

# SPINAL STABILIZATION: AN ANTERIOR APPROACH

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**A**nterior spinal reconstruction is often necessary in the treatment of pathologic conditions such as fractures, tumors, degenerative diseases, or deformities that are located in the anterior pillar of the spine.

Anterior spinal reconstruction may include resection of the pathologic lesion, anterior spinal decompression (a surgical procedure in which the release of pressure on the spinal cord and nerves is achieved by the removal of tissue and bone from around the spinal cord resulting in optimal nerve functions), bone grafting, and stabilization using an anterior spinal instrumentation system.

The spinal cord or the cauda equina (the nerves descending from the lower part of the spinal cord) is compromised by pathologic conditions in the anterior vertebral column much more than in the posterior. Therefore, the most logical treatment in some spinal diseases, for example, fractures, with neurologic deficits is an anterior spinal canal decompression. An anterior decompression should be performed following procedures such as vertebrectomy, discectomy, and resection of the posterior vertebral osteophyte.

General indications for anterior procedures to the thoracic and lumbar spinal regions are the following:

1. To furnish anterior spinal canal decompression.
2. To perform an anterior stabilization when there is (a) deficient bone anteriorly (owing to trauma, tumor, infection, degenerative disease, congenital causes, or deformity), (b) deficient bone posteriorly, (c) late posttraumatic kyphosis, or (d) late kyphosis following laminectomy!

Anterior spinal instrumentation used during reconstructive surgery is very useful for achieving correction of spinal alignment and for attaining immediate stability! It is most frequently performed in the thoracic and lumbar spinal regions. There are many anterior spinal instrumentation systems on the market today. One of these is the Kaneda anterior spinal fixation device (AcroMed Corporation, Cleveland, Ohio), developed by Kiyoshi Kaneda, MD. Dr Kaneda is a professor and chairman of the Department of Orthopedic Surgery, Hokkaido University, School of Medicine, Sapporo Hokkaido, Japan. The device offers a one-stage operation that consists of an anterior decompression by means of resecting the vertebral body in question (Figure 1). It was first used for stabilization after anterior decompression in the treatment of thoracolumbar (TL) burst fractures with neurologic deficits.<sup>2</sup>

The Kaneda device can be used not only for anterior reconstruction of the TL spine in treatment of burst fractures with neurologic deficits but for other spinal disorders as well.<sup>3</sup>

The purpose of this article is to provide surgical technologists with the information necessary to assist with anterior approaches to the thoracic and lumbar spinal regions and the use of the Kaneda device.

## Special Instruments

Each surgeon will have specific instruments that he/she wishes to use. Special equipment may include a drill, saw, or retractors, either hand-held or self retaining; these items should be readily available in the room. The following are those instruments that will most likely be used.

In using the anterior approach, a general or thoracic surgeon may open the incision, and extra-long instruments (right angles, Kellys, etc) and retractors (possibly large self-retaining) will be needed. Since work is being performed near the aorta and vena cava, stick ties should be available. For the orthopedic or spinal surgeon, extra-long Cobb elevators, osteotomes, curettes, and Kerrison and pituitary ronguers may be needed.

## Special Considerations

There are special considerations to which the CST first assistant should pay attention both before and during the operation. A Foley catheter is often inserted into the urinary bladder to monitor urine output, and an arterial line is required for management of air embolism. These two precautions are taken because excessive bleeding is anticipated due to the numerous lumbar veins and arteries. Most surgeons may want antiembolism stockinet or sequential compression devices on the lower extremities to help guard against blood clot formation. Special considerations also include having two suction machines available with one being a cell-saver.

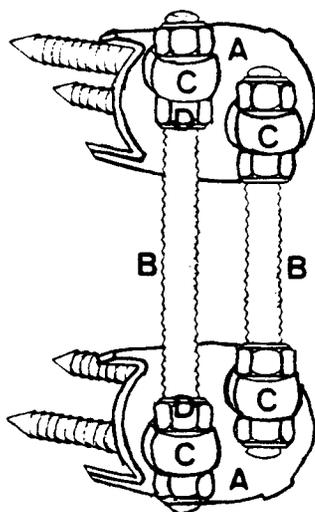
All room personnel should follow OSHA requirements concerning protective eyewear, and double gloving when possible is advised.

The CST first assistant can be most effective by paying attention to the little details that can help this surgical procedure go as smoothly as possible.

