MAJOR VASCULAR COMPLICATIONS OF INTERVERTEBRAL DISC SURGERY*

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SINCE THE REPORT of Mixter and Barr in 1934,[7] many thousands of operations for the removal of protruded intervertebral disc have been performed. The mortality and morbidity have been low. In 1945, however, Linton and White[6] called attention to a complication not reported up to that time. This was an arteriovenous aneurysm between the right common iliac artery and the vena cava, discovered about seven months following a lumbar laminectomy for protruded disc. There was little doubt that the etiologic relationship was direct, although the patient had gone through the original operation without untoward event. Holscher,[3] a few years later, reported another similar accident, occurring while he was supervising another surgeon in the removal of an intervertebral disc; indeed, he was describing Linton's case when, following a sounding of the space with the closed pituitary forceps, there was a gush of blood. This injury also resulted in the formation of an arteriovenous aneurysm, which was later repaired. The complication was mentioned by Falconer, McGeorge and Begg in 1948,[2] and Mixter[8] in 1952, but no personal cases were described by these contributors. Seeley, Hughes and Jahnke in a very recent report[9] describe in detail two cases of injury to the great vessels, both of which were successfully salvaged.

Our interest in the subject was aroused by a single personal experience in the repair of such a complication, and we subsequently attempted to carry out a survey of the incidence of this type of injury.

CASE REPORT

Y. E., a 22-year-old registered nurse, was admitted to the Allegheny General Hospital in January, 1953, with a diagnosis of arteriovenous fistula. Her past history was negative, except for low back pain, which was entirely relieved after removal of a ruptured disc between the 4th and 5th lumbar vertebrae in August, 1952. The competent neurosurgeon who performed the surgery noted nothing unusual during the procedure except for moderate bleeding, easily controlled by gelfoam. Convalescence was uneventful; she returned to work as a secretary, and had no difficulty until about five months after operation, when she noted shortness of breath and swelling of the left leg.

Examination revealed orthopnea, râles in both bases, tachycardia, enlarged liver, ascites, and pitting edema of both ankles. A thrill was felt in the left lower quadrant, but no mass. A continuous murmur was heard over the entire abdomen and lower back, but loudest over the left groin. Sonograms (Fig. 1) supported this impression. An attempted aortogram was not successful. Blood pressure studies were as follows: left arm, 120/70; right arm, 120/70; left leg, 155/95; right leg, 150/90. The dorsalis pedis pulse was slightly decreased on the left. An electrocardiogram showed poorly defined T waves. Pulmonary congestion and marked cardiac enlargement were apparent in the film of the chest (Fig. 2).

Operation was performed on February 4, 1953. After evacuation of 2,000 cc. of ascitic fluid, the whole area over the promontory of the sacrum and up beneath the aorta and vena cava was found to be elevated by a large false aneurysmal sac (Fig. 4). Control of the aorta, then of the right and left common iliac arteries, and finally of the left common iliac distal to the fistula, was accomplished by careful dissection. The common iliac vein was never specifically identified, being incorporated in

