Endovascular retrieval of a migrating pedicle screw within the inferior vena cava after instrumented spinal surgery: case report

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During L3–5 instrumented spinal surgery for degenerative spondylolisthesis in a 75-year-old woman, the right L-3 pedicle screw was accidentally pushed into the retroperitoneum and then migrated to the inferior vena cava (IVC). The patient was transferred to the surgical intensive care unit, and after careful discussion with cardiology specialists, a minimally invasive endovascular technique was used to remove the migrating pedicle screw within the IVC and thus salvage this critical case.

Pedicle screw instrumentation is an effective procedure, but not risk free. Every detail should be scrutinized during surgery, even instrument construction. A minimally invasive endovascular technique should be considered in this patient population.

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KEY WORDS inferior vena cava; instrumented spine surgery; pedicle screw; surgical technique

SPINAL fusion has become one of the most commonly performed surgeries, used not only in patients with spinal trauma, tumor, infection, and scoliosis, but also increasingly in those with degenerative spondylolisthesis and disc-related problems.^{3,6,7,24,28} Posterolateral fusion with pedicle screw instrumentation offers a higher fusion rate than noninstrumented fusion alone and therefore increases patient satisfaction. Wu et al. reported that supplemental pedicle screw fixation after laminectomy and posterolateral fusion is an effective procedure for the ever-increasing number of patients over the age of 65 years.²⁷ However, many studies have also revealed undesired complications related to instrumented fusion surgeries, in both the short- and long-term follow-ups.

A meta-analysis demonstrated that complications of instrumented spinal fusion are frequent, including instrumentation failure (7%), bone graft donor-site complications (11%), neural injuries (3%), pulmonary embolus (2%), infections (3%), and pseudarthrosis (15%).²² Intraoperative complications related to internal fixation hardware are primarily neurological, dural, and vascular injuries and can also be attributable to misplacement of the instrumentation.¹⁶ Although major vessel injuries caused by the placement of posterior pedicle screw fixation have been described, inferior vena cava (IVC) injury due to a migrating pedicle screw during instrumented spinal surgery has not been reported. Inferior vena cava injury and an intravascular foreign body (IVFB) can cause serious complications

ABBREVIATIONS ICU = intensive care unit; IVC = inferior vena cava; IVFB = intravascular foreign body.

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FIG. 1. A 78-year-old female complained of severe low-back pain and associated sciatica. Radiographs (anteroposterior view, **A**; lateral view, **B**) showed an L-2 vertebral compression fracture and L4–5 degenerative spondylolisthesis.

or death. Here, we present a case involving the successful percutaneous endovascular removal of a pedicle screw that had migrated into the IVC during instrumented spinal surgery. The patient was informed that data concerning the case would be submitted for publication, and she provided consent.

Case Report

History and Examination

A 75-year-old woman was hospitalized for severe low-back pain with bilateral leg radiation and intermittent neurological claudication refractory to conservative treatment. She had no other significant medical history. Preoperative radiography showed an L-2 vertebral compression fracture and L4–5 degenerative spondylolisthesis (Fig. 1). Magnetic resonance imaging confirmed a previous L-2 compression fracture and L4–5 severe stenosis (Fig. 2).

Operation

After careful discussion with the patient and her family, L3–5 decompression and instrumented spinal fusion were performed while she was under general anesthesia. The Click'X system (Synthes) was used for immediate posterior fixation. After laminectomy to decompress the neural elements, pedicle screws were inserted from L-3 to L-5. Before constructing the entire structure, we pushed the polyaxial 3D heads one by one onto the inserted screw head using the positioning holder. After finishing the other 5 connections between each 3D head and screw head, we accidentally pushed the right L3-inserted pedicle screw (6.2 mm in diameter and 45 mm in length) anteriorly into the abdomen, and active bleeding occurred with a sudden drop in blood pressure. Plenty of gauze was used to cover and apply pressure to the oozing area lateral to the L-3 vertebral body, and fluid resuscitation was begun. Intraoperative fluoroscopy revealed that the pedicle screw was misplaced at the retroperitoneum. A cardiac surgeon was urgently consulted to identify and control the bleeding sources. He attempted to approach the misplaced pedicle

FIG. 2. Both T1-weighted (**A**) and T2-weighted (**B**) sagittal MR images demonstrated an old L-2 vertebral compression fracture and L4–5 severe stenosis.

screw but failed because the wound was continuously oozing. A stab injury to the IVC was suspected given the location of the pedicle screw, which was noted on intraoperative fluoroscopy; the bleeding was controlled by direct pressure using several pieces of gauze and Gelfoam. As the patient's blood pressure did not drop further with direct pressure and fluid resuscitation, the rest of the procedure was resumed as quickly as possible and completed within 30 minutes.

