Vascular injury during anterior exposure of the spine

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Objectives: Fusion of the spine is often performed from an anterior approach requiring mobilization of aorta, iliac artery, and vein. This study describes the preferred techniques and incidence of vascular complications at a spine center.

Methods: Information and operative notes on all consecutive patients undergoing anterior exposure were entered into a database that was retrospectively reviewed. Four hundred eighty-two procedures performed on 480 patients at one spine center between January of 1997 and December of 2002 were analyzed. Demographics, technique, levels of exposure, and history of prior spine surgery were recorded. Primary outcomes measured included intraoperative vascular complications, estimated operative blood loss, and operative mortality. Vascular injury was defined as any case in which a suture was required to control bleeding. Major vascular injuries were defined as those requiring transfusion, vascular reconstruction, or blood loss greater than 300 cc.

Results: An intraoperative vascular injury occurred in 11% (54/480) of patients. The majority of these (45/54) were minor injuries treated with simple suture repair. Nine (1.9%) major vascular injuries did occur; the majority identified and treated during the exposure and not the spinal fusion. One patient required a return to the operating room 24 hours after the initial procedure for removal of packs placed to control severe bleeding from an avulsed branch of the internal iliac vein. Median estimated blood loss (EBL) was 150 cc and there were no mortalities. Eighty-three percent of overall injuries involved exposure of L4-5, and this was statistically significant odds ratio (OR) 2.73, P = .005. The lowest incidence of injury occurred when L5-S1 alone was exposed (5.1% of injuries) OR .34, P = .01. Prior spine procedures did not significantly increase the risk of injury, P = .67. Other factors that did not significantly increase risk included gender, multiple levels vs single levels and technique of exposure.

Conclusion: Exposure to the lumbar spine can be readily accomplished via a retroperitoneal approach. Minor vascular injuries during exposure, mostly venous, are not uncommon and are easily repaired. They are increased when L4-5 is part of the exposure and are lowest when L5-S1 alone is exposed. Major injuries occur in less than 2% of patients. (J Vasc Surg 2008;48:650-54.)

Anterior fusion of the lumbar spine either alone or in combination with posterior instrumentation has become an increasingly popular surgical procedure used to treat a number of disease processes. It can be performed for patients with degenerative joint disease, scoliosis, spondylolisthesis, and spinal instability due to infection, trauma, or malignancy.1 As technology hastens the development of newer substitute bone grafts and artificial disks, the future promises even more prevalence of this approach to lumbar spinal surgery. An important tenet of the procedure regardless of disease process is to have wide access to the anterior and sometimes lateral aspect of any involved disks. When the orthopedic or neurosurgeon does not perform the exposure, vascular or general surgeons are enlisted to create access to the lumbar spine. In this technique, typically through a paramedian fascial/retroperitoneal exposure, the peritoneal contents and ureter are mobilized away from the kidney and the quadratus lumborum and psoas muscles. This involves mobilization of the iliac vein and artery and/or aorta and vena cava, depending on the disk space(s) of interest. Ligation of the middle sacral vessels, the iliolumbar vein and segmental lumbar veins, and arteries are often required. Many authors have described the potential complications of this approach, including injuries to bowel, nerve and genitourinary structures, infection, and erectile/sexual dysfunction.2-4 Vascular injury is the most common intraoperative complication and the incidence ranging from less than 1% to close to 15%, based on the inclusion or exclusion of minor injuries just requiring suture repair and whether the paper focuses on arterial or venous problems.5-6 Brau et al reported results in 1315 patients and found iliac artery thrombosis and major vein lacerations to occur at rates of .45% and 1.4%, respectively.7 The purpose of this study is to describe preferred techniques as well as to characterize the incidence of arterial and venous injuries.

