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Percutaneous reduction of LC-2 pelvic ring fracture

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ABSTRACT

Minimally invasive reduction of lateral compression type 2 (LC-2) pelvic ring fractures is not well described [1]. While the gold standard remains open reduction and internal fixation with plates and screws, this technique is associated with notable risks, including significant blood loss, nerve injury, wound dehiscence, and postoperative infection [1–3].

A minimally invasive technique of fracture reduction and fixation for LC-2 fractures is presented, with emphasis on imaging to visualize realignment of the reduced ilium.

Introduction

Pelvic ring fractures are rare, sometimes lethal, orthopedic injuries. When surgical intervention is indicated, open reduction and internal fixation (ORIF) is widely regarded as the preferred approach [3,4]. However, this strategy carries risks of substantial blood loss, nerve injury, infection, and urological injuries [4–6].

Percutaneous fixation of pelvic ring fractures is a valid treatment option [7–9]. This approach offers clear advantages including reduced blood loss, fewer wound complications, low infection rate and a generally low overall complication rate [10]. Nonetheless, the techniques for achieving proper reduction are not well described in the literature.

This paper aims to describe percutaneous reduction techniques for LC-2 pelvic fractures. The surgical sequence is detailed, and the fluoroscopic imaging techniques used to guide reduction and screw placement are illustrated.

Operative technique

Preoperative planning

Indications for percutaneous LC-2 fracture fixation are the same as those for the open approach. Patients should be taken to the operating room as early as appropriate to facilitate easier percutaneous reduction of the fracture.

A preoperative CT scan provides a clearer understanding of the size of the crescent fracture and the displacement of the mobile portion of the iliac wing. Displacement can be evaluated on axial cuts through the disrupted sacroiliac joint to assess both anteroposterior and mediolateral displacement (Fig. 1).

Additionally, cephalad or caudad displacement and the potential need for traction should be assessed based on the continuity of the iliac crest.

Patient positioning and draping

Patients are positioned supine on a radiolucent operating table. A small bump may be placed under the sacrum, if needed. The C-arm fluoroscope is positioned contralateral to the fracture. The skin is prepped and draped to the xiphoid process and rib cage, ensuring that the entire hemipelvis and affected side leg is free. Both legs are draped free in the setting of a bilateral injury.

Reduction

Reduction strategy for LC-2 fractures is guided by the fracture pattern.

Reduction can be done either with a pelvic reduction frame or without it [10]. Reduction virtually always requires percutaneous devices to align the fracture. The frame facilitates this but is not absolutely necessary. A skeletal tibial traction pin is inserted and used to correct cephalad displacement of the anterior portion of the iliac wing. This is best assessed on Anteroposterior (AP) and iliac oblique views. Tibial

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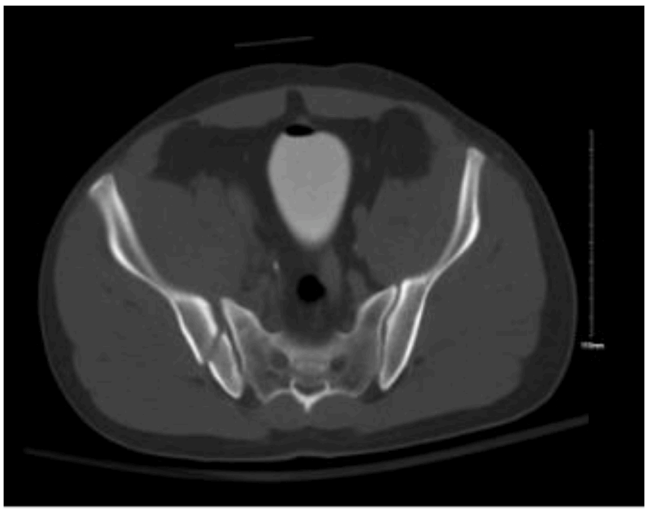

Fig. 1. CT scan demonstrating lateral and posterior displacement of the iliac wing.

traction is preferred over femoral traction when using the frame, as it simplifies assembly and positioning.