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TABLE I

	Level	Vessel(s)	Injury Recognized	Treatment		Result	
				Immediate	Late		
1	5-1	CIA (l)	Yes	Repair rent—3 min.		Good	
2		CIA (l)	No			Died	
3		IA				?	
4		? AV			?	?	
5		Cava				Died	
6	3-4	Cava ?	No			Died 6 hrs.	(Army)
7		C. I.				Died hrs.	Hiccough (Navy)
8	4-5	CIA-V (r)	Yes		6 mos. Ligation	Good	
9		CIA-V (l) AV	No		18 mos. attempt. Repair	Died	2 operations for disc.
10		IA-V AV	No		3 wks. Sym. Ligation	Fair	Loss of Ant. ½ of foot
11		Aorta	No	Repair—fas. graft		Died 7 D	Crush syndrome
12	4-5	EIA-V (l)	Yes	Ligation		Died 7 D	Gangrene leg
13		Cava	Yes			Good	Gelfoam only
14	2-3	Aorta	Yes			Died hrs.	Aorta ruptured by ann.
15		Aorta				Died hrs.	Autopsy
16	4-5	CIA-V?(l) AV	No		2 mos. Sym. Ligation	Fair	Claudication
17	4-5	CIA (l)	No.	Repair		Good	
18	5-1	CIV (r)	No			Died 1 hr.	Autopsy (Army)
19	4-5	CIA (l)	Yes		1 mo. Ligation	Died	Infected hematoma
20	4-5	CIA	No			Died hrs.	Autopsy
21	5-1	CIA-V (l)	No	End-end repair-artery		Good	
22		IIA (l)	No	Rent repaired		Died 7 hrs.	Autopsy—Lig. thin
23	4-5	CIA (r)	No	Rent repaired		Died 12 hrs.	
24	4-5	CIA-V (l) AV	No		6 mo. Repair	Good	Case reported herein
25		Aorta	No		6 wks. Ligation aorta	Died	Autopsy
26		CIA (l)	No			Died hrs.	Autopsy
27	4-5	CIA-V	No			Died 7 D	3 Lac. in artery
28	4-5	CIA (l)	Yes	Rent repaired		Good	
29	4-5	CIA (r)	No	Hematoma inspected	6 wks.-graft-Ligation	Good	
30		CIA (r) cava AV	No		9 mo. Sym. Ligation	Good	
31	4-5	Ileum	Yes	End to end anast.		Good	

* Known data on 30 cases of vascular injury and one case of injury to the intestine occurring during operations upon lumbar intervertebral discs. CIA—common iliac artery. IA—iliac artery. EIA—external iliac artery. IIA—internal iliac artery. V—accompanying vein. (l) and (r)—left and right. AV—arteriovenous aneurysm. Sym—lumbar sympathectomy. Case numbers identify source of information as listed in bibliography. This does not necessarily identify the surgeon performing the original disc operation or the vascular repair.

the sac. The fistula was about 1 cm. long, on the postero-medial surface of the common iliac artery. It was then possible to approach the fistula safely and to place a Potts type clamp upon the artery (Fig. 5). The opening into the false sac was then cut across and sutured quickly; the artery was repaired with silk sutures maintaining its continuity. Sympathectomy was considered but not done because of the interposition of the false sac; also, it seemed unnecessary because of the continuity of the artery after repair. The patient received 1,500 ml. of blood during the operation.

Recovery was entirely uneventful. Within 12 hours the tachycardia had disappeared. The chest film 6 days postoperatively (Fig. 3) showed normal heart and lungs. All her symptoms disappeared. In March, 1954, she had a son, delivered by Caesarian section on my advice. At the operation the false sac was seen to have disappeared, and pulsations in the left iliac artery were quite satisfactory.

REPORT OF SURVEY

Letters requesting information on the problem were written to about 100 surgeons over the country, mostly to members of this Association. The responses have been courteous, frank and illuminating. Reliable information has been received concerning 25 injuries to the major blood vessels occurring as a result of surgery for intervertebral lumbar disc protrusion. These, together with the published cases of Linton, Holscher, and Seeley et al., plus the personal case herein reported, make a total of 30. In addition to the 30 cases of vascular injury, one instance of injury to the small intestine is also included. The data is assembled in Table I. The case number serves to identify the

writer from whom the details were obtained as listed in the bibliography. Certain case histories are unavoidably incomplete, but from the assembled information some valuable observations are made. Three fifths of the patients died (Table II), usually within hours after the injury. Of the total of 30 patients, arteriovenous aneurysms developed in six; of these, four survived, one died, and in one the outcome was not known (Table III). As expected, treatment following immediate recognition of the accident gives a better prognosis (Table IV). The most significant finding of the study, however, is shown in Table V. In 18 of 25 cases, at the time the laminectomy was completed, the diagnosis of great vessel injury was not made. Alarming hemorrhage through the wound did not occur.

