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Case Report

Application of Spinal Minimally Invasive System for Pelvic Anterior Ring Fixation in a Pelvic Fracture-A Case Report

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Abstract

Pelvic fractures, often resulting from high-energy trauma, are associated with high mortality and significant complications. Traditional methods for treating anterior pelvic ring fractures, such as the InFix system, provide excellent biomechanical stability but involve complex procedures. This case report introduces the application of the spinal minimally invasive system for anterior pelvic ring fixation in a patient with a Tile C1 pelvic fracture. A 60-year-old female patient, admitted following a motor vehicle accident, presented with a Tile C1-type pelvic fracture. The surgical team opted for a minimally invasive approach using the spinal screw-rod system, which provided both simplicity in operation and reduced surgical time. Postoperative outcomes indicated successful fixation with no complications, and the patient regained preoperative functional status within two months. This report demonstrates that the spinal minimally invasive system is a viable alternative for anterior pelvic ring fixation, offering advantages in terms of reduced surgical trauma, faster recovery, and fewer complications, particularly for elderly and high-risk patients. Further studies and innovations, including hybrid approaches combining the advantages of both InFix and spinal systems, are warranted to optimize treatment for complex pelvic fractures.

Background

Pelvic fractures are often caused by high-energy trauma and are associated with high mortality, disability rates, and significant complications [1]. Traditional methods for treating pelvic anterior ring fractures, such as the InFix system, have shown excellent biomechanical stability [2]. However, the InFix system's operative procedure remains relatively complex and requires further simplification. In an effort to improve the operational simplicity of InFix, we applied the spinal minimally invasive screw-rod system for anterior pelvic ring fixation in a case of Tile C1 pelvic fracture. Rarely reported is the application of the spine minimally invasive system for fixing the anterior pelvic ring [3].This case demonstrates that the spinal minimally invasive screw-rod system not only offers a minimally invasive approach and simple operation but also effectively shortens the surgical time. Here, we report our findings and further discuss the advantages and limitations of this system.

Case Presentation

A 60-year-old female patient was admitted to the hospital following a motor vehicle accident. Initial examinations revealed a Tile C1-type pelvic fracture involving the anterior pelvic ring, with right iliac wing and sacroiliac joint instability. The patient presented with pain and difficulty in movement but did not exhibit any signs of visceral injury. Imaging studies, including CT and X-rays, confirmed the diagnosis of a Tile C 1 pelvic fracture. Considering the patient's advanced age, high fracture severity, and the potential for complications, the surgical team decided to employ a minimally invasive surgical approach using the spinal minimally invasive screw-rod system for anterior ring stabilization.

Anterior Ring Stabilization: After successful anesthesia, the patient is placed in the supine position. Routine disinfection of the surrounding area of the pelvic

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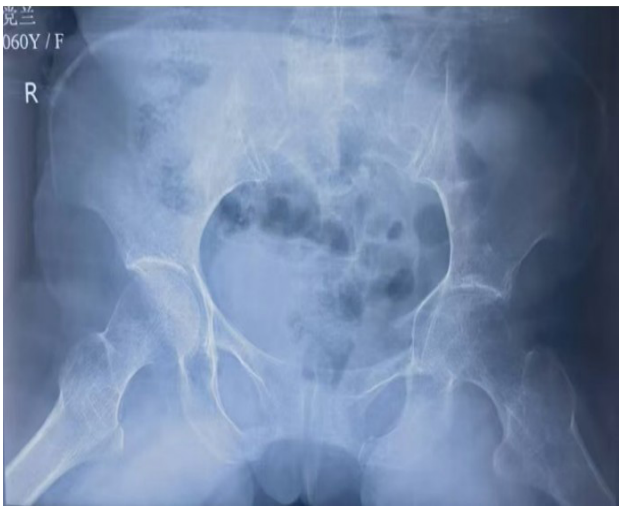