Anteroposterior (AP) and iliac oblique fluoroscopic views of the pelvis are used to assess the amount of traction required, based on the continuity of the inner ring and iliac crest. Traction is adjusted accordingly (Fig. 2).

Once cephalad displacement is corrected, the displacement of the wing medically or laterally is addressed. Depending on the injury pattern, the iliac wing can either be pushed in or pulled out, and reduced to the non-displaced crescent fragment. Various reduction tools may be employed at this stage (Fig. 3). A Schanz pin may be inserted to improve control of the reduction.

Iliac wing reduction is assessed using down-the-wing and iliac views. Care should be taken to keep the LC-2 corridor clear to allow for final fixation of the LC-2 fracture.

Cannulated screws placement

Once reduction is achieved, the next step is placement of the LC-2 screws.

The entry point is identified using the teepee pelvic view (Fig. 4). Once confirmed, the skin is marked and a small incision is made. A joker elevator can be used to dissect the soft tissue down to the entry point. The position is evaluated using the iliac oblique view, with the anterior inferior iliac spine (AIIS) serving as a caudal-to-cephalad anatomical landmark, aiming above the greater sciatic notch. The down-the-wing view is used to confirm that the entry point lies between the medial and lateral walls of the corridor.

A 2.4 mm × 450 mm guidewire (Pacific Instruments, Honolulu, HI) is inserted. The guidewire is advanced through the corridor toward the fracture line and into the intact portion of the iliac wing (crescent fragment). Fluoroscopic guidance using both the iliac oblique and down-the-wing views, confirm correct trajectory. A lateral view can be used to visualize the posterior border of the iliac wing and assess the depth of the guide wire.

If needed, the wire trajectory can be adjusted by replacing the standard guidewire with a bent, spade-tipped guidewire (Pacific Instruments, Honolulu, HI), mounted on a T-handle chuck and advanced with a mallet. The Seldinger technique [11] allows correction of the guide wire trajectory (Fig. 5).

Once optimal guidewire placement is confirmed, a guidewire depth gauge (Pacific Instruments, Honolulu, HI) is used to measure the required screw length. A properly sized, partially threaded, cannulated screw is inserted over the guidewire. Screw position and reduction are confirmed continuously using fluoroscopy throughout screw insertion.

If a spade-tipped guidewire is used, it should be retracted before the screw tip reaches the bent portion to avoid wire breakage. A second screw can be inserted into the LC-2 corridor using the same technique. LC-2 fractures are created by lateral compression. The unstable anterior portion of the iliac wing can be seen as a swinging door. Stabilization of the anterior wing will improve the strength of the entire construct. This can be done with ramus screw, external fixation, INFIX [12], or traditional ORIF.

Discussion

This paper presents a technical guide for minimally invasive reduction and percutaneous fixation of LC-2 type pelvic ring fractures. In our experience, the displaced portion of the ilium can be effectively reduced and stabilized with percutaneous LC-2 corridor screws.

Clinical studies describing percutaneous pelvic fracture fixation have shown promising results [10,13]. However, to date, reduction methods for LC-2 fractures have not been well described in peer reviewed literature. Previous studies have confirmed the presence of safe bony corridors for LC-2 screws [10,14], but percutaneous reduction of displaced LC-2 fracture has not been described and despite the growing interest in minimally invasive approaches, the current standard of care for displaced LC-2 fractures remains open reduction and internal fixation [3,4].

Open reduction is associated with good outcomes, even in elderly patients, provided they are medically stable prior to surgery [4]. However, the open approach carries significant risks of soft tissue disruption and serious complications, including major bleeding, nerve injury, postoperative infection, and, in rare cases, death [4,5]. These challenges

Fig. 2. (A) AP pelvis x ray demonstrating cephalad displacement. (B) Intra-operative AP view after frame assembly with contralateral stabilization pins. (C) Intraoperative AP view, traction was used to realign the displaced hemipelvis.

