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Primary Endovascular Repair of Ilio-Caval Injury Encountered during Anterior Exposure Spine Surgery: Evolution of the Paradigm

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Abstract

Background—Rates of major venous injury are now being reported at between 1% and 15%. Risk factors for injury include the previous spine surgery, level of exposure, and number of retractors used. To review and describe the evolution of our use of stent grafts for repair of life-threatening ilio-caval injuries encountered during anterior exposure lumbosacral (L-S) spine surgery from rescue utilization after failed direct repair to preferred modality using occlusion balloons and covered stents akin to the modern management of the ruptured abdominal aortic aneurysm (AAA) with endovascular aneurysm repair.

Methods—Five-year retrospective review of all anterior and retroperitoneal spine procedures was performed at our institution.

Results—One hundred two procedures were done. Major ilio-caval injury occurred in 3/102 (2.9%) cases. Average blood loss per case decreased as our approach evolved from unsuccessful direct open repair with percutaneous endovascular rescue to primary percutaneous endovascular repair. All treated patients had patent venous repair in short-term follow-up with computed tomography angiography.

Conclusions—Identification and rapid direct repair of major ilio-caval injuries during anterior approach spine surgery can be extremely challenging. When control of these potentially fatal injuries is required, our choice is primary endovascular repair using the modern techniques for endovascular management of ruptured AAA with endovascular aneurysm repair.

Over the past decade, there has been increased utilization of both anterior and retroperitoneal spine exposures for various reasons. At our institution, the number of anterior lumbar interbody fusion cases has increased from 10 in 2010 to 27 in 2014. This has led to an increase in the number of requests for exposure of the retroperitoneal vessels. The risk of major vessel injury is directly related to the level of spine exposure required, with an increased frequency of injury occurring when exposure is needed at the lumbosacral levels due to the proximity of major vascular structures.

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Vertebral fusions can be associated with acute postsurgery complications including stroke, myocardial infarction, infections, and deep vein thrombosis.¹ Anterior lumbar interbody fusions have a complication rate between 5% and 14%.² Known potential complications with exposure include retrograde ejaculation, nonunion, arterial injury, or more common venous injury. Risk factors for injury include the previous spine surgery, level of exposure, and number of retractors used. Historically, posterior lumbar fusions have produced higher levels of vascular and neurologic complications to nearby lumbar muscles.³ Recent studies have brought attention to potentially life-threatening complications that occur during lumbar fusion surgeries such as gastrointestinal hemorrhage and vascular lesions.^{4,5} Lumbar fusions of L3 and L4 have been associated with venous damage to the inferior vena cava and iliac vessels.⁶ Posterior lumbar interbody fusion has been associated with occlusion of the common iliac vein.⁷ The source of the bleeding or occlusion is often hard to locate, but veins can become easily damaged due to the lack of a thick muscular wall. In addition to lumbar fusion, a recent cadaver study found that S1 and S2 pedicle screws come into close proximity with the middle and lateral sacral veins also potentially putting them at risk.⁸

This case series reviews the evolution of our emergent life-saving technique of endovascular stent-graft placement for the management of inadvertent ilio-caval injury encountered during anterior exposure spine surgery from use primarily as a rescue technique after failed direct repair to preferred method.

This was a 5-year retrospective review of all anterior and retroperitoneal spine procedures performed at our institution with increasing number of procedures performed from 10 in 2010 to 27 in 2014. Major vascular injury occurred in 5 of 102 or 4.9% of cases. Two cases had small venous injuries that were handled with direct suture repair. The 3 cases to be presented involved major venous injury not responsive to direct suture repair and were successfully managed with endovascular intervention.

One hundred two procedures were done. Major ilio-caval injury occurred in 3/102 (2.9%) cases. Average blood loss per case decreased as our approach evolved from unsuccessful direct open repair with percutaneous endovascular rescue to primary percutaneous endovascular repair. All treated patients had patent venous repair in short-term follow-up with computed tomography angiography (Table I and Table II).

