J Neurosurg (Spine 1) 96:1–5, 2002

Vascular complications in anterior thoracolumbar spinal reconstruction

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Object. Anterior approaches in thoracic and lumbar spinal surgery have potentially serious vascular injury–related complications. In this study the authors evaluate the incidence of vascular complications in anterior approaches to the thoracic and lumbar spine in cases requiring reconstructive surgery.

Methods. The authors retrospectively reviewed the medical records of 207 patients who underwent anterior thoracic and lumbar spinal reconstructive surgery during the period from 1992 through 1999 to determine the incidence, causes, and management of vascular complications.

Overall, the incidence of vascular complications following reconstructive spinal surgery was 5.8% (12 patients) and the mortality rate was 1% (two patient deaths). In seven patients (3.4%), direct vascular injuries developed as a result of surgical techniques or error; one patient died as a result. Five patients (2.4%) developed deep venous thromboses, and one patient in this subgroup died of pulmonary embolism.

Conclusions. Vascular injury to the great vessels is a known and potentially serious complication associated with anterior spinal reconstructive procedures. The authors found, however, that the incidence is relatively low in cases in which venous injuries occurred acutely and arterial injuries presented in a delayed fashion.

KEY WORDS • vascular complication • vascular injury • spinal cord • reconstruction

THE number of anterior thoracic and lumbar spinal procedures in the treatment of a wide variety of degenerative, neoplastic, traumatic, and infectious processes involving the vertebral column has dramatically increased in recent years.[10–12,15,16] Because these procedures require mobilization and retraction of major vascular structures, certain patients are at higher risk of developing vascular complications.[1,6,8,13,15,16]

It is well known that anterior approaches to the spine are associated with a significant risk of vascular injury; however, little is known of the incidence and management of vascular complications associated with anterior approaches to the thoracic and lumbar spine. Intraoperative vascular complications associated with these procedures are readily apparent at surgery, whereas delayed vascular complications are typically more insidious.

In this study our objective was to evaluate the incidence and management strategies of vascular complications in a large series of patients who underwent anterior thoracic and lumbar reconstructive spinal surgery.

Clinical Material and Methods

Patient Population

A retrospective review of 207 patients who underwent anterior thoracic and lumbar spinal reconstructive surgery between 1992 and 1999 at University of California at Los Angeles Medical Center and affiliated hospitals was conducted to evaluate the incidence, causes, and management of vascular injuries and complications. There were 95 men and 112 women whose mean age was 56.7 ± 7.8 years (standard deviation).

The indications for surgery are detailed in Table 1. In five patients (2.4%) anterior spinal procedures had been previously performed. Traumatic injury, neoplasms, and degenerative disorders were the most common indications for surgery (162 cases [78.3%]). Overall, the majority of patients underwent one-level reconstruction (Table 2).

Surgical Approaches

Transsternal (T1–4), posterior thoracotomy (T4–12), thoracoabdominal (T12–L1) and anterior retroperitoneal (L2–5) approaches to the spine were all performed in the standard fashion by experienced spine and vascular surgeons (Table 3).

Results

Vascular complications developed in 12 patients (5.8%) following spinal reconstructive surgery, and two patients (1%) died. Direct vascular injuries occurred in seven patients (3.4%) and one patient died (see *Illustrative Case*). Of five patients (2.4%) in whom DVT developed, one patient died of a massive pulmonary embolus.

Abbreviations used in this paper: CT = computerized tomography; DVT = deep vein thrombosis.

TABLE 1

Indications for anterior thoracolumbar spinal reconstruction in 207 patients

Indication	No. of Patients (%)
trauma	64 (30.9)
neoplasm	56 (27.1)
degenerative disorders	42 (20.3)
infection	26 (12.6)
reop for failed posterior fusion	16 (7.7)
posttraumatic syringomyelia	3 (1.5)
total	207

The incidence of direct vascular injuries associated with surgical techniques and error was 3.4% (seven patients). Five of these cases were acute venous injuries, and two were arterial in origin and developed in a delayed fashion.

Of the five cases of acute intraoperative vessel injuries, the common iliac vein was injured in three cases and the inferior vena cava in two cases. In three cases the injury was associated with mobilization of a densely scarred retroperitoneum which was caused by a previous L4–5 anterior spinal surgery. In the other two cases, in which L3–4 reconstruction was performed, tuberculous and bacterial osteomyelitis, respectively, were present. Overall, because there were 26 patients who underwent anterior spinal surgery for vertebral osteomyelitis or disc infections, the vascular injuries that occurred in the latter two cases represent an incidence of 7.7% (Table 4). All patients with acute venous injuries underwent primary repair, and there were no postoperative complications such as venous thrombosis, embolization, phlebitis, or venous insufficiency.