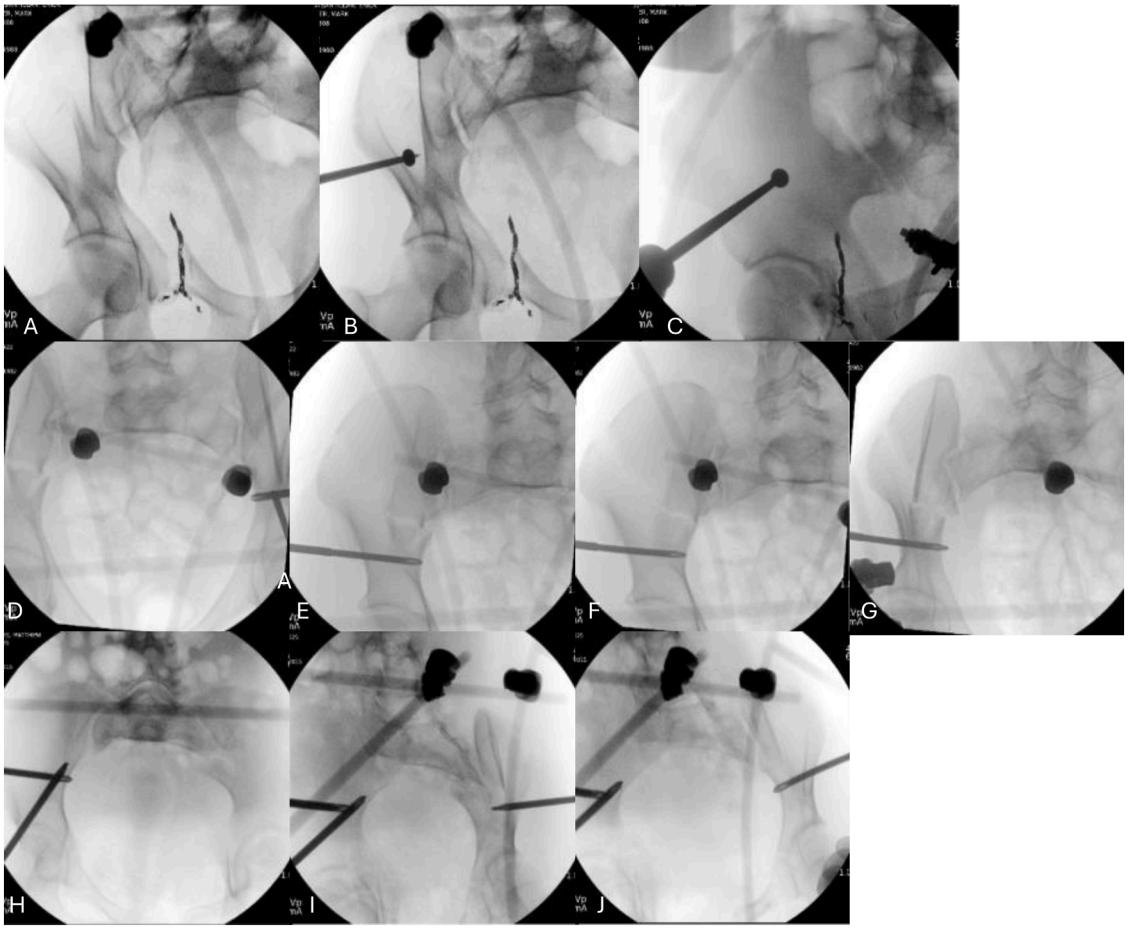

Fig. 3. (A-C) down the wing view was used to demonstrate lateral displacement of the iliac wing. A ball spike pusher was used to reduce the fracture using the same view. The reduction was then assessed using iliac view demonstrating a continuous iliac crest and greater sciatic notch. (D-G) An inlet view demonstrating a medially displaced right iliac wing. A Schanz pin was passed through the wing and used to pull it. Reduction was assessed on both inlet and down the wing views. (H-J) the same technique was used on a pediatric patient. A reduction frame was used with contralateral stabilization pins.