TABLE II. *Mortality Figures.*

Total Cases	30
Outcome unknown	2
Good result	9
Fair result	2
Dead	17
(Mortality	61%)

TABLE III. *Incidence of Arteriovenous Fistulas.*

Total Cases	30
Arteriovenous aneurysms	6
Outcome unknown	1
Survived	4
Dead	1

The distribution of the lesions is shown diagrammatically in Figure 6. Most of the laminectomies were for discs between L_4 and L_5, and the common iliac vessels were most frequently injured. However, the complications occurred during operations as high as L_2 and L_3, and as low as L_5 and S_1. Obviously the higher the level the more likely the chance of injuring the aorta and vena cava, but at the lower levels there is the possibility of injuring various vessels, on either side. Reference to Figure 7, A, B, C and D reveals the anatomical relationships of the vessels (and the small bowel) to the intervertebral disc at several levels.

DISCUSSION

It is apparent from these data that during the course of removing lumbar intervertebral discs, direct instrumental injury may occur to the blood vessels lying immediately anteriorly.

In Case 7 the patient hiccoughed violently, with sudden flexion of his lumbodorsal spine, causing the pituitary rongeur to be driven forcibly forward; in Case 14 a piece of *annulus fibrosus* pierced an arteriosclerotic aorta. In these two cases the precipitating mechanism was apparent. Although it is tempting to assume that too vigorous instrumentation may be at fault, it should be noted that there is marked variation in the thickness and strength of the anterior longitudinal ligament and *annulus fibrosus*. Leavens and Bradford[5] have demonstrated, by diskogram, what apparently was a defect in the anterior *annulus fibrosus* which allowed the dye to escape anteriorly. Kredel[4] suggests that if the bony skeleton is not properly supported in the prone position, pressure upon the soft abdomen may force the vessels (and the small gut?) tightly against the vertebral bodies. If the longitudinal ligament were very thin or defective, and if the annulus

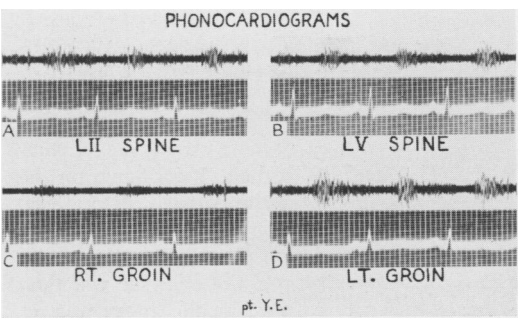


FIG. 1. Sonograms and simultaneous electrocardiograms recorded over lumbar spine and right and left groin. The bruit is maximal in left groin (D).

