Percutaneous Fixation of Hypertrophic Nonunion of the Inferior Pubic Ramus: A Report of Two Cases and Surgical Technique

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Abstract

Symptomatic hypertrophic nonunions of the inferior pubic ramus are amenable to percutaneous screw fixation in patients with suitable osseous anatomy. Preoperative planning, knowledge of bony and surrounding soft-tissue anatomy, and understanding of intraoperative pelvic fluoroscopy are required for proper screw fixation in the medullary canal of the inferior pubic ramus.

In this article, we report 2 cases of adults with symptomatic hypertrophic nonunions of the superior and inferior pubic ramus, treated successfully with percutaneous medullary screw fixation. Percutaneous screw fixation can be used to successfully treat symptomatic hypertrophic nonunion of the inferior ramus and avoid the potential morbidity of a more extensive open surgical procedure.

Fractures of the superior and inferior pelvic rami are common in pelvic ring injuries.[1] These fractures are routinely treated successfully without surgery.[2] When the pelvic ring is injured, and ramus fracture or fractures represent a point of instability, surgical fixation can be performed to impart stability and reduce discomfort.[3] Patients with pubic ramus fracture(s) have overall greater long-term morbidity and mortality.[4] Operative stabilization of the superior pubic ramus can be achieved with open reduction and internal fixation, external fixation, and percutaneous medullary screw fixation.[5-8] Inferior ramus fractures are seldom treated directly and acutely with operative reduction and fixation, as the mechanical advantage inferior ramus fixation provides is unknown.

Persistent nonunion of the pelvic ring can cause pain and disability and make reconstruction increasingly difficult.[9] Open and percutaneous fixation techniques have been used to address symptomatic nonunions of the superior pubic ramus.[9,10] There is limited evidence supporting surgical fixation of the inferior ramus. Open surgical fixation for symptomatic nonunions of the inferior ramus has been described.[11,12] The inferior ramus has an osseous fixation pathway (OFP) amenable to percutaneous screw placement.[13] Placement of a percutaneous screw in the inferior ramus requires use of preoperative computed tomography (CT) and is technically demanding. Surgeons must understand use of intraoperative fluoroscopy to ensure that the screw is contained within bone and crosses the intended zone of nonunion.

In this article, we report 2 cases of adults with symptomatic hypertrophic nonunions of the inferior ramus, treated with percutaneous screw fixation. Both patients presented with focal groin pain and activity limitations. Each had concurrent ipsilateral hypertrophic nonunions of the superior ramus, treated with percutaneous antegrade intramedullary stabilization. The patients provided written informed consent for print and electronic publication of these case reports.

Case Reports

Case 1

A 45-year-old woman fell from a horse about 8 months before presenting to the orthopedic outpatient clinic. Pelvic radiographs obtained after the fall were negative for fracture, but subsequent pelvic magnetic resonance imaging led to the diagnoses of minimally displaced left superior and inferior pubic ramus fractures and associated right-sided sacral ala fracture. The patient was treated with protected weight-bearing according to symptoms, but increasing activity-related pain and discomfort in the left groin persisted for months after injury. These symptoms were treated with analgesic medication, physical therapy, and chiropractic manipulation. Repeat imaging showed hypertrophic nonunions of the left superior and inferior pubic rami (**Figure 1**). Findings of the serologic testing performed for infection and metabolic deficiencies were normal at that time. The patient was referred for surgical consultation.

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Figure 1. Case 1. Preoperative anteroposterior radiograph of pelvis of patient who presented with worsening left groin pain about 8 months after falling from a horse.

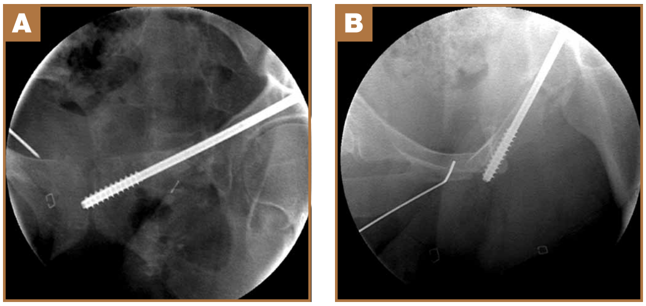

Figure 2. Case 1. (A) Intraoperative fluoroscopic OOOCI (outlet obturator oblique combinative image) and (B) adjusted inlet view show Kirschner wire being used to identify correct starting point on contralateral superior ramus.

