

Percutaneous screw insertion using a navigation system for acetabular fractures: case report

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SUMMARY

Percutaneous screw fixation is a surgical procedure that is increasingly used in pelvic and acetabular fractures which reduces the complications that often happen during open reduction and internal fixation. Despite this, it requires experience, surgical accuracy, a long operation time, and substantial radiation exposure to patient and doctors. The purpose of this case report is to analyze a new fluoroscopic computer-assisted navigation system applied to acetabular fractures that can significantly reduce radiation exposure and shorten the operative time.

Key words: pelvic fracture, acetabular fracture, percutaneous fixation, navigation

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Introduction

Acetabular fractures are often treated in open reduction and internal fixation. This technique has several complications, such as neurovascular lesions ¹, infections ², bleeding ³, and heterotopic calcifications ⁴. Percutaneous screw fixation is a surgical procedure that is increasingly used in pelvic and acetabular fractures which reduces the incidence of these complications ⁵; however, it requires experience and great surgical precision ^{6,7}. Furthermore, this procedure often requires long surgical times and exposes patients and doctors to large quantities of radiation for. The advent of computer-assisted navigation is progressing in the orthopedic and trauma fields. This system may increase the accuracy of screw fixation, while reducing surgical times and exposure to ionizing radiation ⁸.

Indications

Percutaneous fixation can be used in different cases, such as unstable injuries of the pelvic ring to prevent important soft tissue damage, but only if performed within the first five days after injury ⁹ and only after an accurate reduction of the fracture. Percutaneous fixation is a surgical option also in minimally-displaced acetabular fractures, anterior-column fractures, posterior hemitransverse fractures of the anterior column or vertical fractures of the ilium ⁶. In younger

patients the technique should be limited to simple patterns of fracture, which can sometimes be reduced by using closed or limited open methods. Fractures of the posterior wall of the acetabulum are rarely amenable to percutaneous reduction and fixation¹⁰. Application of computer-assisted navigation in percutaneous screw fixation for pelvic and acetabular fractures has demonstrated high accuracy of screw placement compared with a CT-based preoperative plan¹¹. A cadaveric study on percutaneous iliosacral screw placement by orthopedic trainees using intraoperative fluoroscopic navigation coupled with a CT-based preoperative plan showed that navigation has significantly increased accuracy, fewer Kirshner wire insertions, and less radiation time¹².

Case presentation

A 65-year-old man presented to the emergency room after a fall from a height of 1.5 meters. Clinically he presents pain on palpation of the left hemipelvis and functional impotence. The radiographs and CT performed show a minimally-displaced transverse fracture of the left acetabulum (Fig. 1). In order to allow early loading, retrograde percutaneous branch screw surgery was performed with the ATLAS navigation system.

Instruments required

The ATLAS navigation system is equipped with a patient sensor base, a navigable guide wire, a cannula sensor, an infrared viewer, a workstation, and a navigation system that can be attached to a normal C-arm. Furthermore, for the percutaneous screw fixation a drill and a cannulated screw of 6.5 mm are needed.

Surgical technique

Under general anesthesia and supine decubitus, after having implanted the patient sensor on the ipsilateral iliac crest, two radiographic projections were performed, inlet and obturator outlet¹³, acquired by the navigated system. An incision of approximately 1 cm was made centered on the ipsilateral pubic tubercle and a guide wire was inserted with the aid of the navigated system, visualizing its progression simultaneously on the two acquired projections (Fig. 2). Next, the mode for viewing the progression of the drill and calculating the length of the screw was selected from the workstation (Fig. 3). At the end, a partially threaded cannulated screw with washer was inserted through the implanted guide wire (Fig. 4).