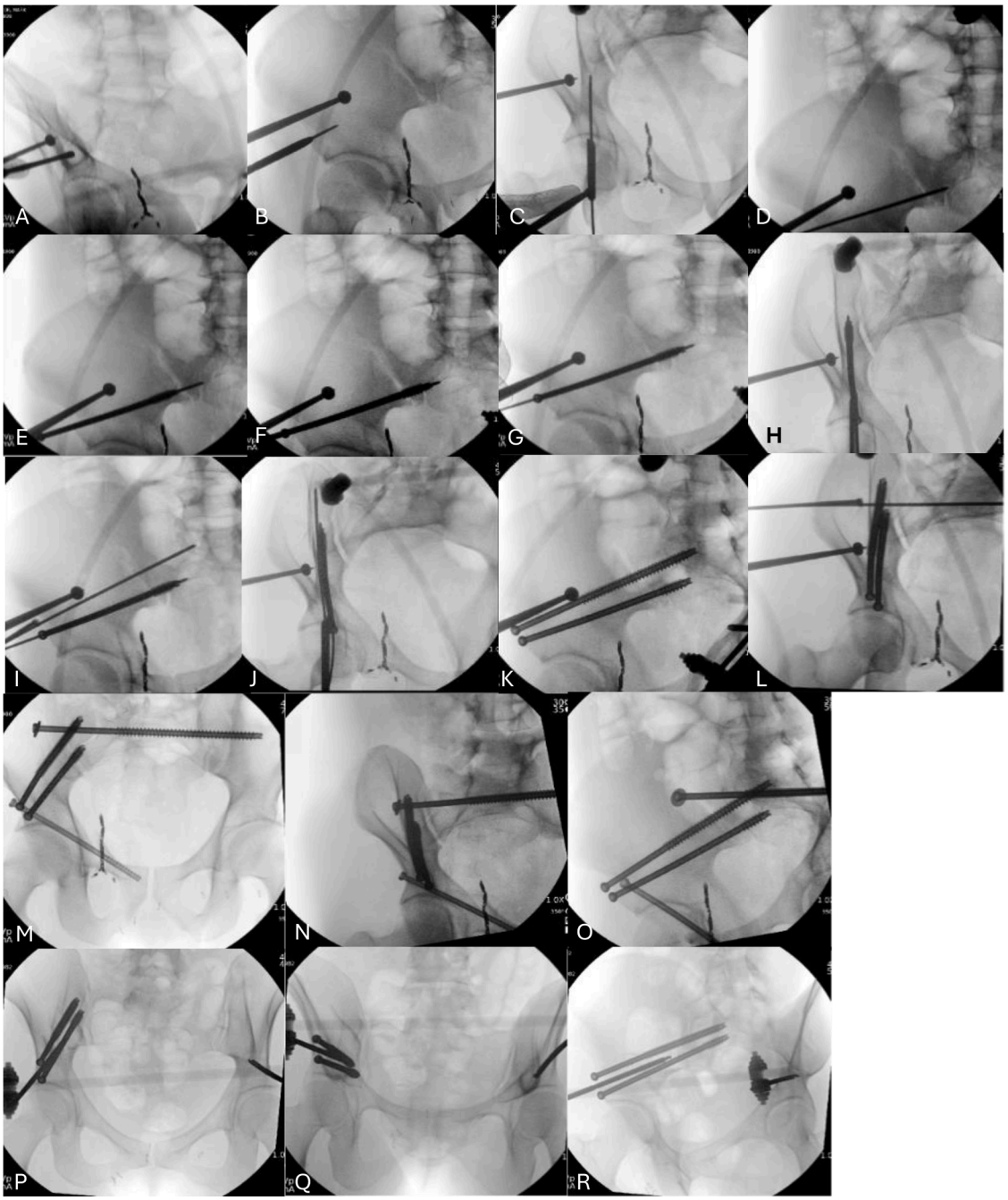

Fig. 4. (A-B) The teepee and iliac views are used to locate the entry point. (C-D) A guide wire is advanced using the down the wing and inlet views. (E-H) A partially threaded screw is advanced gradually to compress the fracture. (I-L) A second screw is added using the same technique. (M-O) Final films demonstrate good reduction. A trans-sacral and arterial column screw were used. (P-R) The same technique was used in this case, with an additional supraacetabular external fixator.

can be further exacerbated in obese patients [6,15].

As with other pelvic ring injuries, minimally invasive techniques are considered safer, provided that adequate reduction is achieved. We hope this paper provides information on minimally invasive reduction sequence and technique for LC-2 fractures.

We recommend following the sequence of the reduction techniques and fluoroscopic imaging presented here. A stepwise approach simplifies the procedure. When performed according to the described technique, this approach is safe and time-efficient, making it an appealing option—particularly for patient populations at higher risk for surgical complications. Importantly, we have not observed any vascular, neurological, or urological injuries associated with this technique.

Conclusions

