A Case Report of a Vertical Zone III Sacral Fracture Due to Acute Lower Extremity Hyperabduction While Windsurfing

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Abstract

Typically associated with motor vehicle accidents and falls, sacral fractures result from sudden compression of the iliac wings, placing bidirectional traction forces on the anterior and/or posterior aspects of the sacrum. Here we describe a vertical Zone III sacral fracture caused by sudden, forceful hyperabduction of the lower extremities. To the authors' knowledge this is the first report of a Zone III sacral fracture caused by this mechanism which occurred when the patient encountered a large wave while windsurfing. Imaging revealed a longitudinal fracture to the anterior sacrum, with a concomitant Zone II fracture and pubic symphysis diastasis. The patient was treated using anterior fixation plating and posterior percutaneous pinning. The purpose of this study is to increase provider awareness of an often underdiagnosed fracture, alert water sports enthusiasts of the risks associated with windsurfing, describe signs and symptoms of this often overlooked fracture, and discuss treatment modalities based on radiographic and clinical assessments of fracture stability.

Keywords

sacrum, Denis classification, Zone III fracture, pelvic ring fixation

Abbreviations

APC = anterior-posterior compression
CT = computed tomography
FFP = fresh frozen plasma
LC = lateral compression
PRBCs = packed red blood cells
SI = sacro-iliac
SICU = surgical intensive care units
TTWB = toe touch weight bearing
TXA = tranexamic acid
WBAT = weight bearing as tolerate

Introduction

Windsurfing has become increasingly popular since its inception in 1971. With advances in sail and board technology, riders now average speeds of 26-30 knots (34.5 mph), making the potential for injury high in inexperienced surfers.[1] Most injuries involve the lower extremities, often due to torques about the knee and ankle.[2-7] Pelvic injuries, however, are uncommon, and this report focuses on one such injury.

Sacral fractures are uncommon injuries presenting in 10-45% of all pelvic fractures, the majority caused by motor vehicle accidents.[8-13] Fractures in young patients are usually due to high energy mechanisms, while those in the elderly are secondary to lower-energy mechanisms.[14,15] These are often underdiagnosed; plain radiographs miss 20-30% of sacral fractures subsequently found on computed tomography (CT). Missed fractures can result in neurologic sequelae, stressing the importance of early diagnosis and treatment.[12]

Sacral fractures occur in three zones as described by Denis: lateral to the sacral foramina (Zone I), transforaminal (Zone II), and medial to the foramina (Zone III).[12,16] Fractures occur most often in Zone II, where the foramina contribute to weaker local structure.[17,18] Despite comprising less than 16% of all sacral fractures, Zone III injuries have the highest risk (57%) for neurological symptoms, most commonly cauda equina syndrome.[12,16,19] The solid bone overlying the sacral midline, especially the anterior cortex overlying S1 and S2, makes midline Zone III fractures extremely rare,[20] and this patient's injury attests to the sheer suddenness and force required to produce the observed fracture.

Case Report

A 62-year-old healthy male windsurfer presented after a large wave struck him, forcing his legs into sudden hyperabduction in opposite directions. He did not hit any hard surfaces and swam back to shore unassisted. He was hypotensive on scene and taken to an outside hospital, where he received 1% tranexamic acid (TXA) and a pelvic binder. Initial radiographs detected significant pubic diastasis; a CT of the chest, abdomen, and pelvis further detected a Zone III sacral fracture. A Foley catheter was placed; no hematuria was noted. A retrograde CT cystogram ruled out urologic injury, however a large surrounding hematoma was found. Initial hemoglobin was 8.0 (normal range 13.8 to 17.2 g/dL for men). An angiogram ruled out extravasation; no embolization was performed. He received 4 units of packed red blood cells (PRBCs) and 4 units of fresh frozen plasma (FFP); he was then transferred to a tertiary Level 1 trauma center.

Upon arrival, the patient was evaluated by the trauma team and an orthopaedic consultant. He responded well hemodynamically to the multiple transfusions, and a repeat hemoglobin was 12.7. On examination his pelvis was grossly mobile to anterior-posterior (APC) and lateral compression (LC), but there was no saddle anesthesia, radiculopathy, paresthesias, or loss of bowel/bladder control.