METHODS

Information and operative notes on all consecutive patients undergoing anterior spine exposure were entered into a database that was retrospectively reviewed. Analysis was conducted of 482 procedures performed on 480 patients at one spine center between January 1997 and December 2002. This group of patients underwent procedures for degenerative joint diseases, scoliosis, discogenic back pain, and for joint instability due to failed previous joint fusion. Demographics, technique and levels of exposure and history of prior spine surgery were recorded. Primary outcomes measured included intraoperative vascular complications, estimated operative blood loss, and op-

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Competition of interest: none.


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operative mortality. Vascular injury was defined as any case in which a suture was required to control bleeding. Major vascular injuries were defined as those requiring transfusion, vascular reconstruction or blood loss greater than 300 cc.

Statistical analysis was performed with R Statistical Software version 2.3.1 software. The significance of predictors of vascular injury was determined by Fisher exact test for categorical variables. The association between spinal level exposed and vascular injury was determined with univariate logistic regression analysis; P values of less than .05 were considered significant, and no adjustments were made for multiple comparisons.

**Technique.** Following identification of the appropriate spinal level, a left paramedian fascial incision of the anterior rectus sheath is performed. Early in the series, the skin incision included infraumbilical midline, oblique, paramedian, or Pfannenstiel approaches. Currently, the midline incision is the preferred skin approach except in women either with prior Pfannenstiel incisions or in women who only need exposure of L5-S1. The precise length and location of the incision is often dictated by body habitus as well as the degree of exposure needed. The anterior rectus fascia is incised, and the belly of the left rectus muscle is reflected laterally. This allows for limited denervation of the rectus and prevention of a “bulge” more typically seen with the oblique approach. The transversalis fascia is incised and the retroperitoneal space is entered. By sharp and blunt dissection, the peritoneum and its contents are reflected out of the left iliac fossa to the right. In female patients, the round ligament is divided. In males the spermatic cord is mobilized but not skeletonized and retracted inferiorly. At this point, a self-retaining retractor is placed and the sacral promontory is identified by visual inspection as well as by palpation. The L5-S1 disk can be exposed in between the bifurcation of the iliac vessels. Following this, the middle sacral artery and vein are doubly ligated and divided. For exposure of L4 or above, the iliolumbar vein(s) are identified, ligated, and divided (Figs 1 and 2). Automatic clips on the distal aspect of the vessel are very helpful. Blunt and sharp dissection is used to mobilize the iliac vessels off the anterior surface of the spine. Smaller tributaries of the iliac vein can be ligated and divided using bipolar cautery. Use of the bipolar is important in limiting potential injury to sympathetic and parasympathetic nerves. Vessel loops are placed around the iliac vessels and retracted to the right. Segmental lumbar vein and arteries are ligated typically one level above the desired exposure to avoid shearing off the inferior vena cava or aorta. At this point, adequate exposure is generally ensured for the desired orthopedic procedure. Pedal pulses are checked preoperatively, intraoperatively, and in the recovery room.

**RESULTS**

A total of 482 anterior spinal exposures were performed on 480 patients. The median age at operation was 42 (range 19-74) and 55% (267) of patients were men. One hundred thirty-nine patients (28.8%) had previous spinal procedures, most commonly posterior spinal fusion. A retroperitoneal approach was utilized in 456 cases via a midline, paramedian, transverse, Pfannenstiel, or oblique skin incision. 52% of procedures were done via a lower midline skin incision, currently the preferred approach. Other approaches include thoracolumbar (14), flank (6), thoracoabdominal (4) and transperitoneal (3). 118 anterior fusions (24.4%) were performed in conjunction with a posterior spinal procedure during the same anesthetic. Seven exposures were for artificial disk placement and one patient underwent laparotomy for removal of a dislodged artificial interlumbar disk. Operative indications are listed in Table I.

One spinal level was exposed in 41.9% (202/482) of cases (Table II). The average number of levels explored was 1.78 (range 1-8). The most common levels exposed were L5-S1 and L4-5 (Table III).