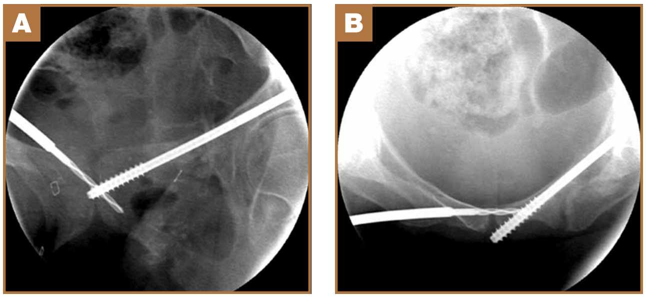

Figure 3. Case 1. (A) Intraoperative fluoroscopic OOOCI (outlet obturator oblique combinative image) and (B) tangential pelvic inlet view confirm placement of 2.5-mm drill bit in inferior ramus before advancement past nonunion.

On evaluation, she reported constant pain in the left groin with ambulation. Specifically, squatting, pushing and pulling activities were extremely uncomfortable. She had been unable to return to work either full-time or part-time. On physical examination, she walked with an antalgic gait with a decreased stance phase of the left lower extremity. She had tenderness to palpation medial to the hip joint without evidence of hernia or lymphadenopathy. The pelvis was stable to manual compression testing.

Pelvic CT showed the nonunion site and the osteology of the inferior and superior pubic ramus of the pelvis, as well as minimal displacement and good alignment of the rami.

The patient was placed supine on a flat radiolucent table (Mizuho OSI, Union City, California). Preoperative cephalosporin antibiotics were administered. After induction of general anesthesia, the lumbosacral spine was elevated under 2 folded blankets. Arms were abducted to allow for pelvic imaging, and all bony prominences were padded. A urinary catheter was inserted aseptically to decompress the bladder. The entire abdomen and bilateral flanks were shaved, prepared, and draped in usual sterile fashion. A partially threaded cannulated screw was placed using a percutaneous antegrade technique to address the hypertrophic superior ramus nonunion.

A C-arm fluoroscopy unit (Ziehm, Orlando, Florida) was positioned on the injured side. The surgeon stood on the contralateral side. A pelvic OOOCI (outlet obturator oblique combinative image) of the symphysis pubis was obtained. This view defined the medial and lateral extents of the inferior ramus. A 0.062-in smooth Kirschner wire was used to percutaneously locate an ideal starting point on the cranial aspect of the contralateral superior pubic ramus. The starting point was adjusted on this view until an ideal intended trajectory into the contralateral (affected) inferior pubic ramus was visualized (**Figure 2A**).

The C-arm beam was then oriented to an "excessive" pelvic inlet view tangential to the posterior cortical surface of the affected inferior pubic ramus (**Figure 2B**). The tip of the wire was then adjusted to position and aim it slightly anterior to the posterior cortical surface of the affected inferior ramus. The wire was advanced into the bone about 1 cm, and the location and direction of the wire were reconfirmed as accurate.

A vertical skin incision was then made around the wire, and the 4.5-mm cannulated drill was placed over the wire. A soft-tissue protective drill sleeve and oscillating technique were used to protect the soft-tissue anatomy. The trajectory of the drill was again confirmed on pelvic OOOCI and advanced into the bone. The intended path of the drill was from the cranial-medial symphyseal cortex of the contralateral superior ramus, through the symphysis pubis obliquely, and then into the medullary canal of the affected inferior ramus. Frequent biplanar fluoroscopic imaging followed this progression of the drill to the nonunion site. The cannulated drill was then removed and exchanged for a calibrated extra-long 2.5-mm drill bit, placed through the soft-tissue drill sleeve and into the glide hole created by the 4.5-mm cannulated drill. The C-arm unit ensured accurate positioning of the 2.5-mm drill on both pelvic OOOCI and "excessive" inlet view before advancement (**Figures 3A, 3B**). The 2.5-mm drill was advanced caudally, laterally, and anteriorly in the ramus, past the nonunion site, and then was stopped before it exited the cortex of the ischial tuberosity (**Figures 4A, 4B**).

The depth of the drill bit was assessed with a known-length

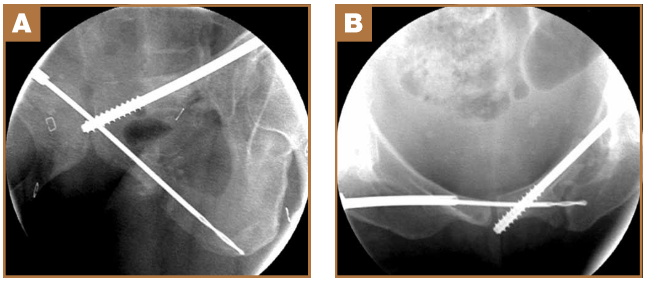

Figure 4. Case 1. (A) Intraoperative fluoroscopic OOOCI (outlet obturator oblique combinative image) and (B) tangential pelvic inlet view show final position of drill bit in inferior ramus, across nonunion, and in ipsilateral ischial tuberosity.