Plain films and repeat CT demonstrated a 2.5 cm symphyseal diastasis, a midline Zone III sacral fracture bisecting S1, S2, and S3 and extending to the right of the S1 facet, and a right sided Zone II sacral fracture involving the first through fifth sacral foramina (**Figures 1A-C**). This constellation of physical exam and radiographic findings was strongly suggestive of an unstable fracture. Other injuries included a fracture of the ninth right rib and large extraperitoneal hematomas in the bilateral pelvic sidewalls, retropubic space, and presacral space. The pelvic binder was replaced and surgery planned for the following day. Overnight he developed hypotension warranting admission to the surgical intensive care unit (SICU) where he received another unit of PRBCs. He responded well to transfusion and was cleared for surgery the next day.

An open reduction and internal fixation of the symphysis was performed, along with percutaneous screw fixation of the sacral fracture. A standard suprapubic Pfannenstiel approach was used to reduce the diastasis. Initial fixation was achieved using an anterior plate, and a curved acetabular plate for superior fixation. Two cannulated screws were then placed through the sacro-iliac (SI) joint across the fracture site. Routine closure was performed, a compression dressing applied, and the patient transported to the SICU. Postoperative imaging demonstrated stable fixation (**Figure 2**).

On postoperative day 1, the patient remained neurologically intact; however, he had extensive ecchymosis and edema to his penis and scrotum. He was kept on a non-weight bearing status to both lower extremities given his recent operation. No chemical thromboprophylaxis was given due to hemodynamic instability and significant transfusion requirement. Serial hemoglobin measurements were within normal limits and stable. He was downgraded from ICU status and did not require further transfusions.

On postoperative day 2, he was permitted toe-touch weight bearing (TTWB) to his right lower extremity and weight bearing as tolerated (WBAT) to his left. Postoperative antibiotics were completed and the Foley catheter removed. He continued to improve over postoperative days 3-5; by the time of discharge he was ambulating >200 feet with axillary crutches. He was discharged with a four-wheeled walker on postoperative day 5.

Postoperative Follow Up

On postoperative day 13, imaging demonstrated a stable construct (**Figure 3A**). Strength was 5/5 in bilateral lower extremities, his scrotal edema had improved, and pain was well controlled. He maintained bladder control and reported the occasional drop of blood during micturition. His only deficit was persistent erectile dysfunction; this was unknown if it was a true neurological sequela or secondary to local soft tissue injury. He was recommended to follow up with a urologist if his symptoms did not improve.

By 4 weeks he could perform activities of daily living (ADLs) and instrumental activities of daily living (IADLs), and was able to drive. He had since regained limited erectile function. At 6 weeks, repeat X-rays demonstrated backout of the shorter SI screw and a single superior pubic ramus screw (**Figure 3B**). Osseous healing appeared satisfactory, and he was encouraged to continue physical therapy. At 3 and 6 months, radiographs demonstrated further backout of screws in both the superior and anterior symphyseal plates (**Figures 3C, 3D**). At 9 months, the anterior and superior plates and screws were removed intact and without complication.

Discussion

Fractures to the sacrum are rare in the surfing community. While these usually result from high-energy APC or LC mechanisms, our case suggests that sacral fractures can also result from abrupt, high-magnitude tension forces. Our case is unique in that rather than a compressive mechanism, our patient underwent hyper-abduction of the lower extremities, leading to injury to the pelvic ring in two areas: anteriorly, a traction-type symphyseal diastasis; and posteriorly, a traction-type midline sacral fracture. Our case exemplifies the well-known fact that sacral fractures often present without neurologic symptoms, even in high-risk fracture patterns,[8,12,21] and clinicians should maintain a high degree of suspicion, even with uncommon mechanisms. This case also highlights the importance of a thorough workup for hemorrhage, pelvic ring fractures, and urogenital injury.