Median estimated blood loss for exposure was 150 cc, and there were no perioperative mortalities. A vascular injury occurred in 11% (54/480) of patients. This included two arterial injuries and 52 venous injuries. The preponderance of injuries were minor (45/54) and were treated with
simple suture repair. The most common site of injury was the left common iliac vein (Table IV).

Even though nine injuries were classified as major by prior definitions, seven were treated with suture and did not require any reconstruction. Of these, two were arterial injuries, while seven others were venous. One arterial injury sustained was from an avulsed branch of the left internal iliac artery, which was easily controlled with surgical clips and suture ligation. This patient required intraoperative transfusion of one unit of packed red blood cells. The other arterial injury sustained was a laceration of the left common iliac artery secondary to orthopedic implant which required vascular reconstruction using Dacron graft. Three major injuries to the left common iliac vein and three major injuries to the left internal iliac vein were repaired with suture. One major injury occurred secondary to a tie that became dislodged from a previously divided iliolumbar vein that was repaired with suture ligation. One patient sustained an avulsed branch of the left internal iliac vein that bled sufficiently to require transfusion of 1 unit of cell-saver blood as well as placement of packs that were removed 24 hours later. Finally, one patient sustained an avulsed branch of the right common iliac vein that was repaired with suture but required one unit of packed red blood cells. The average estimated blood loss (EBL) for major vascular injuries was 520 cc. Though not explicitly studied, no arterial or deep vein thromboses, pulmonary emboli, or long-term vascular sequelae were noted.

Of 318 patients who had exposure of L4-5, 44 experienced a vascular injury (13.8%) while in the remaining 162 patients, only nine experienced a vascular injury (5.6%). Statistical analysis revealed that exposure of L4-5 is associated with increased rate of injury (odds ratio [OR] = 2.73, P = .005 for all injuries, OR = 3.9, P = .005 for all injury). A significantly lower risk of injury was seen in isolated L5-S1 exposures (6/123 patients with isolated L5-S1 had injury vs 47/358 patients who had exposure of other level(s); OR = .34, P = .01). Interestingly, multilevel exposures as an independent factor did not predict vascular injury (32/275 patients with multilevel exposure vs 20/201 patient with one level exposure, 10.0% vs 11.6%; OR = 1.18, P = .66). One hundred thirty-nine patients had a history of previous spinal surgery (Table V). A previous history of spinal surgery was not predictive of increased risk of vascular injury (17/54 patients with injury had previous procedure vs 47/358 patients who had exposure of other level(s); OR = .34, P = .01). No independent variable predicted risk of major vascular injury. Data on postoperative morbidity was not kept. However, no mortalities were noted.

Table IV. Location of vascular injury

<table>
<thead>
<tr>
<th>Location</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left common iliac vein</td>
<td>44</td>
<td>81.5</td>
</tr>
<tr>
<td>Left internal iliac vein</td>
<td>3</td>
<td>5.6</td>
</tr>
<tr>
<td>Right common iliac vein</td>
<td>2</td>
<td>3.7</td>
</tr>
<tr>
<td>Iliolumbar vein</td>
<td>2</td>
<td>3.7</td>
</tr>
<tr>
<td>Inferior vena cava</td>
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<td>1.9</td>
</tr>
<tr>
<td>Left internal iliac artery</td>
<td>1</td>
<td>1.9</td>
</tr>
<tr>
<td>Left common iliac artery</td>
<td>1</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Table V. Previous spinal surgery

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior fusion</td>
<td>93</td>
</tr>
<tr>
<td>Laminectomy</td>
<td>12</td>
</tr>
<tr>
<td>Discectomy</td>
<td>9</td>
</tr>
<tr>
<td>Anterior fusion</td>
<td>4</td>
</tr>
<tr>
<td>Discography</td>
<td>3</td>
</tr>
<tr>
<td>Anterior/posterior fusion</td>
<td>1</td>
</tr>
<tr>
<td>Artificial disk implant</td>
<td>1</td>
</tr>
<tr>
<td>Laminotomy</td>
<td>1</td>
</tr>
<tr>
<td>Foraminotomy</td>
<td>1</td>
</tr>
<tr>
<td>Posterior fusion/laminectomy</td>
<td>1</td>
</tr>
<tr>
<td>Unknown</td>
<td>13</td>
</tr>
</tbody>
</table>
DISCUSSION