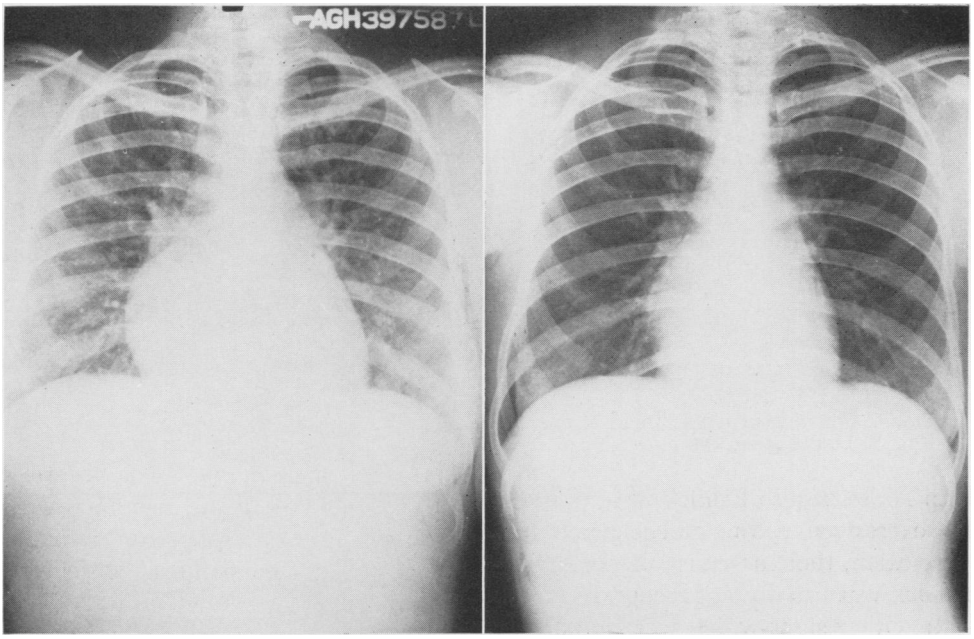


FIG. 2. Preoperative roentgenogram of chest showing cardiac enlargement and pulmonary congestion.
FIG. 3. Postoperative roentgenogram of chest showing normal heart and lungs.

were degenerated, actual protrusion of a portion of the vessel into the interspace might occur. This may explain Case 31, in which a piece of bowel mucosa was found in the pituitary forceps. Following closure of the laminectomy wound in this patient, a laparotomy was carried out, and the injured gut resected with end to end restitution of continuity.

Where the guilty instrument was identified, it was almost always the pituitary forceps. It seems logical to assume that a biting instrument could do more harm under these conditions than a scraping one, since the latter would be expected to push away the vessel wall. Holscher's case[3] is an exception, and in discussing it he stated "the ease with which this complication can occur can only be appreciated by the surgeon in whose hands such an unfortunate incident has happened." This statement is exceedingly important, since most of these accidents did occur in competent hands. Many notes are made that, at the time, the surgeon was being both gentle and careful, and the injury came as a complete surprise.

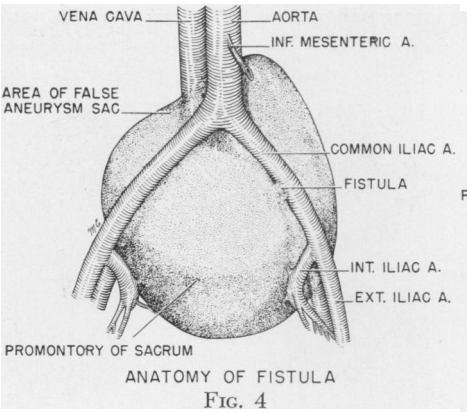
TABLE IV. *Effect of Immediate Treatment.*

No immediate treatment	19
Died	13
Immediate treatment	9
Died	4

TABLE V. *Injuries not Recognized at Time of Closure of Laminectomy.*

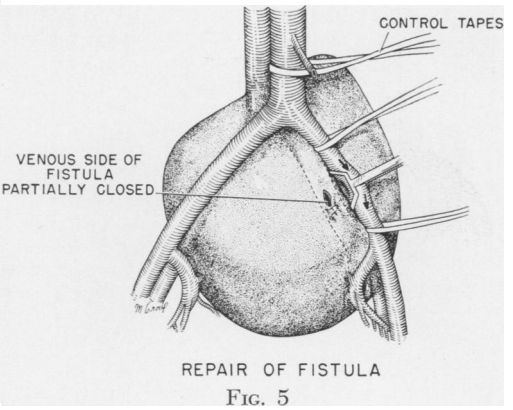
Cases	25
Accident unrecognized at time of closure of laminectomy	18

The diagnosis of injury to a great vessel in this series of cases was usually not immediately obvious. As previously emphasized, profuse bleeding into the wound occurred in only seven of 25 instances, Therefore, other signs must be considered. Analysis of the replies received in our survey reveals that in all fatal cases dying within 24 hours of operation, a fall in blood pres-



ANATOMY OF FISTULA

FIG. 4



REPAIR OF FISTULA

FIG. 5

FIG. 4. Drawing of lesion found at operation.
FIG. 5. Drawing indicating technic of repair.