CASE REPORT

Case 1

A 59-year-old male with a past medical history of Parkinson's disease, depression, chronic obstructive pulmonary disease, and gangrenous cholecystitis. He was previously taken to the operating room 9 months prior for lumbar spinal stenosis and scoliosis with posterior lumbar decompression from T11 to sacrum with posterior spinal fusion. Patient was evaluated 8 months with complaints of back pain and difficulty moving. There was concern for failed hardware with fracture to the right side of rod at the level of L5-S1. Plan was for the patient to undergo 2-staged procedure 2 days apart. The first procedure involved removal of segmental lumbar instrumentation at L1-S1 and revision of posterior spinal fusion L1 to pelvis with the use of cancellous allograft.

The second part of the procedure was plan for anterior lumbar interbody fusion L5-S1 with Synthes femoral ring allograft and cancellous allograft with initial plan to include L3-L4 and L4-L5 anterior lumbar interbody fusions. Patient was in supine position with bump of 20° under the left buttock with knee flexed to relax vasculature. Oblique incision was made by the orthopedic team on the left side followed by dissection down to the retroperitoneal space. Operation continued with the identification of L5-S1 with iliac vessels dissected medially and laterally. Two previous posterior lumbar interbody fusion grafts were removed, and endplates were curettaged down to the bony endplate. Next dissection proceeded along the left side of the vessels. The iliolumbar vein was identified and ligated. The L4 segmental vessel was taken down as it crossed the L4-L5 disk. Bleeding noted as dissection proceeded on the posterior 1/3 of disk. Vascular surgery was consulted.

The caval injury control was initially attempted with sponge stick and 3.0-interrupted prolene. Owing to inadequate control, the endovascular approach was started with a modified Seldinger technique with a 6-French sheath into the right groin via access to the right common femoral vein. A wire was passed into the inferior vena cava and a 12-French sheath was exchanged. A large non-compliant balloon was advanced to the level of the iliac and cava injury and inflated with the appearance of control of bleeding. Next, 2 16-mm abdominal endovascular grafts were deployed over the common iliac vein and postdilated using the balloon. The patient continued to bleed proximally from what appeared to be an extension of the tear to the level of the inferior vena cava or more proximal common iliac injury. Decision was made to completely cover the inferior cava with extension of a stent into the left common iliac vein and therefore occluding the right common iliac vein. A 22-French sheath was exchanged, and a 26-mm thoracic endograft was deployed proximally and was deployed in usual fashion, which adequately controlled the bleeding (Fig. 1). The abdomen was closed and the patient was transported to intensive care unit (ICU). A decision was made to not continue the 2-stage procedure. The patient underwent massive transfusion and received 35 units of packed red blood cells, 20 units of fresh frozen plasma, 6 units of platelets, and 3 units of cryoprecipitate with an estimated blood loss of 20 liters. The patient was also given 8 mg of factor VII in operating room and 250 ml of albumin.

Spinal X-rays 3 months postoperatively showed the location of the stent grafts (Fig. 2).

Case 2

A 56-year-old female with a past medical history of osteoporosis, rheumatoid arthritis, and gastroesophageal reflux disease presented with a 4-year history of pain down her left leg that goes down to her lateral toes due to traumatic injury from motor vehicle accident. Preoperative evaluation showed degenerative L5-S1 spondylolisthesis, so plan was made for L5-S1 anterior lumbar interbody fusion with L5-S1 pedicle screws.

Vascular surgery was consulted for help with exposure via anterior approach to the L5-S1 disk. Patient was in supine position and suprapubic incision was made. Retroperitoneum was entered via blunt dissection. The left iliac vessel was freed from surrounding tissue and retracted to the left of the patient. The same was performed on the right. Fluoroscopy was used to verify proper disk exposure. The neurosurgery team requested additional exposure in the superior aspect. The right retractor tension was increased leading to laceration of the