The anterior approach for lumbar surgery was first described by Ito et al for the treatment of Pott’s disease in 1934. Since its introduction and modification, the anterior approach has been popularized as an acceptable method for exposure of the anterior spine. This has been possible, in part, because of the introduction of new cages and artificial lumbar disks that can be used for the treatment of degenerative disk disease, scoliosis, and spine instability due to failure of previous posterior spinal fusion. When the orthopedic or neurosurgeon does not perform the exposure, vascular or general surgeons are enlisted to create access to the lumbar spine. Since many centers have adopted a multidisciplinary approach employing separate teams for approach and spinal instrumentation, it is imperative that all involved surgeons have a thorough understanding of the procedure as well as potential pitfalls.

The overall complication rate for open anterior lumbar exposures has been estimated to be as high as 30% to 40%. Such complications include, but are not limited to, vascular injury, bleeding, thrombosis, damage to nervous or genitourinary structures, postoperative infection, seroma formation, bowel perforation, hernia, and ileus.

The most prevalent and feared complication is due to vascular injury, which has an overall published rate of incidence ranging from as low as 1.9% to as high as 15.6%. When restricted to examining intravascular injury using the definitions outlined, the results of this series indicate that injuries occur in 11% of patients. This incidence is similar to rates reported by others. The majority of these injuries were avulsed branches of the left common iliac vein (27) or common iliac vein lacerations (16) that were repaired with sutures. While the stated definition of injury may appear overly stringent, this is consistent with criteria used by other authors. Furthermore, it is important to track all injuries requiring a stitch for repair, as manipulations of the aorta, vena cava, and iliac vessels can often exacerbate small injuries that would seem negligible in other procedures.

Arterial injuries occur in 0.45% to 1.5% of cases and generally present as thrombosis or vasospasm though arterial lacerations and avulsions are known to occur. While arterial complications are rare, the sequelae can be quite serious. In contrast to arterial thrombosis, which are most often seen in the postoperative phase, arterial lacerations are generally immediately evident. When encountered, they can typically be repaired directly with suture. In our study, two arterial injuries were encountered in 482 procedures. One case resulted in an iliac artery laceration secondary to an exposed prosthetic device that necessitated an arterial reconstruction with Dacron graft. While our study found several cases of adhesions of the vena cava to the lateral spine in patients who had undergone prior posterior instrumentation, based on the fact that the majority of patients who had undergone previous spine surgery were operated on via a posterior approach, it is not surprising to find a lack of relationship between prior surgery and increased risk of vascular injury. Although 66% (6/9) of patients who sustained major vascular injuries and 50% (1/2) of patients who sustained arterial injury had undergone previous spine surgery, our sample sizes were too small to predict increased risk of either major vascular injury or more specifically arterial injury with any certainty.

CONCLUSION

Anterior lumbar surgery has many distinct advantages to posterior surgery and has become an increasingly attractive and popular alternative to posterior spinal fusion. Regardless of technique employed, the anterior lumbar approach requires extensive dissection that places vascular structures at risk of injury. A detailed understanding of
retroperitoneal anatomy in combination with careful operating and a heightened vigilance for intraoperative and postoperative complications is essential for patient safety.

AUTHOR CONTRIBUTIONS
Conception and design: AH, MS, FP
Analysis and interpretation: AH, JM, MS
Data collection: AH, JM, BA, SB
Writing the article: AH, JM
Critical revision of the article: AH, JM, MS
Final approval of the article: AH
Statistical analysis: AH, JM, MS, SD
Obtained funding: AH, FP
Overall responsibility: AH, FP

REFERENCES

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