Discussion

In the literature, the use of three-dimensional-guided and 2D-fluoroscopic navigation systems for fragility fractures of the pelvis¹⁴, for nondisplaced and displaced pelvi-acetabular fractures¹¹⁻²⁰, and for sacroiliac fractures^{15,16,22} has been reported. However, the amounts of radiation for the patient with

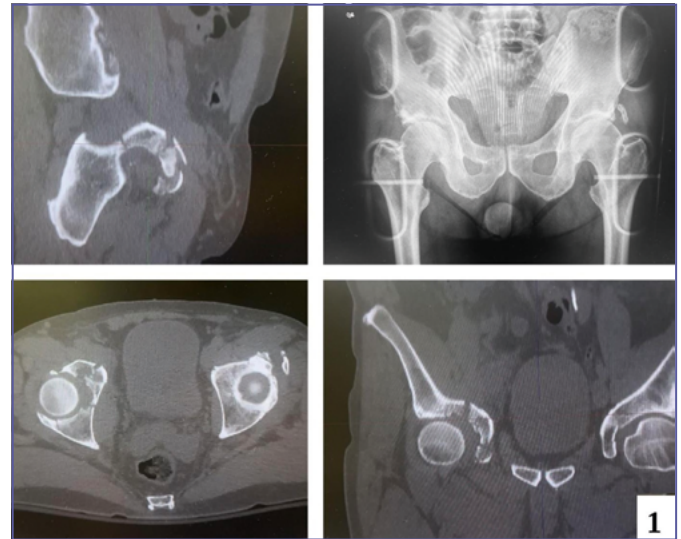


Figure 1. Pre-operative images.

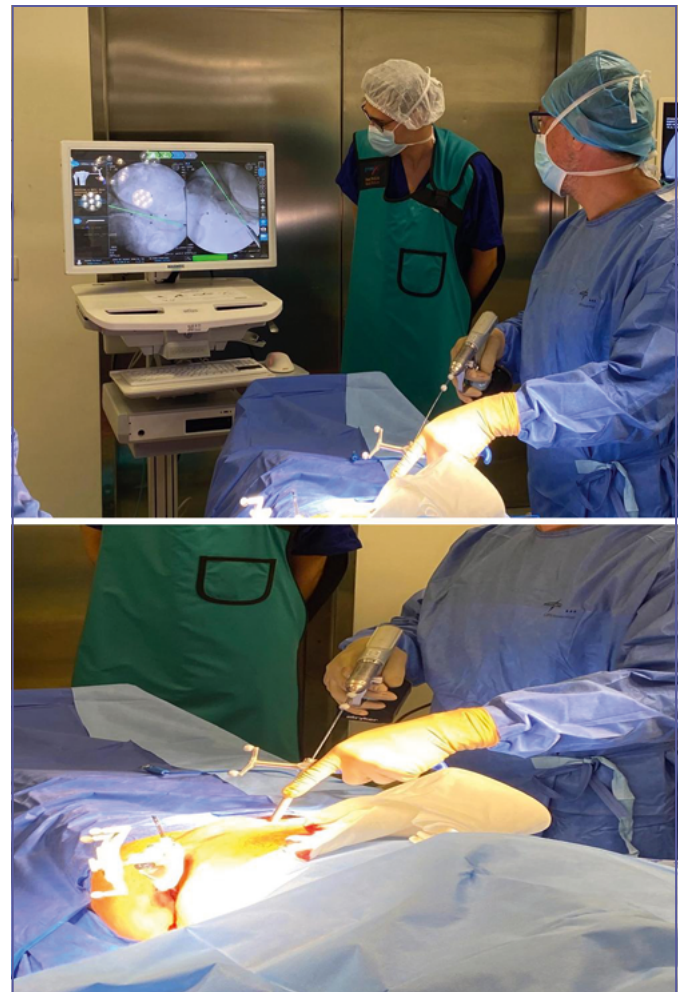


Figure 2. Guide wire insertion.

a three-dimensional-guided navigation system are higher than during traditional fluoroscopy¹⁷⁻²⁴. Mouhsine et al.¹⁸ reported a mean fluoroscopic time of 62 sec in percutaneous screwing by traditional fluoroscopy. Crowl and Kahler¹⁹ reported an average of 73 sec of fluoroscopy in percutaneous screw fixation of anterior column acetabular fractures with fluoroscopy only, and the time decreased to less than 45 sec with a fluoroscopic computer-assisted image. Yu-Chuan Lin et al.²⁰ used a fluoroscopic-based computerized navigation system and have reported that the fluoroscopic time decreased to less than 45 sec. In our case, we used fluoroscopic-based computerized navigation and the radiation exposure was significantly shorter than traditional percutaneous screwing and three-dimensional-guided navigation systems, with a quantity of X-rays equal to 26 sec of exposure and 154.44 cGy/cm².