sure and other signs of shock were present. Unless excessive bleeding had occurred during operation, the true cause of postoperative shock was usually not recognized until too late. Other signs which were important include a palpable abdominal tumor sometimes with a bruit, usually increasing in size, and a decreased or absent pulse in the affected extremity. If the patient had regained consciousness after anesthesia, pain, nausea and vomiting frequently occurred. The surgeon's most valuable asset at this time would seem to be a high index of suspicion, followed by careful examination. In the cases developing arteriovenous communications, characteristic bruits were of course heard, and several of these were diagnosed first because of heart failure, as in our own case.[24]

Treatment obviously depends upon prompt action. The action involves control of shock and hemorrhage, then restoration of vessel continuity, if possible. Seeley *et al.*[9] mention arterial transfusion in one of their cases, and this procedure may, in certain circumstances, be life-saving. Particular attention is directed to Cases 1, 28 and 21. Successful restoration of function was accomplished in all three under emergency conditions, in the first two by closure of the rent in the vessel and in the third by end to end anastomosis. Later elective procedures for the arteriovenous aneurysms would be expected to be successful.

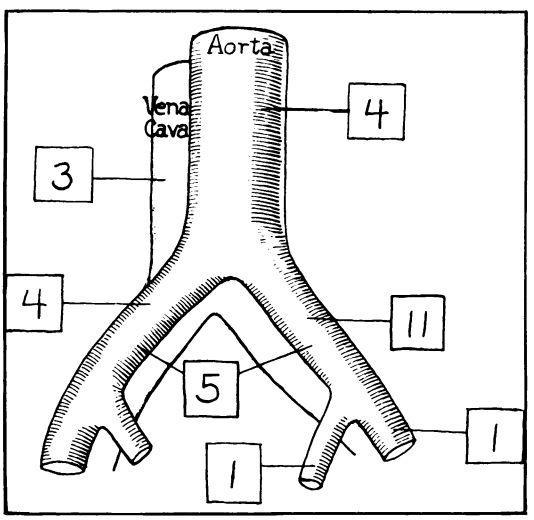


FIG. 6. Diagrammatic representation of the location of the reported injuries.

CONCLUSIONS

Injuries to the aorta, vena cava and iliac vessels occur uncommonly during the course of operations for removal of lumbar intervertebral disc. Thirty cases are herein reported following a survey.

In over half of the cases reported such injuries do not manifest themselves by external hemorrhage and therefore are frequently not diagnosed.