Fractures to the pelvic ring are commonly classified using the Young-Burgess system; however, this system describes APC injuries of increasing severity as symphyseal widening accompanied by SI ligament injury, not sacral fractures. Furthermore, while the Denis system was sufficient for our purposes, it does not account for other injuries to the pelvic ring or complex sacral fractures.[22-24] Our patient's injury could instead be described as an APC type 2 variant: the diastasis suggests anterior instability, and the sacral fracture suggests posterior instability.

The most common indications for surgical intervention are unstable fractures, neurological compromise, and severe axial or sagittal misalignment. Although the lumbosacral injury classification system (LSICS), like the widely used thoracolumbar injury classification system (TLICS) for thoracolumbar injuries,[25] demonstrates good to excellent inter- and intra-observer reliability, validation on a multicenter level remains to be determined. Due to the uncomplicated nature of our patient's injury, we did not apply LSICS as part of our treatment algorithm as it would not have changed our method of fixation.

While we cannot make a generalized treatment algorithm for these combined anterior-posterior injuries involving sacral fractures, recent literature emphasizes stabilizing the pelvic ring anteriorly and posteriorly to facilitate early mobility and return to weight bearing, as isolated anterior fixation for combined anterior-posterior injuries results in loss of fixation by one year.[28] Posterior fixation has thus become a cornerstone in sacral

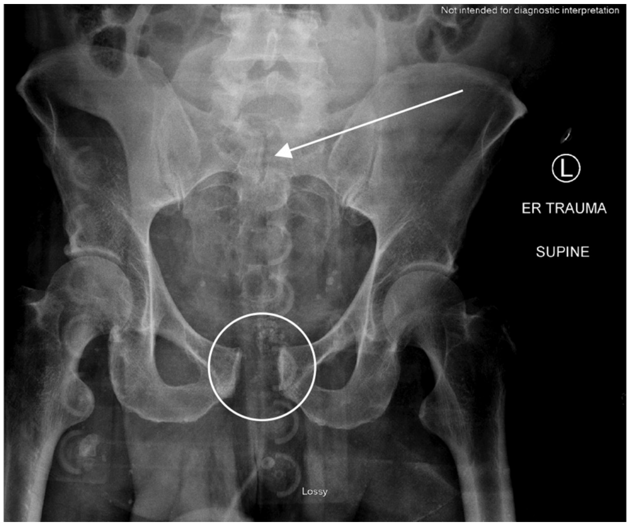

Figure 1A. AP radiograph of the pelvis, day of admission. Readily visible anteriorly is the widened pubic symphysis (white circle). The midline sacral fracture can be seen posteriorly (white arrow), partially obscured by the shadow of the overlying pelvic binder.

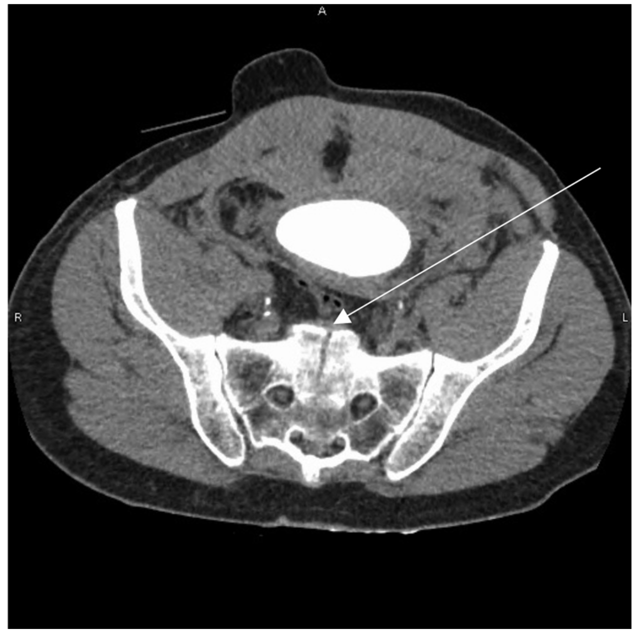

Figure 1B. Axial slice of the CT pelvis, day of admission. The Zone III sacral fracture is more easily appreciable (white arrow).

