible and effective technique. Our study indicates that pin placement without intraoperative fluoroscopy is feasible without compromising the reliability of its placement.

Introduction

Pelvic ring injuries represent 1–3% of all skeletal fractures [1]; however, only 13% are isolated injuries [2]. Despite the progress in the treatment of these injuries, mortality rates range from 5% to 60% [3]. Many of these fractures are usually sustained in severely multiple injured patients, who are in an “unstable” or “in extremis” clinical condition, where damage control orthopedics is the current gold standard [4]. Urgent pelvic external fixation has become an integral part of the early resuscitation protocol, increasing hemodynamic stability and significantly reducing mortality rates [5]. Pelvic external fixators allow two locations of pin purchase: the iliac crest and the supra-acetabular region. Currently, the supra-acetabular technique is considered the most suitable option [6] because: (1) biomechanically, the anterior inferior iliac spine (AIIS) is a more stable location for inserting bone pins [7]; (2) it allows for reducing the pelvis in the transverse plane of the deformity; (3) it facilitates concurrent or subsequent laparotomy procedures; and (4) it may allow for performing an improved reduction of the posterior elements with a femoral distractor as a compressor [6].

The technique for a supra-acetabular external fixation has been previously described [8]. Optimally positioned supra-acetabular pins should provide maximal frame stability, patient comfort, hip mobility, and avoid obstructing potential internal fixation osseous pathways [5]. Nevertheless, the technique requires fluoroscopical guidance for avoiding malposition of the supra-acetabular pins (e.g. intracapsularly), exposing patients and surgical teams to radiation [9], using expensive resources, and spinning-out the surgical time.

The aim of this study is to describe an ultrasound-guided technique for supra-acetabular half-pin placement as an alternative surgical procedure.

Material and methods

A cross-sectional study was conducted in cadaveric pelvises, fresh–frozen or preserved using Thiel’s method [10]. The specimens were provided by medical schools in our city between January 1, 2015 and June 1, 2015. We excluded all pelvises with previous surgeries involving the supra-acetabular area, pelvises without intact muscles and viscerae or known pathological changes in the pelvic region.

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Surgical technique

The specimen was placed supine on an operating table [11]. The entire abdomen and bilateral flanks were draped. The antero-superior iliac spine (ASIS) was located by digital palpation. The transducer M-Turbo® ultrasound system. 15 MHz linear probe (Sonosite®; Fujifilm®, Minato, Tokyo, Japan) was positioned parallel to the innominate line to obtain a sagittal view (Figures 1 and 2), and perpendicular to the innominate line to obtain a coronal view of the antero-inferior iliac spine (AIIS) (Figures 3 and 4).

In a coronal view, the transducer was placed at the ASIS and carried distally until locating the anterior inferior iliac spine (AIIS). Once the AIIS was located, its position was marked with a 22 G 1/2 needle.

In a sagittal view, we established the point of entry of our pin at the AIIS tip and marked its position with the needle. A 10 mm transverse skin incision was then made with a surgical scalpel blade (No. 24) at the needle's site (Figure 5). Using a mosquito forceps, deep blunt dissection was then carried down in longitudinal direction to the ASIS. Under a sagittal view, a 6 mm pin (180 × 6 mm self-drilling pin. Hoffman® II external fixation system (Stryker®; Kalamazoo, MI, USA) was guided for inserting it immediately distal to the AIIS tip. The pin position was confirmed under ultrasound in both planes (Figures 6 and 7), and the distance from the acetabular edge was measured, modifying its position if it was under 20 mm [12]. Although not essential, visualization of the femoral head is helpful for keeping oriented in space during the procedure. The 6 mm pin was then introduced, with a 20° medial inclination in the transverse plane and a 70–80° cephalad inclination in the sagittal plane until the desired pin purchase was obtained [13] (Figures 8 and 9). The pin was slowly inserted in the supraacetabular region between the medial and lateral cortical bone, which enhanced its purchase.

The same steps were repeated for inserting a pin in the opposite hemipelvis. After both hemipelvis were pinned, the external fixator was assembled using clamps and a connecting bar. The reduction can be achieved by manual compression or using pins as manipulation devices prior to definitive frame assembly.

Variables and outcomes

We studied our success for positioning the pins and the safety of the technique. After pin placement, a double evaluation was performed: an indirect evaluation under fluoroscopic vision, and a direct evaluation after the anatomical dissection.