Figure 1: *Anteroposterior X-ray of the Pelvis*

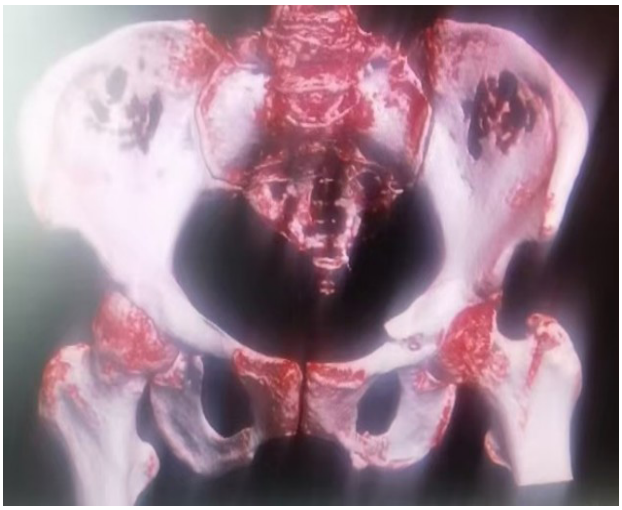

Figure 2: *Three-Dimensional CT Reconstruction of the Pelvis*

Figure 3: *Placement of the guide needle through the LCII channel under fluoroscopic guidance at the anterior inferior iliac spine.*

Figure 4: *Insertion of the pedicle screw through the guide needle*

Figure 5: *Image after pedicle screw insertion.*

Figure 6: *Schematic diagram of the incision length*

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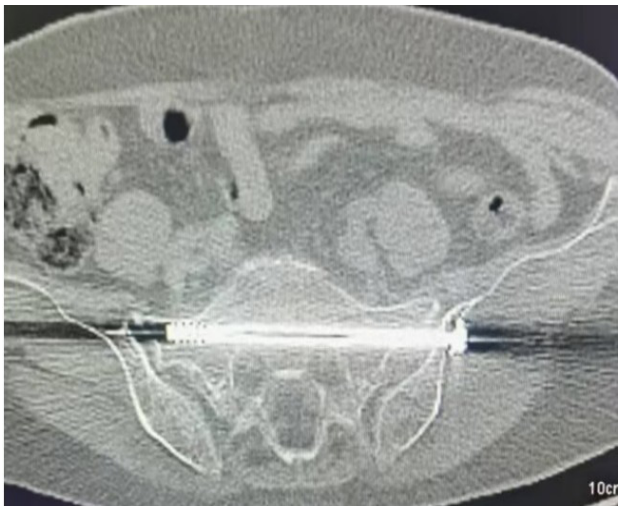