Percutaneous screw fixation of LC-2 pelvic ring fractures allows for stable anatomical reconstruction of the pelvic ring while minimizing soft tissue injury and surgical complications. This technical guide provides a step-by-step description of the procedure to assist surgeons considering the adoption of this technique.

Ethics statement

No identifiable information is presented, and all images have been anonymized in accordance with ethical publishing standards. As this is a technical note paper, formal ethics committee approval was not

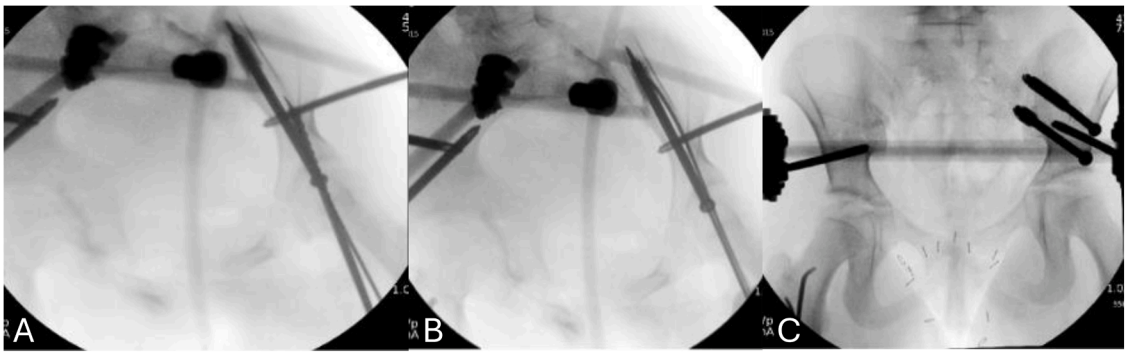

Fig. 5. Seldinger technique. (A) Using a hollow reamer to preserve the entry point a straight guide wire is replaced with a spade tipped wire. (B) The spade tipped wire is advanced while adjusting the trajectory. (C) Final AP view of LC-2 screws and an anterior supraacetabular external fixator.

required.

CRediT authorship contribution statement

Alona Katzir: Data curation, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Matthew Morones:** Data curation, Validation. **Taylor C. Kot:** Data curation, Validation. **Ishvinder S. Grewal:** Supervision, Validation. **Ashoke K. Sathy:** Supervision, Validation. **Adam J. Starr:** Conceptualization, Methodology, Resources, Supervision, Validation, Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Adam J Star reports a relationship with Starr Frame LLC that includes: equity or stocks. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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