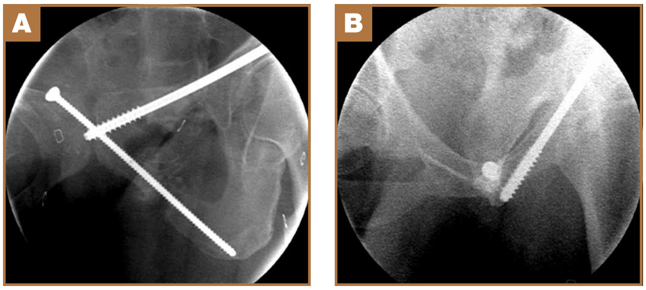

Figure 5. Case 1. (A) Final intraoperative fluoroscopic OOOCI (outlet obturator oblique combinative image) and (B) inlet view show fully threaded 4.5-mm cortical screw contained in osseous fixation pathway of inferior ramus.

protective drill sleeve and calibrated drill. Alternatively, depth can be assessed with another same-length calibrated drill bit positioned adjacent to the inserted drill bit. A fully threaded, blunt-tipped 4.5-mm cortical screw was then placed through the glide hole. Both fluoroscopic views were used to confirm that the screw followed the same trajectory as the drill. Finally, the screw was again checked on biplanar fluoroscopy to confirm it had remained in the OFP of the inferior ramus (**Figures 5A, 5B**).

Postoperative pelvic CT confirmed position and length of the screws. The patient was allowed weight-of-limb weight-bearing on her affected side after surgery. She was discharged the first day after surgery and allowed use of oral analgesics. Six weeks after surgery, pelvic radiographs showed partial healing, and she reported symptom relief. Resistive strengthening exercises were instituted, and progressive weight-bearing proceeded to full weight-bearing over the next 6 weeks. The patient reported almost complete relief of pain by 3 months, and she was able to return to work and daily activities without medication. Radiographs showed consolidation of the fractures. She was essentially symptom-free 17 months after surgery (**Figure 6**).

Case 2

An obese 51-year-old woman presented to the orthopedic clinic with a 6-month history of left groin pain that worsened with ambulation. She did not recall a specific injury but acknowledged a history of previous falls. Past medical history was significant for ulcerative colitis/irritable bowel syndrome and degenerative disease in the lumbar spine and right ankle. Previous pelvic radiographs showed no evidence of fracture or abnormality, but radiographs obtained before evaluation in the clinic showed hypertrophic nonunion of the left superior and inferior pubic ramus.

Figure 6. Case 1. Anteroposterior radiograph of pelvis shows consolidation of both hypertrophic ramus nonunions at latest follow-up.

The patient had pain deep in the left groin with weight-bearing. On physical examination, she denied pain with log roll of the left hip or resisted straight leg raise. The pelvis was stable to manual compression. There was no sign of hernia or lymphadenopathy in the region of the left groin.

The patient had obtained a technetium-99 nuclear medicine scan of the pelvis in addition to standard preoperative CT of the nonunion area. The nuclear medicine scan showed uptake in the area of the superior and inferior ramus, and CT confirmed presence of a superior and inferior ramus that would accommodate a medullary screw.

The patient was taken to the operating room, where percutaneous fixation of the left superior and inferior ramus was performed (as described above). The patient was discharged on postoperative day 2 and followed the same weight-bearing protocol that the first patient used.

At 6 weeks, the patient returned to clinic with improved comfort. At 3 months, she denied left groin pain and was limited in activity only by preexisting arthrosis in the left ankle and lumbar spine. She was using a walker only for long distances and was symptom-free 13 months after surgery.

Discussion

Acute surgical fixation of the inferior ramus is seldom performed. The anatomical location of the inferior ramus and the lack of defined criteria for fixation often leave the inferior ramus ignored, unreduced, and without stabilization. In the setting of symptomatic nonunion, open stabilization has been used.[11,12]

Plate fixation after open débridement of an inferior ramus nonunion requires more extensive dissection and may increase the risk for perioperative infection and hardware prominence compared with an intramedullary implant.[14] If plate prominence becomes symptomatic, the plate must be removed in a second surgical procedure. Percutaneous medullary screw fixation avoids the risks of surgical soft-tissue dissection and placement of a surface implant on the bone and reduces the need for a second surgical procedure to remove bothersome hardware. Percutaneous pelvic fixation has been well described and shown to provide stability to the pelvis. It can also be used to treat hypertrophic nonunions of the pelvis when mechanical stability is required for healing.[13]

In the cases reported here, inferior ramus stabilization was combined with intramedullary fixation of the superior ramus. As each patient had deep groin pain that could not be localized to either ramus, both rami were stabilized after close assessment on preoperative CT. Solitary fixation of the superior ramus may or may not provide stability sufficient for inferior ramus union and should be performed when the OFP of the inferior ramus is unavailable.