Figure 7: *CT scan of screw position after sacroiliac joint screw insertion.*

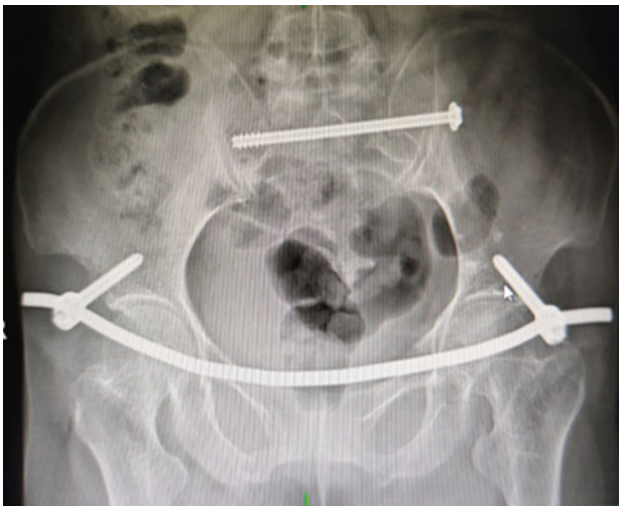

Figure 8: *Postoperative pelvic anteroposterior X-ray.*

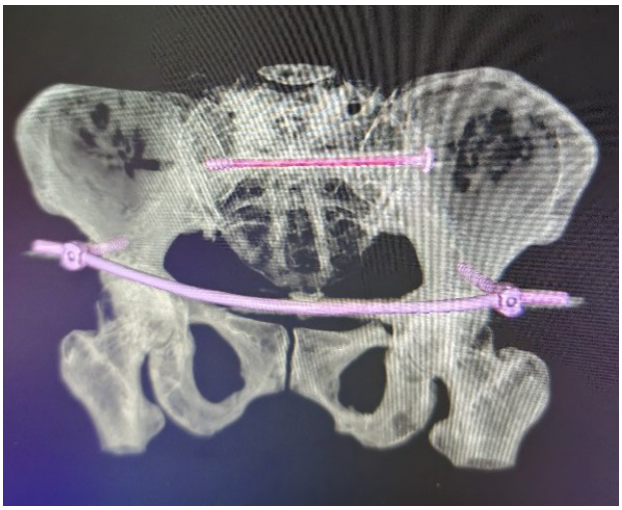

Figure 9: *Postoperative CT three-dimensional reconstruction.*

Figure 10: *Postoperative CT three-dimensional reconstruction.*

fracture incision is performed, and sterile drapes are applied. The minimally invasive fixation of the anterior pelvic ring is then initiated. First, mark the point on the anterior superior iliac spine (ASIS) and the symphysis pubis line at the fourth equal division from the ASIS, which is approximately the projection of the ASIS on the surface of the body. A 1 cm oblique incision is made along the direction of the sartorius muscle, and the skin, subcutaneous tissue, and deep fascia are cut layer by layer. Under C-arm fluoroscopy, a guide cone is inserted for piercing and guiding.

Once the position of the guide cone is confirmed to be within the LCII channel on both sides of the pelvis, a guide pin is placed through the cone. Then, a 6.5 mm minimally invasive pedicle screw is inserted using the guide pin. The position of the screw is confirmed with C-arm fluoroscopy to ensure that it is located between the iliac bone plate and the acetabulum.

Next, the connection rod is pre-curved according to the shape of the lower abdomen, and a subcutaneous tunnel is created by bluntly separating the superficial fascial plane of the lower abdomen. The connection rod is passed through this subcutaneous tunnel and inserted into the groove at the tail end of the pedicle screw. By using compression or separation, the anterior ring is reduced. The tail cap of the pedicle screw is tightened to lock the rod in place, completing the minimally invasive anterior pelvic ring fixation.

Posterior Ring Stabilization: Hollow screws were placed across the sacroiliac joint to stabilize the posterior pelvic ring.

Postoperative Management: The patient was closely monitored post-surgery with regular follow-up imaging (X-ray and CT) to ensure proper fixation positioning.

Postoperative Outcome

Postoperative X-rays and CT scans showed satisfactory placement of the anterior and posterior ring fixations, with no signs of screw loosening or displacement. The patient's pain decreased significantly, and she was able to start walking on the 30postoperative day. At the 2-month follow-up, the fracture showed signs of healing with no complications, and the patient regained preoperative functional status.

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Discussion

Advantages of Using the Spine Minimally Invasive Instrumentation System for Fixing the Anterior Pelvic Ring

The use of spine minimally invasive instrumentation systems for the fixation of the anterior pelvic ring offers several advantages, particularly in the context of complex pelvic fractures. The method is gaining traction due to its numerous benefits, which include reduced surgical trauma, faster recovery times, and lower complication rates.

Reduced Surgical Trauma and Soft Tissue Damage: One of the primary advantages of minimally invasive techniques is the reduced damage to surrounding soft tissues. Traditional open surgical approaches to pelvic fracture fixation often involve significant dissection and retraction of soft tissues, leading to longer recovery times and higher risks of complications such as wound infections and deep vein thrombosis. In contrast, minimally invasive techniques, including the use of the spine minimally invasive instrumentation system, significantly minimize the need for extensive tissue dissection, thus reducing surgical trauma and promoting quicker healing. This approach is especially beneficial in elderly patients, who are at higher risk for complications from extensive surgeries [5].

Faster Recovery and Shorter Hospitalization: Minimally invasive surgery (MIS) allows for quicker stabilization of the pelvic ring, which in turn leads to faster recovery times. Patients who undergo MIS for pelvic fractures typically experience less pain postoperatively, which enables earlier mobilization and rehabilitation. This is particularly important in elderly patients, as early mobilization can prevent complications associated with prolonged bed rest, such as pressure sores or pneumonia [6]. Studies show that the minimally invasive approach leads to shorter hospital stays and faster return to normal activities [7].