In this series there were no cases of acute arterial injuries to the aorta or aortoiliac arterial system. There were, however, two cases (1%) in which delayed vascular complications, which were arterial in origin, developed. Both of these patients initially underwent transthoracic surgery for symptomatic vertebral fractures (one pathological and one traumatic injury). One patient underwent successful reoperation in which ligation of an avulsed intercostal artery was performed 2 days following the initial operation. The other patient suffered a fatal hemorrhage resulting from an aortic dissection and rupture following the initial surgery before reoperation could be undertaken (see *Illustrative Case*).

Illustrative Case

Case 1

History. This 68-year-old man presented with symptomatic back pain and progressive paraparesis secondary to a T6–7 solitary plasmacytoma that caused a pathological fracture (Fig. 1). Initially he underwent radiotherapy, but because progressive kyphosis and paraparesis developed, surgical reconstruction was required. His medical history was significant for severe chronic obstructive pulmonary disease and recurrent asthmatic bronchitis treated with long-term steroid therapy. Other risk factors included severe peripheral vascular disease, a smoking history of 40 packs of cigarettes per year, and a right middle cerebral artery aneurysm that was surgically clipped 10 years prior.

TABLE 2

Number of spinal levels reconstructed in 207 patients

No. of Levels	No. of Patients (%)
1	143 (69.1)
2	61 (29.5)
3	3 (1.5)

Operation. A left posterior thoracotomy and T6–7 corpectomy, tumor resection, and spinal cord decompression were performed. Vertebral body reconstruction was successfully performed by placing a titanium mesh cage filled with autologous iliac crest bone graft and a T5–8 anterolateral plate system (Fig. 2).

Postoperative Course. The postoperative course was prolonged because of the patient's poor pulmonary function and because the process of weaning him from the ventilator was slow, requiring reintubation and subsequent placement of a tracheostomy. He made slow progress until postoperative Day 11, when he complained of severe midthoracic back pain, and 300 ml of bright red blood was drained from the chest tube. A chest CT study revealed a hemothorax and a dissecting aneurysm of the descending thoracic aorta (Fig. 3). Shortly thereafter, he suffered a massive hemorrhage before surgical reexploration could be performed. Postmortem examination revealed a severely calcified aortic wall in which a transmural rupture of a dissecting aortic aneurysm had occurred at the site where the aorta was retracted for spinal reconstruction. The aortic rupture appeared to be related to surgical retraction of the calcified vessel wall and was not related to direct compression or injury from the spinal instrumentation as the dissection was superior and anterolateral to where the spinal hardware had been placed.

Discussion

Background and Summary of Findings

The literature in which vascular complications associated with spinal surgery is described is largely limited to acute injuries associated with a posterior approach lumbar laminectomy and disc excision.[2–4] Vascular injuries in cases of lumbar discectomy are actually quite rare, and most occur when an instrument penetrates the anterior annulus and injures the common iliac vessels at the L4–5 level. In a large series of 6000 patients who underwent lumbar discectomy, DeSaussure[3] reported only one vascular injury, for an incidence of 0.017%. Harbiston[6] found that the mortality rate in cases of these vascular complications exceeded 50%; however, if they were treated with

TABLE 3

Surgical approaches in 207 patients

Surgical Approach	No. of Patients
transsternal (T1–4)	5
posterior thoracotomy (T4–12)	103
thoracoabdominal (T12–L1)	58
retroperitoneal (L2–5)	41

TABLE 4

*Mechanisms of vascular complications in anterior approaches to the spine**

Case No.	Age (yrs), Sex	Approach, Level	Cause	Time	Cause of Complication	Medical Treatment	Complication
1	67, M	posterior thoracotomy, T-6	aortic dissection w/ massive hemothorax	postop Day 11	dissection postop secondary to retraction	patient died prior to intervention	death
2	83, F	posterior thoracotomy, T-12	intercostal artery avulsion	postop Day 2	postop avulsion	reexploration w/ ligation	none
3	66, M	lumbar retroperitoneal, L3–4	IVC	intraop	retraction during exposure (TB osteomyelitis)	primary vascular repair	none
4	61, F	lumbar retroperitoneal, L3–4	IVC	intraop	retraction during exposure (bacterial osteomyelitis)	primary vascular repair	none
5	63, M	lumbar retroperitoneal, L3–4	common iliac vein	intraop	retraction during exposure (previous L4–5 surgery)	primary vascular repair	none
6	61, F	lumbar retroperitoneal, L4–5	common iliac vein	postop Day 3	DVT	IVC filter	none
7	62, F	lumbar retroperitoneal, L3–4	common iliac vein	postop Day 4	DVT	anticoagulation	none
8	64, M	lumbar retroperitoneal, L4–5	common iliac vein	postop Day 2	DVT	anticoagulation	none
9	47, F	lumbar retroperitoneal, L4–5	common iliac vein	intraop	retraction during exposure (previous L4–5 surgery)	primary vascular repair	none
10	57, M	lumbar retroperitoneal, L4–5	common iliac vein		retraction during exposure (previous L4–5 surgery)	primary vascular repair	none
11	53, F	lumbar retroperitoneal, L4–5	common iliac vein	postop Day 3	DVT	anticoagulation	none
12	59, M	lumbar retroperitoneal, L4–5	common iliac vein	postop Day 2	DVT, pulmonary embolus	patient died prior to intervention	death