iliac vein. Control was performed emergently with pressure. The incision was extended laterally to allow proper exposure. Decision was made to proceed with endovascular approach. Bilateral common femoral veins were accessed with 6-French sheaths. Guide wires were advanced in both common iliac veins. Owing to initial injury thought to have occurred at the right common iliac vein, a 15 cm endoprosthesis consisting of iliac limb with 16/27 diameters was deployed. Control of bleeding was deemed suboptimal and venogram on the left side revealed an injury at the bifurcation. Decision was made that a stent graft across the ilio-caval bifurcation would be needed, so the left 6-French sheath was exchanged for a 20-French sheath over a guide wire. A 26 mm × 15 cm thoracic endograft was deployed across the ilio-caval bifurcation (Fig. 3). The wound was packed using gauze and laps and abdomen was left open. Patient remained intubated and was transferred to the surgical ICU. Patient received 22 units of packed red blood cells, 11 units of fresh frozen plasma, 5 units of platelets, 5 units of cryoprecipitate, and 3,600 from cell saver.

The following day, the patient was taken back to the operating room for evacuation of hematoma, removal of lap pads, and closure of abdominal wound. A negative-pressure wound therapy dressing was applied. Follow-up computed tomography scan is shown in Figure 4.

Case 3

A 54-year-old female with a past medical history of polycystic kidney disease, hypertension, anxiety, and depression had previously undergone L3–L5 posterior lumbar decompression with L3–L4 interfacet fusion. She developed late instability at the L3–L4 level with plan to undergo posterior lumbar fusion from L3 to S1 and lateral lumbar interbody fusion at L3–L4 and L4–L5.

The patient was placed in the supine position with 30° of left lateral decubitus position. Dissection was carried down until the retroperitoneal space was identified. Next, the psoas muscle was identified, and muscle was bluntly split to identify the L4–L5 disk space. A Cobb retractor was placed and psoas muscle was elevated dorsally along the course of the disk space. A sharp annulotomy was made with a knife. Next, a Cobb elevator was placed running right to left along the endplate to free up the disk space. While passing it along the inferior endplate of L4, the Cobb retractor kicked out anteriorly. On removing the Cobb, a rush of venous blood was noted. The source of the bleeding could not be directly visualized due to it being anterior to the operative exposure. At this point, packing was placed in the wound and pressure was held on the vein. Vascular surgery was emergently consulted, transfusion protocol was initiated, and patient was placed supine. The patient was hemodynamically unstable with systolic blood pressure of 40 and required 1 dose of epinephrine.

Bilateral 6-French sheaths were placed. A wire was advanced into the inferior vena cava, and a venogram was performed. The true location of the injury could not be definitively identified, but suspicion was that the injury occurred at the proximal common iliac vein. A 16-mm abdominal endovascular iliac limb was deployed without postdilating with some extension of the stent into the inferior vena cava. A venogram was performed revealing patency of the vessel and some extension of the stent into the inferior vena cava without

occlusion of left common iliac vein (Fig. 5). Patient became hemodynamically stable and was brought to the ICU intubated and without pressors. Intraoperatively, she received 4 units of packed red blood cells, 1 unit of platelets, and 1 unit of fresh frozen plasma.

The following day, she was brought back to the operating room by orthopedics for wound exploration. The lap sponges were removed from the retroperitoneal space, and the retroperitoneal hematoma was evacuated. No active bleeding was noted, and the wound was closed in multiple layers. Patient was discharged on postoperative day 5 without deep vein thrombosis prophylaxis.

Postoperative clinic visit imaging shows the stent in right common iliac vein (Fig. 6).

DISCUSSION

One of the most feared complications associated with spine surgery, despite modern advances in surgical approach, are injuries to the major vascular structures.⁹ Anterior fusion of the spine, in particular, often requires mobilization of the aorta, inferior vena cava, iliac artery, and iliac vein.¹⁰ Presurgery risk factors for vascular injury include discogenic infection, previous anterior spinal surgery, and spondylolisthesis.¹¹ During surgery, placement of instrumentation, such as retractors and screws, provides the highest risk for life-threatening vascular damage.¹² Veins are at increased risk for injury due to friability of vein walls and the potential for laceration with retractors.¹³ In addition, the site of highest vascular risk is exposure of L4–L5.¹⁰ Recent evidence suggests that the midline anterior approach from the right side provides greater ability to mobilize the inferior vena cava without injury compared with the traditional approach from the left.¹⁴ It is also advised to ligate the iliolumbar vein to prevent hemorrhage.¹⁵ Hemorrhage, however, due to venous laceration is still a major complication and has been reported in 2–3% of anterior approach cases.¹⁶ Recent reports have also verified that screws placed through the pedicles can readily damage the inferior vena cava and/or iliac vein during placement.¹⁷ The resulting hemorrhages must be aggressively managed to limit excessive bleeding.