Postoperative Course

The patient was transferred to the surgical intensive care unit (ICU). Intraoperative blood loss was 1500 ml, and the blood transfusion amounted to 2000 ml. Once the patient's vital signs gradually stabilized in the ICU, CT was performed 12 hours postoperatively, revealing that the right L-3 pedicle screw had migrated into the suprarenal IVC near the heart (Fig. 3). After consultation with cardiologists, emergency endovascular removal of the migrating pedicle screw was planned and done within 18 hours postoperatively. A vascular introducer was inserted into the right femoral vein under fluoroscopic guidance after inducing sedation with intravenous anesthesia. A 30-mm gooseneck snare made with a Radifocus guidewire (Terumo) was inserted through a guide catheter to capture the pedicle screw and maneuver it from the IVC distally into the external iliac vein and finally the femoral vein, from which it was retrieved via venotomy (Videos 1 and 2).

VIDEO 1. Endovascular removal of the migrating pedicle screw within the IVC via the femoral vein. Copyright Shih-Chieh Yang. Published with permission. [Click here to view.](#)

VIDEO 2. Venography showing that the pedicle screw migrating into the IVC was removed from the right femoral vein. Copyright Shih-Chieh Yang. Published with permission. [Click here to view.](#)

After the procedure, IVC patency was confirmed with angiography. After 2 weeks of anticoagulant treatment with heparin, the patient was discharged without further major complications (Fig. 4). In 1 year of clinical follow-up, the patient had a generally stable condition with improvement in her symptoms of low-back pain and associated sciatica.

FIG. 3. Coronal (A) and axial (B) CT scans demonstrated a migrating pedicle screw at the suprarenal IVC near the heart.

Discussion

Posterior spinal surgeries for implantation procedures are increasingly performed for a variety of spinal disorders.^{3,6,7,24,28} Although most spine surgeons are familiar with pedicle screw instrumentation via the posterior approach, pedicle screw misplacement remains possible even under intraoperative fluoroscopic assistance. Numerous pedicle screw instrumentation-related complications, both intraoperative and postoperative, have been reported.^{16,22} Some of these complications, such as neurological or vascular injury, result from pedicle screw malposition. Postoperative CT studies of instrumentation in patients with scoliosis have revealed pedicle screw malposition incidences ranging from 4% to 25%.^{9,11,15,18} In most large series on spinal instrumentation surgery, reported neurological injury rates range from 0.4% to 22%.^{16,22} The close anatomical relationship between the spine and neural elements places it and other major retroperitoneal structures at risk during these complex procedures.

Iatrogenic vessel injuries are uncommon. Several previous reports have detailed abdominal or chest vascular injuries after instrumented spinal surgery.^{17,21,23} Most vascular injuries associated with spinal surgery are delayed, occurring after chronic irritation of the pulsating aortic wall against a metallic implant.^{10,14,26} In a retrospective analysis of postoperative imaging records (CT and MRI) from patients undergoing thoracic, lumbar, and lumbosacral pedicle screw fusion, 33 (4.9%) of 680 inserted screws were found to contact a major vessel.⁸ Since no clinically relevant sequelae such as aneurysm formation or vessel erosion were noted in this series, the risk of leaving a misplaced pedicle screw causing no symptoms had to be weighed against the risks of exploration and revision surgery. However, pedicle screw insertion also carries the potential for immediate major vascular complications. Matsuzaki et al. described a thoracic aortic perforation from an anteriorly placed pedicle screw that had sealed the injury, preventing hemorrhage.¹² Extensive surgery was performed, including thoracotomy, cardiopulmonary bypass, and replacement of an 8-cm segment of the proximal descending thoracic aorta.