## Positioning

The patient is placed on the operating table in the lateral position with the side to be operated on facing superior. Maintaining a secure position is essential during this procedure. This may include using a bean bag positioner, pillows, blankets, or other devices. All peripheral nerves should be padded for protection, with special attention to the common peroneal nerve and the axillary nerve. The head is positioned to keep the cervical spine straight. The pelvis is immobilized by a safety belt and a wide adhesive tape across the greater trochanter and attached to the operating table (remember that the iliac crest must be available for graft harvesting). In most

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**Figure 1.** Kaneda device, new device for anterior instrumentation. The device consists of two pieces of the vertebral plate with tetraspikes (A), two rigid threaded rods (B), four screws (C), and eight nuts (D). These are affixed to the vertebral bodies above and below the injured body in a trapezoidal configuration.

cases, the patient position is stable enough to allow tilting of the table, because this tends to keep the patient's abdominal and retroperitoneal contents towards the nonoperative side. Once the patient has been positioned, an anteroposterior x-ray film should be taken to confirm that the patient's spinal column can be seen. The patient is then prepped and draped according to the surgeon's preference!

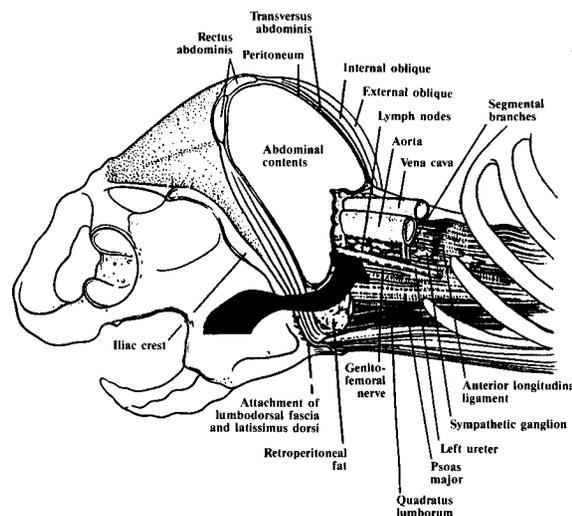
### Surgical Approach and Relevant Anatomy

The surgical approach in most patients should be based on the site of the primary pathologic lesion or the area of the fracture.

To approach the T11-T12 vertebral bodies, a thoracoabdominal approach may be needed, which involves a transpleural and retroperitoneal dissection. The lumbar vertebral bodies are approached through a retroperitoneal dissection.

When the retroperitoneal approach is made through an oblique flank incision, three muscles of the abdominal wall (external oblique, internal oblique, and transversus abdominis) are divided in line with the skin incision (Figure 2). The peritoneal cavity and its contents are gently mobilized and retracted medially. The exposure used for routine spinal fusion comes from the left because the aorta is on the left and is a much tougher structure that is more resistant to injury than the vena cava. When retracting the peritoneal contents, the ureter will follow since it is connected loosely to the peritoneum. The psoas fascia is identified and followed medially to reach the anterolateral surface of the vertebral bodies. Smaller vessels, the segmental lumbar arteries and veins, must be tied and ligated or excessive bleeding will occur. The sympathetic nervous chain along with the genitofemoral nerve are attached to the anterior aspect of the psoas muscle fascia and should be preserved.

The anatomy of a lumbar vertebra (Figure 3) will be discussed during the procedure.



**Figure 2.** The anterior abdominal musculature and viscera have been transected and removed at the level of the iliac crest. The arrow indicates the route of surgery between the peritoneum anteriorly and the retroperitoneal structures posteriorly.