Localizing the exact location of the ilio-caval injury can be difficult. Even when the site of injury is localized, exposure for direct repair can be challenging due to patient position and instrumentation in the field. Initial treatment includes the use of compression proximal and distal to site of injury with sponge sticks. Vascular clamps should be avoided, and it is often encouraged to place the patient in Trendelenburg's position. Previous recommendations were that repair should begin with a prolene suture on a cardiovascular needle in conjunction with the use of hemostatic agents,⁹ and if repair is not possible with this method, an endovascular technique should be started.

Repair of the iliac vessels has historically been done with conventional and branched stent grafts.¹⁸ A recent postlaceration iliac vein repair was successfully done using kissing stents carefully selected by venography for appropriate diameter.¹⁹ Another commonly used option is endoprosthesis iliac limbs in conjunction with a thoracic endograft. Venous occlusion with large caliber semicomplaint balloons can be used for control of bleeding, structural support for graft placement, and postdilation of the vessel to help prevent occlusion.²⁰

When control of these potentially fatal injuries is required, our choice now is with primary endovascular repair. It should be performed early (before major blood loss and the ensuing shock) via bilateral percutaneous groin venous access to allow for hemorrhage control using occlusion balloons and for the rapid deployment of covered stents. We recommend using the iliac limbs of aorto-bi-iliac grafts or as needed even larger-sized thoracic aortic stent grafts. Fluoroscopy being used for the spinal procedure can be used to direct stent-graft placement. Unless clearly apparent, we do not try to spend precious time to identify the site of injury in the ilio-caval region and recommend “blind” deployment of covered stents in a kissing fashion across the ilio-caval bifurcation and if needed a thoracic endograft extension up into the infrarenal cava. As the patient’s abdomen is open with pressure being held, stent-graft deployment can be directly visualized and hemorrhage control confirmed directly upon release of manual pressure. We do not routinely postdilate the covered stents due to potential for tear extension and continued bleeding.

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Fig. 1.
Case 1: Intraoperative fluoroscopy.

Fig. 2.

Case 1: Lumbar spine X-ray 3 months postoperative showing stent grafts.

Fig. 3.
Case 2: Intraoperative fluoroscopy after stent deployment.

Fig. 4.
Computed tomography scan of abdomen/pelvis at follow-up appointment.

Fig. 5.
Case 3: Intraoperative fluoroscopy. **(A)** Before stent placement. **(B)** After stent placement.

Fig. 6. Postoperative computed tomography scan of abdomen/pelvis showing stent in right common iliac vein. **(A)** Coronal view. **(B)** Axial view. **(C)** Sagittal view.

Table I

Incidence of spinal fusion procedures performed

Year	2010	2011	2012	2013	2014
	10	15	25	25	27

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Table II

Case series summary

Procedure	Position	Injury location	Endovascular stent graft placed	Blood
ALIF L5-S1	Slight right decubitus with bump	Inferior vena cava and right common iliac vein	Two 16-mm abdominal endovascular graft; 26-mm iliac limb extension	RBCs: 35 PLTs: 5 FFP: 20 Cryo: 3
ALIF L3-S1	Supine	Ilio-caval bifurcation	1 16/27 × 15 cm 2 Thoracic endovascular graft 26 mm × 15 cm	RBCs: 22 PLTs: 5 FFP: 11 Cryo: 5
ALIF L3-L5	Supine 30° lateral decubitus	Right common iliac vein	16-mm abdominal endovascular iliac limb	RBCs: 4 PLTs: 1 FFP: 1 Cryo: 0

ALIF, anterior lumbar interbody fusion; FFP, fresh frozen plasma; PLTs, platelets.