The anatomy of the inferior ramus must be carefully reviewed before surgery, as it is seldom encountered in open and percutaneous orthopedic pelvic surgery. The inferior ramus extends from the symphysis pubis to the ischial tuberosity. The ramus is wider medially and thinner laterally near the obturator foramen. The anterior surface of the ramus is flat and concave, whereas the posterior surface is flat and convex. The anatomy of the inferior ramus varies somewhat, and any distortion (eg, fracture, nonunion) of the OFP can render it incapable of accommodating screw fixation.[13]

Percutaneous placement of a medullary screw in the inferior ramus requires an understanding of the fluoroscopy required. Challenges, including body habitus and unique osseous anatomy, must be recognized. Soft tissues must be protected with a drill sleeve during preparation of the screw pathway, and care must be taken to avoid placing the screw beyond the cortex of the ischial tuberosity. A prominent screw tip can irritate the patient in the hamstrings or while sitting.

Intramedullary screw fixation of the inferior ramus is a technically demanding surgical procedure. Meticulous evaluation of preoperative radiographic studies must accompany strict attention to surgical detail. A misplaced or malpositioned drill bit or screw can injure surrounding neurovascular structures. A screw that does not cross the fracture or is not in the OFP of the inferior ramus will be ineffective and potentially dangerous.

Conclusion

We have presented a technique for percutaneous screw placement in the inferior ramus. This technique requires an understanding of the anatomy of the inferior ramus and of the intraoperative fluoroscopy required for screw placement. We have used this technique to successfully treat symptomatic hypertrophic nonunions of the inferior ramus that require skeletal stability for healing.

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References

1. Hill RM, Robinson CM, Keating JF. Fractures of the pubic rami. Epidemiology and five-year survival. *J Bone Joint Surg Br*. 2001;83(8):1141-1144.
2. Matta JM, Dickson KF, Markovich GD. Surgical treatment of pelvic nonunions and malunions. *Clin Orthop*. 1996;(329):199-206.
3. Barei DP, Shafer BL, Beingessner DM, Gardner MJ, Nork SE, Routt ML. The impact of open reduction internal fixation on acute pain management in unstable pelvic ring injuries. *J Trauma*. 2010;68(4):949-953.
4. van Dijk WA, Poeze M, van Helden SH, Brink PR, Verbruggen JP. Ten-year mortality among hospitalised patients with fractures of the pubic rami. *Injury*. 2010;41(4):411-414.
5. Simonian PT, Routt ML Jr, Harrington RM, Tencer AF. Internal fixation of the unstable anterior pelvic ring: a biomechanical comparison of standard plating techniques and the retrograde medullary superior pubic ramus screw. *J Orthop Trauma*. 1994;8(6):476-482.
6. Routt ML Jr, Simonian PT, Grujic L. The retrograde medullary superior pubic ramus screw for the treatment of anterior pelvic ring disruptions: a new technique. *J Orthop Trauma*. 1995;9(1):35-44.
7. Matta JM. Indications for anterior fixation of pelvic fractures. *Clin Orthop*. 1996;(329):88-96.
8. Routt ML Jr, Nork SE, Mills WJ. Percutaneous fixation of pelvic ring disruptions. *Clin Orthop*. 2000;(375):15-29.
9. Gautier E, Rommens PM, Matta JM. Late reconstruction after pelvic ring injuries. *Injury*. 1996;27(suppl 2):B39-B46.
10. Altman GT, Altman DT, Routt ML Jr. Symptomatic hypertrophic pubic ramus nonunion treated with a retrograde medullary screw. *J Orthop Trauma*. 2000;14(8):582-585.
11. Archdeacon MT, Kuhlman G, Kazemi N. Fellow's Corner: grand rounds from the University of Cincinnati Medical Center—painful superior and inferior pubic rami nonunion. *J Orthop Trauma*. 2010;24(11):e109-e112.
12. Schofer M, Illian C, Fuchs-Winkelmann S, Kortmann HR. Pseudoarthrosis of anterior pelvic ring fracture [in German]. *Unfallchirurg*. 2008;111(4):264, 266-267.
13. Bishop JA, Routt ML Jr. Osseous fixation pathways in pelvic and acetabular fracture surgery: osteology, radiology, and clinical applications. *J Trauma Acute Care Surg*. 2012;72(6):1502-1509.
14. Schmidt AH, Swiontkowski MF. Pathophysiology of infections after internal fixation of fractures. *J Am Acad Orthop Surg*. 2000;8(5):285-291.