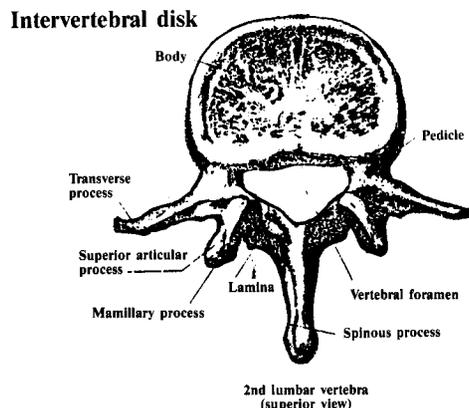
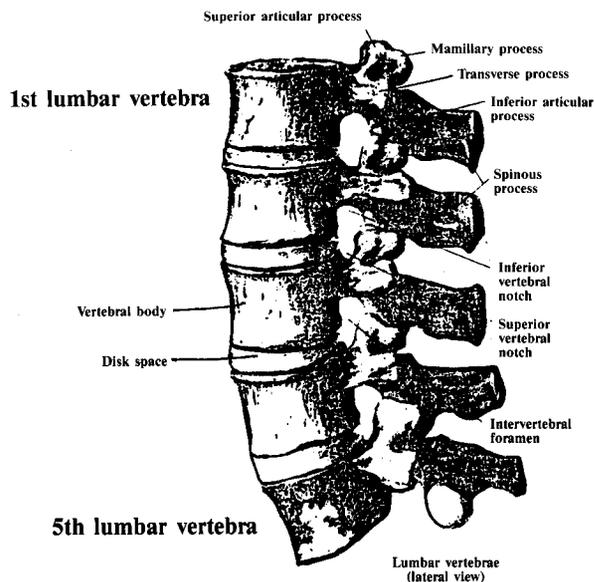
### Surgical Procedure

As mentioned previously, the approach for this procedure depends on the level of the lesion or fracture. The TL junction is approached through the bed of the 10th or 11th rib, usually resulting in the taking of that rib. The rib is saved in case the surgeon may want to use it as bone graft later. The costal cartilage is then split longitudinally, remembering that the retroperitoneal space is located just ventral. Blunt dissection is used to separate retroperitoneal fat and structures from the iliopsoas muscle and the spine itself (Figure 4).

Once the retroperitoneal space is opened, the aorta is identified by palpation. The aorta and vena cava are to be protected at all times. Next the thoracic portion of the exposure is extended, either by retropleural or intrapleural dissection. The diaphragm is peripherally transected and is marked for later closure if it prevents proper spine exposure. The segmental vessels in the area of proposed dissection are doubly tied and ligated according to the surgeon's preference. Using blunt dissection, the iliopsoas muscle is taken away from the spinal segments that are to be instrumented.

With exposure complete, an x-ray film may be necessary to confirm the correct level. The disks above and below the vertebral body in question are exposed and excised with knives, curettes, and disc rongeurs. The surgeon uses these instruments along with some type of power equipment (eg, Midas Rex drill) to perform the anterior decompression (Figure 5). Only three fourths of the vertebral body in question is excised leaving the anterior and deep cortex to enhance incorporation of the strut graft. At this point, bleeding is controlled. The Kaneda device is made ready for use.

The appropriate vertebral plates with terra spikes (staple with four spikes) are selected and tapped into place (Figure 6) remembering that the spikes of the plate should not be inserted into the intervertebral disk and do not touch the great vessels. These plates must be positioned so that a trapezoidal configuration is created. With this configuration, anterior



**Figure 3.** Anatomy of the lumbar vertebrae.

screws of the Kaneda device should be farther apart than the posterior screws. The length of the screw, chosen by use of a depth gauge, should allow its blunt tip to penetrate the contralateral cortex of the vertebra up to 2 mm. The screws are tightened so that the base of the screw head contacts the end plates (Figure 7).

Using a spreader, the kyphotic deformity that was formed is now corrected. This newly created deficit is measured with a ruler. A tricortical cortical iliac crest graft is obtained and the appropriate length is tapped into place (Figures 8 and 9).

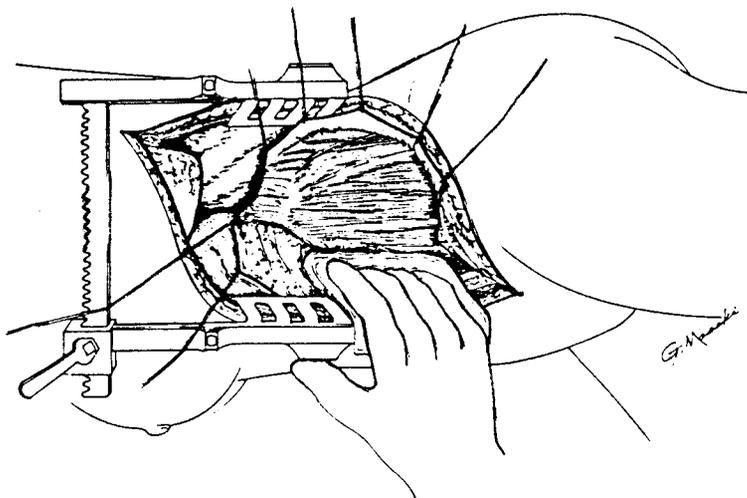
Absorbable gelatin (Gelfoam) is used to protect the anterior surface of the spinal cord. The bony fragments that were saved from the vertebrectomy are now added anteriorly to the iliac crest graft. A single iliac crest graft may not be large enough, so the entire bony deficit that was created should be filled with a bone graft.