* IVC = inferior vena cava; TB = tuberculosis.

surgical exploration and vessel repair within 24 hours, the mortality rate decreased to 24%. Although these injuries rarely occur, they remain a distinctly different complication from those that occur as a result of anterior exposures, which place major vascular structures at risk during spinal procedures.[5,10–12,14–16]

The purpose of this report was to evaluate the incidence and cause of vascular complications associated with anterior spinal reconstruction. Technical errors and decision making regarding the surgical procedure were indeed the cause of the most frequent vascular complications in this series.

Anterior Surgery and Vascular Injuries

The incidence and management of vascular complications during anterior approaches to the thoracolumbar spine are not well known, and it is likely that most acute or delayed vascular injuries and complications are not reported. Although the authors of several reports discuss vascular injuries, in only one do the authors specifically address the incidence of those associated with anterior spinal surgery.[1] The series reported on by Baker, et al.,[1] largely reflected the use of anterior reconstruction to treat degenerative lumbar disc disease, and the authors reported an overall incidence of 15.6% of acute intraoperative venous injuries. This result was largely attributed to the limited exposure obtained with the mini–anterior lumbar interbody fusion for which the complication rate was 18.4% compared with that for the standard open retroperitoneal exposure which was 7.7%.

In other reports on anterior thoracolumbar spinal procedures the authors have cited acute venous complication rates ranging from 2 to 4% and rates of DVT of approximately 10%.[9,11,12] Our experience was similar to that of Baker, et al.,[1] but we found much lower rates of acute intraoperative venous injuries (2.4%) and DVT (2.4%). Our two cases of arterial injury were distinctly unique, as no other arterial injuries associated with anterior spinal reconstruction have been described.

Causes of Vascular Injuries

Venous injuries are associated with vessel mobilization and retraction or laceration during spine surgery in which direct repair is needed. Hemorrhage-related delayed venous complications are unlikely because of a tamponade effect exerted by lower venous pressures. Based on our review of the literature on venous injuries, we found that the most common complications are thrombophlebitic syndrome, DVT, and postrepair thrombosis.[1,6,7,9,13]

The anatomical location at which spinal procedures are performed may also relate to the type of vascular injury most likely to occur.[8] Most anterior lumbar spinal procedures are performed via a left-sided approach, which involves mobilization of iliac vein that overlies the L4–5 intervertebral disc; the L5–S1 disc lies between the iliac vessels, which are not at high risk. The aorta is retracted in the upper-lumbar/thoracic region and is not typically at high risk for injury. Vascular tortuosity of the aorta and iliac arteries can vary significantly with progressive patient age and many affect the degree of retraction needed to expose the spinal column.

Alternatively, right-sided surgical exposures would primarily place the vena cava and its major venous tributaries

FIG. 1. Sagittal T_2-weighted magnetic resonance image of the thoracic spine revealing a solitary tumor mass at the level of T6–7. An isointense mass with moderate contrast enhancement and a homogeneous hypointense mass are shown.

FIG. 2. Postoperative x-ray film demonstrating a titanium mesh cage filled with autologous iliac bone graft and T5–8 anterolateral plate system.

at risk for acute injuries, and arterial injuries would be less likely. Because the vena cava is actually located more anteriorly than the aorta and does not become ectatic with age, a right-sided exposure may be the preferred approach in elderly patients. In our illustrative case it was believed that a left-sided thoracotomy would ensure a more direct approach to the lesion. Given the patient's outcome, we strongly believe that the left-sided approach and the anterior positioning of the spinal instrumentation predisposed this patient to developing a dissecting aneurysm despite the fact that it was not directly caused by the prominent instrumentation (Figs. 2 and 3).

Division of intercostal vessels in anterior spinal procedures places each intercostal vessel, as well as the adjacent levels, at risk for rupture or avulsion, particularly in cases of arteriosclerotic vessels. Because intercostal arteries are direct, high-pressure conduits off the aorta, they may be more prone to delayed complications related to a partial avulsion injury. The thoracic aorta may be at the highest risk for this type of injury because it is relatively immobile as a result of multiple small segmental vessels. Conversely, the lumbar aorta and aortoiliac vessels may be at lower risk because of their greater mobility. In one of our patients an avulsion of an intercostal artery developed as a result of an intraoperative surgical error and was most likely not recognized at that time, or it developed postoperatively secondary to retraction-induced injuries.

