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The Lumbar Anterior Ligament and Its Role in Interbody Fusion: A Cadaveric Anatomical Study

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Abstract

This study is an anatomic study about the anatomy of the anterior lumbar ligament, the anatomic features are very important to clear the best way and strategy in the spine surgery.

The aim is to describe the surgical anatomy of the lumbar anterior ligament to reach the best placement in the intersomatic space of the expansion cages to reduce the stress on the vertebral bone plates and minimize the risk of subsidence.

Introduction

The methods utilized in spine surgery have changed over the course of the last 25 years. In the past, spine surgeons typically treated herniated discs and vertebral stenosis with microdiscectomy in accordance with the Caspar technique, or with laminectomy. The fusion technique has typically only been used in cases of scoliosis deformities or spine injuries.

The results of treatment for these degenerative pathologies were not satisfactory, however, although they improved with the advent of vertebral fixation using different techniques; posterior arthrodesis with pedicle screws and rods was especially effective in treating these pathologies [1].

A major complication encountered when using this technique was degeneration to the upper discus [2].

For this reason, there is a strong need to improve the technique of replacing the discus with spacers and achieving interbody fusion to restore proper sagittal balance with physiological lordosis.

The aim of this study was to describe the surgical anatomy of the lumbar anterior ligament to achieve optimal placement of expandable spacers in the intersomatic space in order to reduce stresses on the vertebral bone plates and minimize the risk of subsidence.

Materials and Methods

This cadaveric study was performed using five cadavers; it analyzed four lumbar disc levels for each specimen based on the results of 20 surveys. The anatomy of the anterior ligament was observed and described.

The four-disc levels studied in each cadaver were L2-L3, L3-L4, L4-L5, and L5-S1. Surgeons performed laminectomy and facetectomy, and discectomy *via* anterior and posterior approaches. After removing the disc, they placed the expandable spacer in the midline of the intervertebral body space and opened the spacer maximally. They then recorded the distraction of the discus space, measuring the distance from the middle point of the lateral facet lower to the middle point of the lateral facet upper. The discectomy was performed using an endoscope and radiological fluoroscopy.

Three measurements were recorded:

1. With the spacer expanded maximally using the anterior approach and cut only the anterior ligament.

2. With the spacer expanded maximally using the posterior approach and the anulus fibrous removed on the midline anteriorly.

3. With the spacer expanded maximally with posterior approach and removed the anulus fibrous and cut the anterior ligament.

Results

Analysis of the anterior ligament anatomy was performed in 20-disc spaces. In the midline, the

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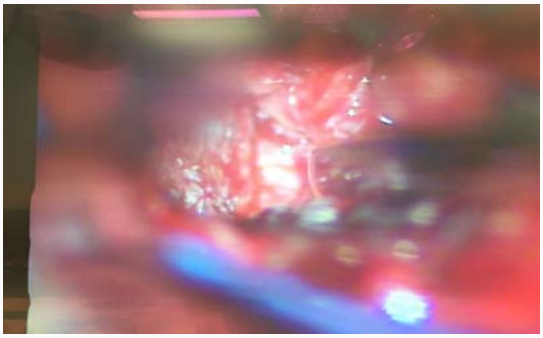

Figure 1: The white anterior ligament following removal of the anulus fibrous disc using a posterior approach. The direction of the fiber can be seen vertically in the midline.

Figure 2: Lateral view of the lumbar spine. The opening with cutting of the anterior ligament after removed fibrous annulus from posterior approach.

direction of the fibers was vertical and the ligament was very thin. Laterally, the fibers went in two different directions and crossed over each other; their thickness was greater and harder than the midline. This anatomic characteristic was detectable in all cases (Figure 1).

Measure the tension force of the expansion cage on the disc plates in three conditions:

1. Anterior approach with the complete anterior ligament removed

2. Posterior with the complete discus and fibrous anulus removed, integrity of the anterior ligament

3. Posterior approach with the complete discus and fibrous anulus and anterior ligament removed (Figure 2).

Results are reported in Table 1. Measurements are in centimeters.