Since the surgical exposure is limited and the screwing corridor is very narrow, good pre-operative planning is necessary. A clinical study reported that the screw implant malposition rate under fluoroscopic guidance alone was 16.7%²¹. Zwingmann et al.²² demonstrated that computer-navigated ileosacral screw insertion shows a better screw position and fewer malpositioned screws. Application of computer-assisted navigation in percutaneous screw fixation for pelvic and acetabular fractures has demonstrated high accuracy of screw placement compared with a preoperative plan¹¹. A cadaveric study on percutaneous iliosacral screw placement by orthopedic trainees using intraoperative fluoroscopic navigation showed that navigation uses significantly increased accuracy, fewer Kirshner wire insertions, and decreased radiation time¹². In our case we used a two-dimensional-guided navigation system connected to a traditional C-arm that allowed accurate and simultaneous visualization of the guide wire and drill in the acquired fluoroscopic projections. However, for accurate and precise visualization of the trajectory, the patient sensor must be fixed and well anchored throughout the operation.

Starr et al.²³ reported a mean operative time of 75 min in percutaneous screwing of displaced fracture of the acetabulum. In our case, the surgical time was 60 minutes including image acquisition, surgical planning, guidewire insertion, and screw implantation. The guidewire was successfully inserted on the first attempt.

Conclusions

The use of a fluoroscopic computer-assisted navigation system for percutaneous screwing in pelvic and acetabular fractures makes the procedure easier and highly reproducible even for less experienced surgeons, and ensures less exposure to radiation compared to traditional procedure or three-dimensional-guided navigation. Furthermore, it is easily available and can be applied to a traditional C-arm.

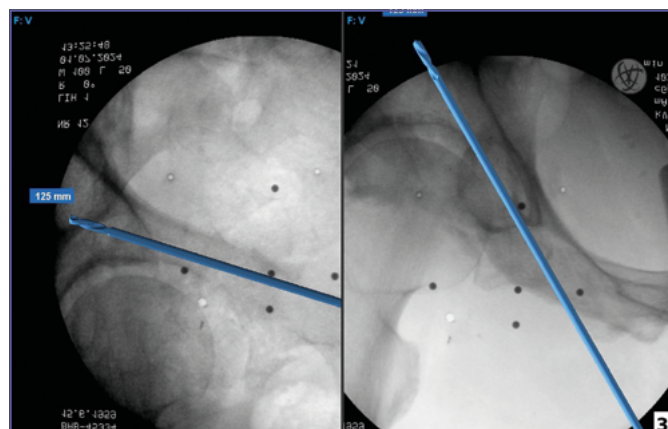


Figure 3. Drill progression.

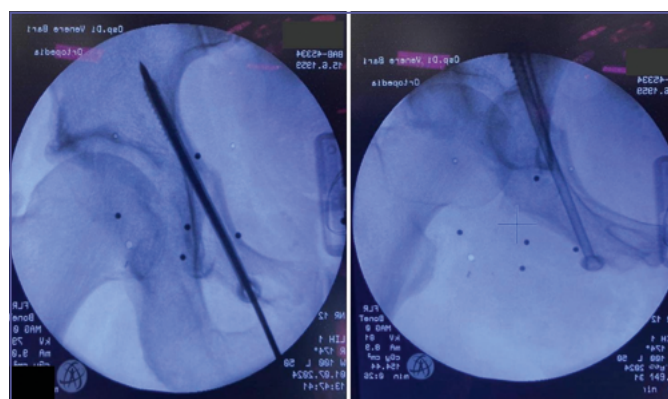


Figure 4. Cannulated screw insertion.

Conflict of interest statement

The Authors declare no conflict of interest.

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This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author contributions

The Authors contributed equally to the work.

Ethical consideration

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013).

This study is a case report and therefore does not require ethical committee approval. Written informed consent was obtained from the patient for study participation and data publication.

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