Paraspinal rods of the appropriate length are now selected.

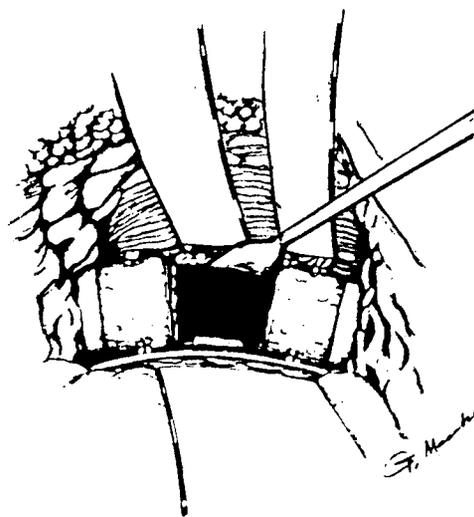
Before the rods are inserted, thread the nuts for the inner side of each screw so that they can be compressed into the eye of the screw. After the rods are inserted into the eye of both screws with the posterior rod being first, the outer nuts are added with a nut holder (Figures 10 and 11).

After the rods have been properly inserted, tightening the nuts on each end of each paraspinal rod, the graft is compressed into place. Because this system depends on strong, healthy tricortical graft for secure fixation and for long-term healing, if the graft is not firmly compressed during the instrumentation, the fusion will last. After the outer nuts have been tightened by using two wrenches and turning in the opposite directions, each rod is firmly locked into the eye of the screw. This technique stabilizes the paraspinal rod in the screw eye (Figure 12).

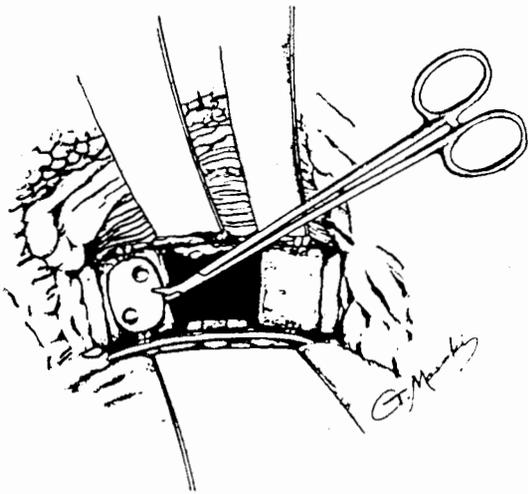
Two transverse fixators are added to create a rectangular configuration that appears in Figure 13. To close the wound,



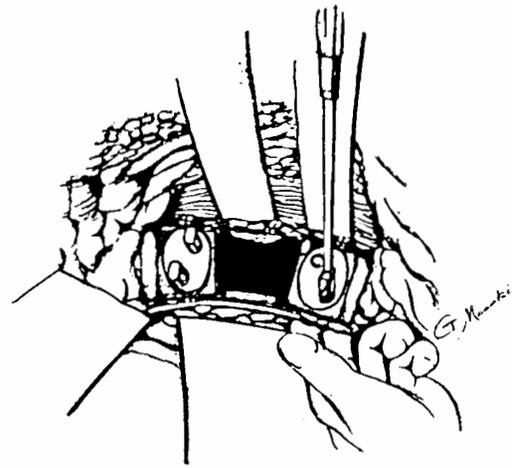
**Figure 4.** The iliopsoas muscle is bluntly dissected from the spinal segments that are to be instrumented.



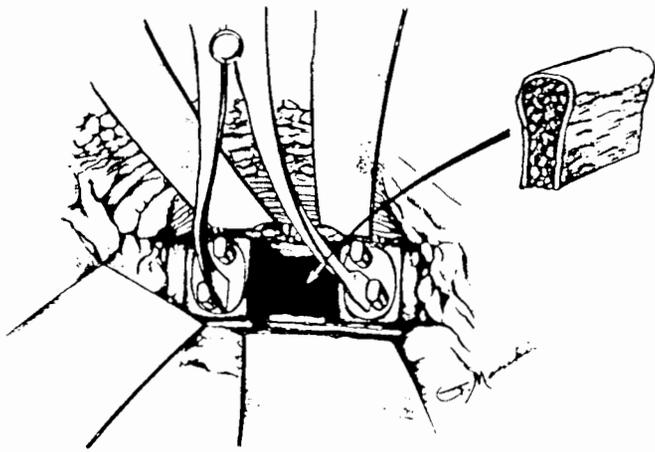
**Figure 5.** Vertebral body being resected.