In the indirect evaluation, success was defined as placing the pin in the supra-acetabular bone inside the radiological "teepee" limits described by Gardner and Nork [6]. In order to obtain the tepee view, the image intensifier was positioned to acquire an outlet hemipelvis view and then turned to an obturator oblique view towards the desired side, positioning the beam 30° cephalad and 20° medial. Both left and right hemipelvises were examined in this manner.

In the direct evaluation, an anterior approach to the hip (Smith-Petersen) [11] was performed. Success was defined by placing the bone pin fully and strictly into the AIIS. Partial pin placement outside the AIIS was considered unsuccessful. The lateral femoral cutaneous nerve (LFCN) was identified, defining safety as the absence of any damage to the LFCN injury. An absence of LFCN visualization during the anatomical dissection was considered as a damaged nerve.

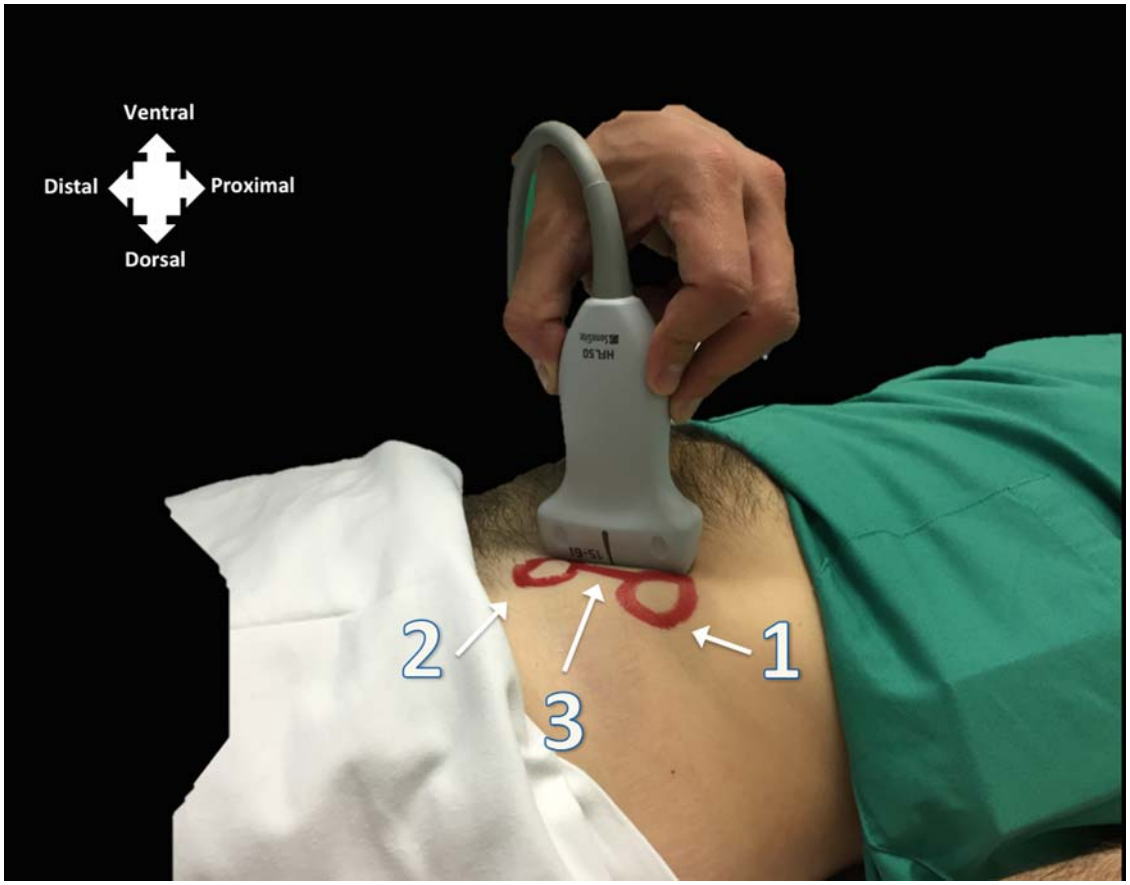

Fig. 1. The transducer is placed parallel to the innominate line to obtain a sagittal view. (1) Antero-superior iliac spine (ASIS). (2) Antero-inferior iliac spine (AIIS). (3) Innominate line.