Abdominal vascular injuries and IVC injuries in particular are among the most challenging to manage for trauma

FIG. 4. Postoperative anteroposterior (A) and lateral (B) radiographs demonstrate L3–5 instrumented spinal fusion with no L3 right pedicle screw.

surgeons.¹ One-third of all patients with IVC injuries do not reach the hospital alive, and 30% of those who do reach the hospital die within the first 24 hours from exsanguination or the sequelae of multiple-organ injuries.¹³ In a retrospective study of 74 patients with penetrating abdominal IVC injuries (91% involving gunshot wounds and 9% involving stab wounds), 77% underwent lateral venorrhaphy, 5% underwent infrarenal IVC ligation, and 18 died perioperatively before vena cava repair could be performed, for an overall perioperative mortality rate of 39%.⁴ Thus, regardless of the improvements in resuscitation and available operative methods, penetrating abdominal IVC trauma remains life-threatening. Inferior vena cava ligation is an acceptable damage-control technique, although it remains associated with high mortality and morbidity.¹⁹

To our knowledge, there has been no report of a penetrating pedicle screw inside the IVC. Wang et al. reported the case of an IVC tear occurring during posterior spinal fusion surgery.²⁵ Emergent exploratory laparotomy was performed to disclose the IVC tear, but the patient ultimately died due to multiple-organ failure. The current case occurred during instrumented spinal surgery. The patient had already been intubated with ventilator support, and critical resuscitation could be performed immediately after the occurrence of the IVC injury. Since an aggressive exploratory laparotomy was not necessary to stop the bleeding, it is possible that the pedicle screw may have initially penetrated the IVC without causing a large laceration. It then migrated toward the suprarenal portion near the right atrium because of the subsequent packing, manipulation, and venous return. Given the limited size of the pedicle screw (6.2 mm in diameter), the primary injury to the IVC may have been the same as an intravenous cannulation wound. Therefore, the injury around this area could be tamponed by packing pressure and retroperitoneal hematoma even though the IVC was not transected. Fortunately, the patient could be transferred to the ICU even with rather unstable vital signs where she underwent endovascular removal of the migrated screw.

An IVFB is a serious complication. Reports of IVFB in-

clude atrial septal defect closure devices, balloon catheters, endovascular stents, embolization coils, IVC filters, cardiac valve fragments, intravascular ultrasound catheters, sheaths, pacemaker wires, and temporary pacing wires.^{5,20} The most common source of iatrogenic IVFB is dislodged central venous catheter-related emboli, which usually migrate into the right atrium and even the pulmonary artery. An IVFB derived from orthopedic implants is extremely rare. In the past, surgery was the only treatment option for iatrogenic IVFB. Currently, endovascular retrieval of an identified IVFB should be attempted because of its high success rate and minimal morbidity and mortality.²

Several precautions should be taken to prevent the same mishap we experienced. First, the present case involved an older woman. Therefore, a rather simple procedure, such as decompression at L4–5, should have been considered first to improve symptoms, which could have avoided the potential risks of instrumented spinal surgery. Second, in addition to intraoperative fluoroscopy and a pedicle probe to check the position of the pedicle screws, real-time CT monitoring or a navigation system could have assisted in preventing the critical complication. Third, a diagnostic imaging study should have been arranged as soon as possible. In the current case, CT, which was used to determine the exact position of the migrating pedicle screw, was performed in the ICU but not immediately during surgery because of the very urgent situation. The only goal at that moment was to keep the patient alive.

Conclusions

In summary, IVC injury from a penetrating pedicle screw is rare and associated with high mortality. Spine surgeons should pay more attention to every detail, especially making sure that the pedicle screw is introduced into the pedicle in the increasingly popular pedicle screw instrumentation for various spinal disorders. The present case suggests that percutaneous endovascular retrieval can be considered as an alternative, minimally invasive salvage strategy to minimize the morbidity and mortality caused by an intravascular migrating pedicle screw during instrumented spinal surgery.

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Disclosures

The authors report no conflict of interest concerning the materi-

als or methods used in this study or the findings specified in this paper.

Author Contributions

Acquisition of data: Yen. Drafting the article: Yen. Critically revising the article: Chen. Reviewed submitted version of manuscript: Tu. Approved the final version of the manuscript on behalf of all authors: Yang. Administrative/technical/material support: Yang, Chen. Study supervision: Tu.

Supplemental Information

Videos

Video 1. <https://vimeo.com/228665901>.

Video 2. <https://vimeo.com/228666043>.

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