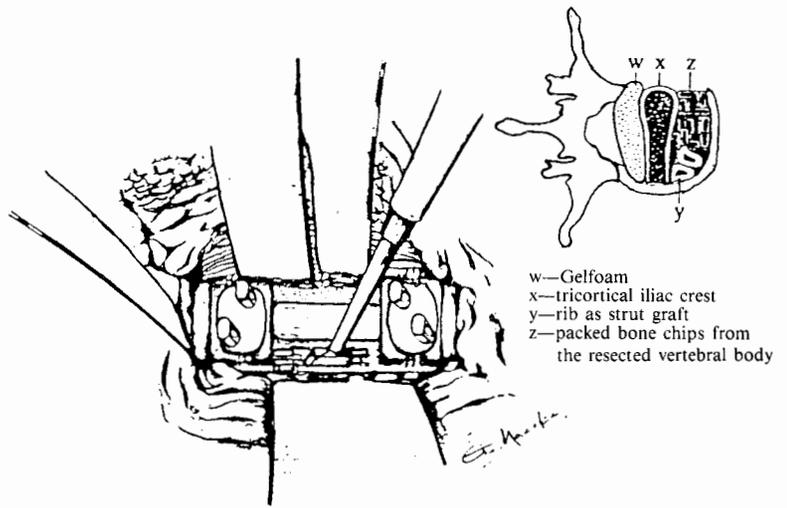
**Figure 6.** When decompression is complete, appropriate spinal plates are selected and tapped into place.



**Figure 7.** Vertebral screws are inserted through spinal plates.

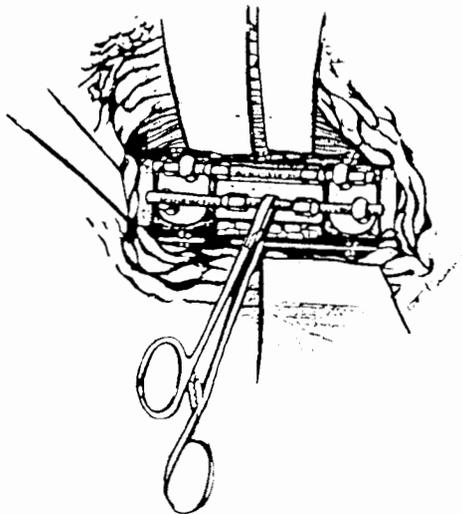


**Figure 8.** Using a spreader, the kyphotic deformity at the site of injury is corrected.

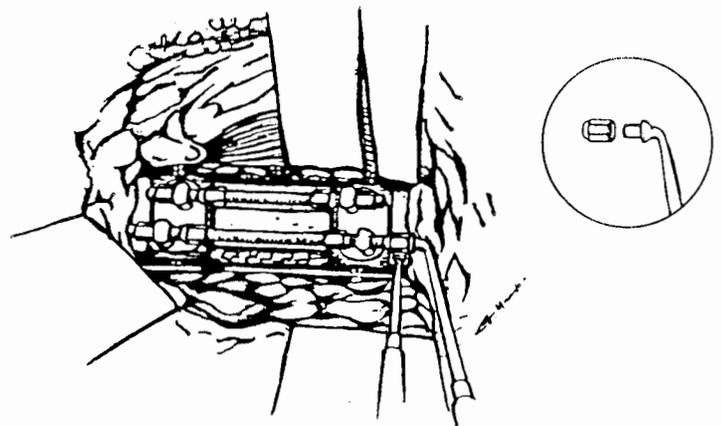


w—Gelfoam  
 x—tricortical iliac crest  
 y—rib as strut graft  
 z—packed bone chips from the resected vertebral body

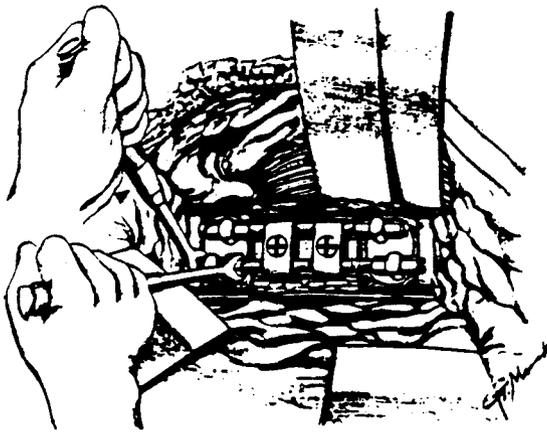
**Figure 9.** The tricortical bone graft is tapped into place.