Table 1 demonstrates that maximum distraction was achieved with the expandable spacer utilizing the posterior approach after laminectomy and facetectomy and removal of the fibrous anulus (condition 2), decreased with the use of an anterior approach (condition 1), and stayed the same with the addition of opening the anterior ligament (condition 3).

Discussion

In the author's opinion, optimal placement is actually achieved through the anterior approach, where it is possible to open the anterior

Table 1: Measurement are in centimeters.

Disc Level	1 anterior	2 posterior	3 posterior + ligament
L2-L3	2.05-2.10	2.04-2.10	2.04-2.11
L3-L4	2.65-2.71	3.05-3.15	3.05-3.15
L4-L5	2.45-2.50	2.70-2.80	2.70-2.77
L5-S1	2.20-2.22	2.55-2.60	2.55-2.60

ligament without risk of damaging the neurovascular structures, just as in cervical surgery. This strategy, known as the Anterior Lumbar Interbody Fusion (ALIF) technique, is highly effective when the problem is limited to a disc without a hernia, as well as in preserving wellness of the facet joints.

This pathological condition is known as black disc disease, a term that refers to a degenerated and dehydrated spinal disc. The name refers to how such discs are viewed on an MRI as being completely black in color. The clinical signs of this syndrome are low back pain without neurological deficits [3,4].

When the pathology is severe with suffering of neurological structures within the vertebral canal, performing surgery from the posterior approach using laminectomy and facetectomy may help to ensure that optimal decompression of the suffering nerves and fixation of the damaged joins facets are achieved [5-9].

The correct choice is debatable, and it is now possible to consider the option to operate on a patient using a double approach. Anterior to guarantees the placement of a very large spacer with high-grade lordosis and a wide contact surface between spacer and vertebral plate, while posterior to guarantees the decompression of the nerve structures with the laminectomy and facetectomy and complete replacing of the neuroforamen.

However, that means that this strategy would require two approaches and two operations, doubling the risk for patients.

The main complication that commonly occurs during spacer placement is subsidence. It is typically due to movement of a spacer that is too small; the second most common contributing factor is high stress to the vertebral plate with broken of this and subsidence of the spacer inside the vertebral body.

Potential limitations of a posterior single approach for arthrodesis with intersomatic cages such as Posterior Lumbar Interbody Fusion (PLIF), Transforaminal Lumbar Interbody Fusion (TLIF), or Oblique Lumbar Interbody Fusion (OLIF) techniques include the possibility of placement of a spacer that is too small, or less contact surface area between spacer and vertebral body plates [15-18]. The main limitation of an anterior single approach for ALIF is the potential for placement of a cage that is too big and wide for the available contact surface [8].

This anatomic study demonstrates that the single anterior approach performed without opening the fibrous anulus in contact with the dura may reduce mobility of the vertebral bodies. Also, the expanding spacer may then exercise a higher force tension with risk in the time with the loading to break the vertebral bodies plates, on the other side with a static spacer, the risk of pull-out if the cage is too large and doesn't integrate with the vertebral bodies [19-22].

By using a microscope or endoscope, it is possible to look inside the intersomatic space and remove the disc completely, and to operate on the anterior ligament without risking damage of the retroperitoneal neurovascular structures.

Conclusion

The utilization of arthrodesis with intersomatic cages in lumbar surgery is a common practice. The author is confident that this technique may achieve very good results of neurological decompression and fixation with correct lumbar lordosis. It may help surgeons avoid putting mechanical stress on the vertebral plate, and may also reduce potential subsidence complications.

The author suggests that during the operation, surgeons should take the time to clear and remove a gross total part of anulus fibrosus, making sure to never pass the anterior ligament, the anatomical landmark to avoid for preventing vascular structure damage. Endoscopy, a microscope, or robotic navigation may provide effective technical support.

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