The injuries may occur in competent hands and in spite of the gentleness of in-

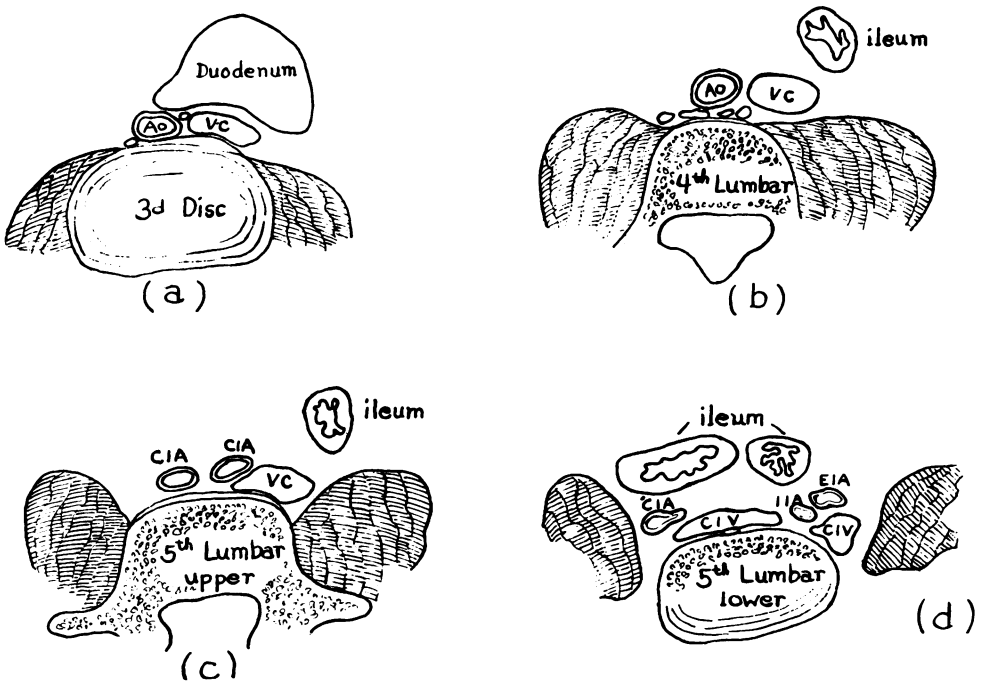


FIG. 7, A, B, C and D. Cross sectional anatomy showing relationships of vertebral bodies, discs, vessels and intestine at four lumbar levels.

strumental manipulation. Variations in the strength and thickness of the anterior longitudinal ligament and the annular ring, in addition to pressure caused by the prone position to force the vessels against the lumbar interspaces may contribute to the ease with which the accidents may happen.

A biting instrument, such as a pituitary forceps, appears more dangerous than a curet.

Prompt recognition of the complication, especially in the absence of overt hemorrhage, is essential for effective treatment.

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Case 21	Harwell Wilson
Case 22	Richard C. Schneider
Case 23	Rollin A. Daniel, Jr.
Case 24	Reported herein
Case 25	Francis Murphy
Cases 26, 27	Fritz Cramer
Cases 28, 29	See Ref. 9
Case 30	See Ref. 6
Case 31	Eldridge Campbell

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DISCUSSION.—DR. WILLIAM JASON MIXTER, Woods Hole, Massachusetts: I believe this is a very important subject, certainly to the neurosurgeon, because we don't want this to happen. There are various causes.

One, of course, is the feeling by some neurosurgeons that they must remove every bit of torn disk tissue from the cavity of the disk, and leave as little annulus as possible. Another is that there may be a tear anteriorly in the disk margin through which the curette or forceps may pass without any resistance whatever.

A homely analogy might be the case of the hole in the doughnut. If one strikes a doughnut sharply between the hands, the doughnut will not break simply in one, place, but almost always will break in two places. If the annulus breaks anteriorly as well as posteriorly, then you have a perfectly straight passage through the disk.

I would agree with Dr. Harbison that undoubtedly there are a good many more of these cases than have been reported, and I think it is up to the neurosurgeons to review their operative procedure and make sure that this does not happen any more frequently than we can possibly help.

DR. ELDRIDGE CAMPBELL, Albany, New York: Mr. President, Members and Guests: The anterior annulus and anterior longitudinal ligament are particularly likely to become attenuated, as Dr. Mixter has pointed out, in instances in which the disk is fragmented and loose, particularly when the two adjacent vertebrae are loose. In those cases one's instrument may pass through very readily, and if one is not aware of this possibility, enormous damage can be done.

In one instance to which Dr. Harbison referred, a patient whom I saw in consultation, the surgeon had recognized the accident immediately, had performed a laparotomy with repair of the ileum at once, thus preventing a catastrophe.

I know that I myself have gone through the anterior annulus at least twice, happily without any serious mishap.

In over 900 such cases on the Albany Hospital Neurosurgical Service we have had no such complication of which we were aware, and no deaths at all; but as Dr. Arthur Allen so appropriately remarked on a previous occasion, "it's the fat hog that needs to worry."

DR. SAMUEL P. HARBISON, Pittsburgh, Pennsylvania: There were a great many negative replies to the letters which were sent out. Dr. Spurling reported 2400 cases without a major vascular injury. However, in many of the other letters there were references to the complication which I could not include, because the data was not sufficiently complete. I am sure it is more frequent than previously believed.

I am frankly somewhat embarrassed to come before you on this subject, because I have never done an operation for intervertebral disk; but I will be very glad to consult if the patient bleeds or goes into shock.