**Figure 10.** Appropriate length paraspinal rods are selected to span the created defect.



**Figure 11.** The distal end nut is introduced into the rod with the nut holder. The insert shows the relation of the nut and the tip of the nut holder.



**Figure 12.** Final stage of instrumentation: tightening the nuts from both sides into the screw head holes.

the diaphragm is repaired if needed, and muscle layers are closed. If an intrapleural exposure was used, the chest is closed over a thoracotomy drain. If retropleural exposure was used, no chest drain is necessary. Drainage of the retroperitoneal space will depend on the surgeon. The wound is now closed in routine fashion according to the surgeon's preference, and a sterile dressing is applied.

### Complications

Complications that can cause the system to fail include the following:

1. Fracture-dislocation (contraindication)
2. Incorrect application of the vertebral plates
3. Misdirection of the screws into the spinal canal
4. Failure to tighten the nuts properly
5. Failure to fashion graft properly and compress it so share-loading can occur

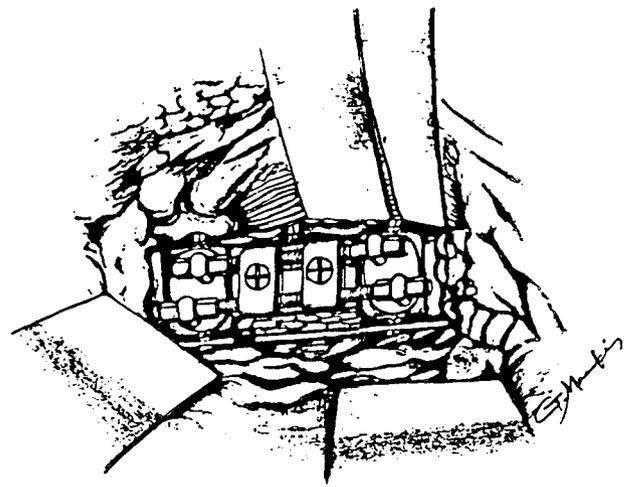
As with any spinal procedure, these are some possible adverse effects that can occur:

1. Non-union of the graft
2. Loosening of the implant itself
3. The body's allergic reaction to a foreign material
4. Infection
5. Nerve damage due to surgical trauma
6. Dural leak (cerebrospinal fluid)
7. Metal sensitivity, or allergic reaction to a foreign body
8. Bending or fracture of the implant, causing loosening of the implant.

### Postoperative Care

Postoperative care and the patient's ability and willingness to follow instructions are the most important aspects of bone healing. A patient should be instructed in the wearing of the thoracolumbar spinal orthotic (TLSO) for 3 to 6 months after the surgery. Even wearing this brace, the patient must be made aware of implant limitations. An overactive, debilitated, or demented mentally impaired patient who does not understand these limitations will be at risk for failure of the implant. These implants are only intended to be a temporary device to assist normal healing and are not intended to replace normal body structures.

The following are specific warnings, precautions, and adverse effects that should be understood by the surgeon and explained to the patient:



**Figure 13.** Final appearance of the construct.

1. Correct selection of the proper implant is extremely important. Implants can break when subjected to an increase in load-sharing associated with delayed union or nonunion. Notches, scratches, or bending of the implant during the surgery may also cause metal fatigue. Patients should be informed of the risks of implant failure.

2. Mixing metals can cause corrosion. The presence of corrosion often accelerates fatigue of the implants. Internal fixation devices, such as plates, screws, etc, that come in contact with other metal objects must be made from like or compatible metals.

### Conclusion

An anterior approach to the spine is often necessary in the treatment of pathologic conditions that are located in the anterior pillar of the spine. A spinal canal decompression can be performed safely and effectively because of advances in diagnostic modalities and surgical instrumentation. With advances in the study of spinal biomechanics and a wide range of clinical experiences, anterior spinal instrumentation will be improved for safer and more effective application.<sup>4</sup> □

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