Management of Vascular Complications

Clinical symptoms of a delayed vascular injury are varied, subtle, and difficult to diagnose. Patients with venous complications can present with cough, shortness of breath, dyspnea, hemoptysis from a pulmonary embolism, or leg swelling secondary to a DVT. These are appropriately evaluated by obtaining lower-extremity Doppler studies, ventilation perfusion scans, and pulmonary angiograms and should be managed by anticoagulation therapy or placement of a vena cava filter if the patient cannot undergo anticoagulation therapy.

Arterial complications are more likely to cause hemodynamic instability, which is evidenced initially by tachycardia and subsequently by hypotension. The sudden onset of pain or hemodynamic instability should prompt an evaluation, which should include assessment of vital signs and hematocrit levels, an electrocardiogram, and whole-body CT scan obtained through the surgically treated region to evaluate for the most immediate life-threatening causes.

Although the presence of an arteriovenous fistula in such cases has not been reported in recent years, it was described as a delayed complication associated with lumbar discectomy.[13] These injuries are extremely rare and can arise after anterior spinal surgery, causing complex hemodynamic changes with nonspecific symptoms such as deep vein phlebitis, abdominal discomfort, and ultimately may cause severe hemodynamic alterations secondary to congestive heart failure.

Prevention and Alternative Surgical Procedures

Preoperative studies in which CT scans and magnetic

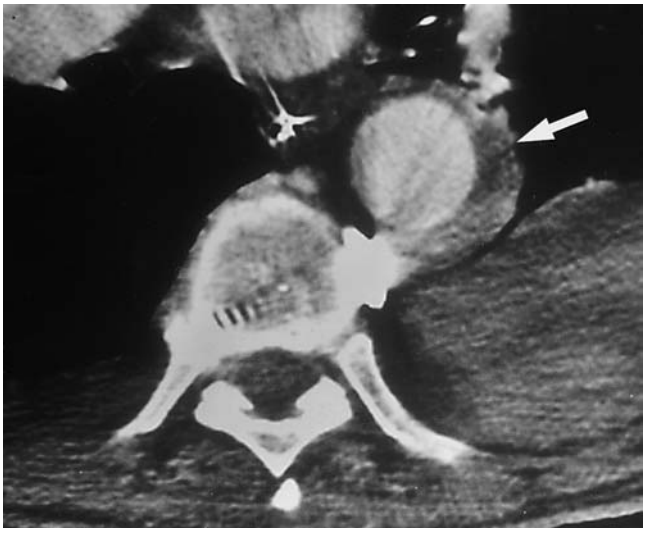

FIG. 3. Chest CT scan revealing a hemothorax and dissection of the descending aorta with the true lumen measuring 3 cm in diameter. The crescentric false lumen *(arrow)* measures 1 cm in thickness posterolaterally.

resonance images are acquired can reveal the relative position of the aorta to the vertebral column and may assist the spine surgeon in determining the degree of vessel retraction required during the procedure. Thus, a tortuous aorta may require that a different surgical approach be performed to prevent unnecessary retraction in those patients in whom risk factors for systemic vascular disease are significant. Consideration of an alternative surgical approach with a posterolateral extracavitary or costotransversectomy procedure would also avoid direct mobilization of major vascular structures.

Although there are anecdotal reports of spinal instrumentation and prominent hardware potentially causing vascular injury as a result of erosion into a vessel wall, none has been cited in the literature. Nonetheless, potential complications associated with placement of anterior spinal hardware should be considered when evaluating a patient who presents with clinical symptoms of vascular injury.

Because elderly patients have the most significant risk factors for systemic vascular disease, the surgeon should be aware of the possibility of vascular injuries and consider different surgical approaches in which mobilization and retraction of major vasculature are minimized as was illustrated in our case.

Conclusions

Vascular complications can and do arise in patients undergoing anterior spinal reconstruction procedures in which mobilization and retraction of major vascular structures are often required. Although such complications are uncommon, our experience suggests that acute or delayed vascular complications can arise when performing these approaches. The risk of venous injury is small and is associated with mobilization of the common iliac vein at L4–5, particularly in patients who have undergone previous anterior spinal surgery or those with osteomyelitis. Arterial injuries are even more infrequent; however, they are most likely to occur in elderly patients with underlying vascular disease.

In summary, we have found that if one does not pay meticulous attention to the surgical techniques involved (that is, side of surgery, site of reconstruction, retraction of vascular structures, and placement of hardware), such inattentiveness will increase the potential risk of causing major vascular complications. Careful planning regarding surgical techniques and early recognition with rapid treatment of all complications regardless of the cause can reduce potential morbidity and mortality.

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Manuscript received March 19, 2001.
Accepted in final form August 22, 2001.

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