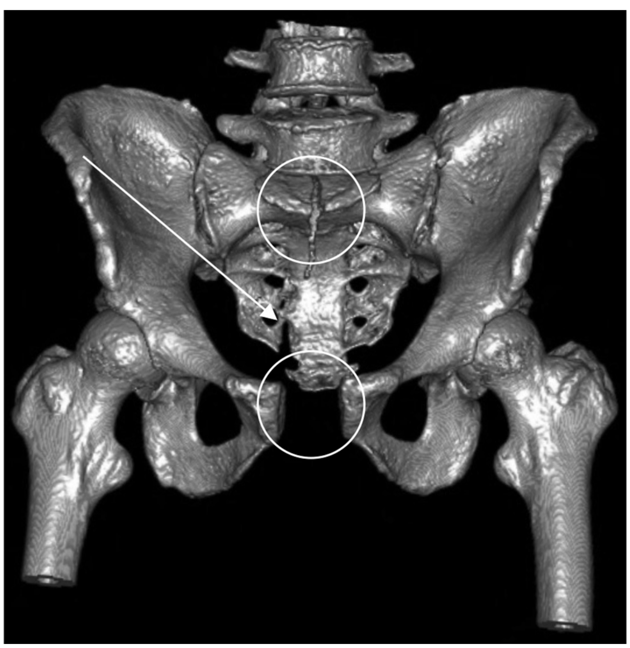

Figure 1C. 3D reconstruction image of the pelvis, day of admission. Redemonstrated here are the pubic diastasis and zone III sacral fracture (white circles). Also seen in this image is the right sided zone II fracture (white arrow).

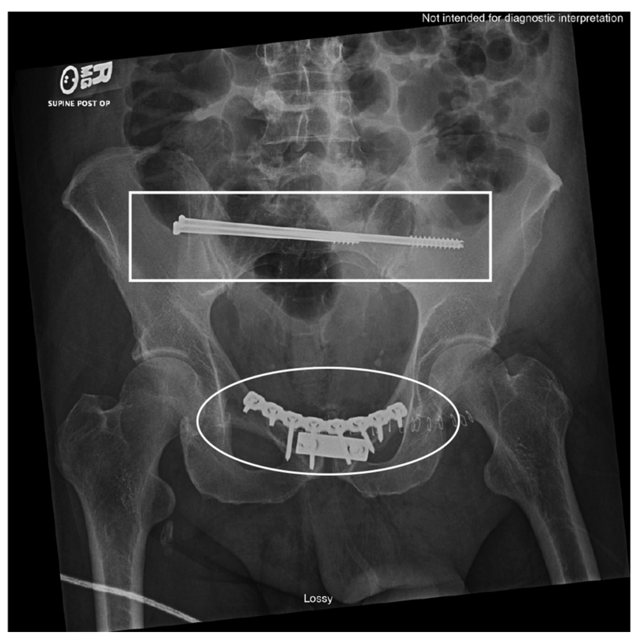

Figure 2. AP pelvis, postoperative day 0. Two constructs are seen here: the plate-screw fixation construct anteriorly (white oval), and the two percutaneous screws posteriorly (white box).