Improved Precision in Fracture Fixation: The use of advanced navigation techniques, such as three-dimensional printing and robotic assistance, in minimally invasive surgery further improves the accuracy of screw placement in the anterior pelvic ring. This precision reduces the risk of malalignment and the need for revision surgery. The use of spine instrumentation systems ensures a more controlled, precise approach that minimizes the risk of complications and provides optimal fracture stabilization8. Furthermore, the minimally invasive approach enables real-time imaging and navigation, which can guide the surgeon in achieving precise anatomical reduction[9].

Lower Risk of Infection and Complications: With smaller incisions and less soft tissue disturbance, the risk of postoperative infections is considerably reduced compared to open surgery. The minimal access required for the fixation system helps preserve the skin and muscle integrity, thus reducing the exposure of internal organs and bone to potential sources of infection. This reduction in infection rates is especially crucial in elderly patients, who often have diminished immune response and a higher propensity for complications[10].

Better Cosmetic Outcomes: The minimally invasive approach offers cosmetic benefits, as the smaller incisions are less noticeable and result in less scarring. This is particularly important for patients who are concerned with aesthetic outcomes, especially in younger patients or those with significant social interactions [11].

Application in Elderly and High-Risk Patients: The use of minimally invasive techniques is particularly beneficial in elderly patients and those with comorbidities, such as cardiovascular disease, diabetes, or obesity. These patients are often not ideal candidates for open surgery due to the higher risks of complications and prolonged recovery. The spine minimally invasive instrumentation system provides an option for fracture stabilization in this patient population, allowing them to recover faster and with fewer complications [5].

The integration of the spine minimally invasive system for fixing the anterior pelvic ring has proven to be a significant advancement in pelvic trauma surgery. As noted by previous studies, the benefits of minimally invasive surgery in treating pelvic fractures are substantial, especially for elderly patients who are more vulnerable to the stresses of traditional open surgeries5. This approach not only minimizes surgical trauma but also enhances recovery time, thus improving the overall quality of life for patients following surgery [12].

Recent advances in technology, such as 3D printing and robotic assistance, further improve the precision and safety of minimally invasive techniques, making them an increasingly popular choice among surgeons [13]. Additionally, these advancements align with the goals of reducing complications and improving long-term outcomes for patients, which is crucial for the success of pelvic fracture treatments [14].

Furthermore, the approach is shown to be highly effective in minimizing the risk of infection, an issue that has long been a concern with more invasive surgical methods 15. The ability to achieve fracture fixation with smaller incisions leads to fewer complications, less blood loss, and a quicker return to normal activities, which makes the minimally invasive approach an ideal choice for managing complex pelvic fractures.

Improvements in the InFix System: Potential Hybrid Approach

While the spinal minimally invasive screw-rod system

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simplifies the surgical procedure and reduces patient trauma, its biomechanical stability may be less than that of InFix. Future innovations could involve combining the advantages of both systems. A hybrid system that incorporates the strong biomechanical stability of InFix along with the minimally invasive and operational simplicity of the spinal screw-rod system could provide a solution that is both effective and efficient, particularly in complex pelvic fractures.

Socioeconomic Benefits

The use of minimally invasive systems like the spinal screw-rod system offers significant socioeconomic advantages. It reduces surgical complexity and operative time, leading to a reduction in healthcare costs. For elderly patients, who often face extended recovery periods, the shorter recovery times from minimally invasive surgery also reduce the need for long-term care. Moreover, the reduction in postoperative complications results in fewer hospital readmissions, further decreasing the financial burden on the healthcare system.

Conclusion

The spinal minimally invasive system is a promising alternative for the fixation of pelvic anterior ring fractures, particularly in elderly patients. Although its biomechanical stability is not as strong as the InFix system, combining the benefits of both systems could create a more optimal solution for pelvic ring fractures. This approach not only improves clinical outcomes but also brings significant economic and healthcare benefits. The potential for further improvement and integration of these systems could greatly enhance the treatment of pelvic fractures in the future.

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