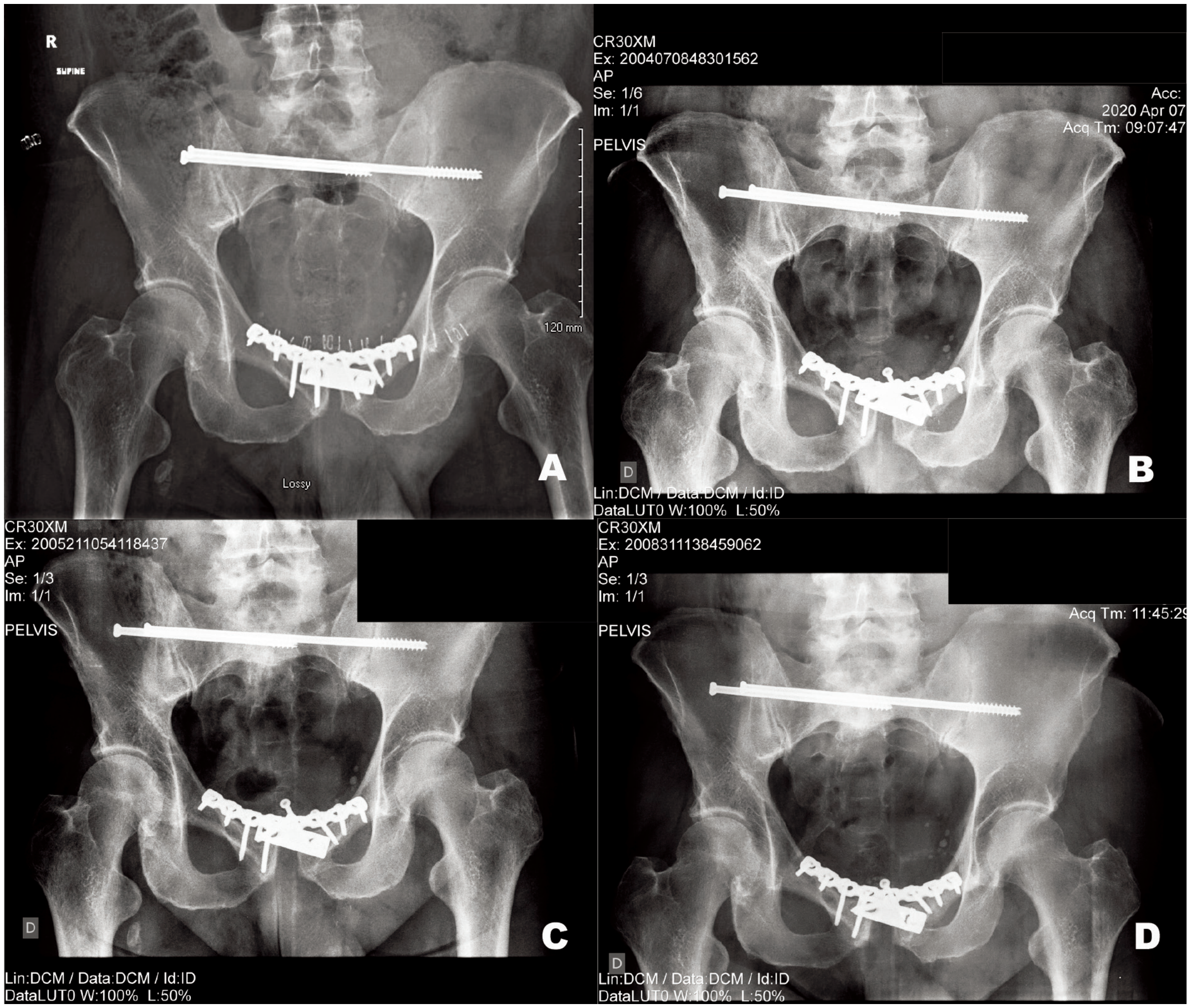

Figure 3. Postoperative AP views of the pelvis after discharge. (A) Thirteen days postoperatively. A stable fixation construct can be seen, compared to immediate postoperative imaging. (B) Six weeks postoperatively. There has been interval backout of the shorter SI screw by about 1 cm, and one of the left-sided symphyseal screws has begun to back out. (C) Three months postoperatively. Backout of the SI screw has remained stable, but the symphyseal screw appears to have backed out more compared to the 3-month image. (D) Six months postoperatively. The SI screw position has remained stable, and there has not been much interval change in the symphyseal screw's position. This was the last image taken before hardware removal at nine months from the index procedure.

fractures, pelvic ring disruption, and lumbopelvic dissociation, further supported by biomechanical studies.[13,18,24,27,29-34] Of note, while percutaneous screw fixation is useful for uncomplicated fractures, complex fracture patterns may require rigid instrumented constructs.[27, 35-39]

Conclusion

The patient presented in our report sustained an uncommon injury with an atypical mechanism of injury. He underwent a standard anterior-posterior fixation construct with a consequentially stable pelvic ring and recovered uneventfully. The authors present this case to stress that unpredictable forces can lead to severe injuries such as this one, and both sports enthusiasts as well as physicians must be aware of the inherent risks.

Conflict of Interest

None of the authors identify a conflict of interest.

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