

## Original articles

## Paraspinal approach for thoracolumbar fracture

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**【Abstract】 Objective:** To explore the advantages and indications of the paraspinal approach by anatomical study and clinical application.

**Methods:** The anatomical data and clinical practice of 27 cases were analyzed to explore the accurate approach between the paraspinal muscles and the structure of ambient tissues, as well as the results of clinical application of paraspinal approach. The operation time, blood loss, incision length, radiographic result (Cobb angle, height of anterior edge of the vertebrae) were compared with those in 24 cases treated by traditional approach.

**Results:** Complete exposure of the facets could be easily performed by identifying natural cleavage plane between the multifidus and longissimus muscles. The natural muscular cleavage was (1.47±0.23) cm lateral to the midline for females, and (1.64±0.35) cm for males at T<sub>12</sub> level. The distance was (3.3±0.6) cm lateral to the midline for females, and (3.7±1.0) cm for males at L<sub>4</sub> level. In paraspinal approach group, the operation time was (76.2±15.7) min, blood loss was (91.6±16.9) ml and incision length was (7.6±0.8) cm. In

traditional approach group, the operation time was (121.4±19.6) min, blood loss was (218.7±32.3) ml and incision length was (17.4±2.1) cm. To compare paraspinal approach with traditional approach, the operation time, blood loss and incision length had statistical difference ( $P<0.05$ ) and the radiographic result (Cobb angle, height of anterior edge of the vertebrae) had no statistical difference ( $P>0.05$ ).

**Conclusions:** When the paraspinal approach is performed through natural cleavage plane between the multifidus and longissimus muscles, there are no wide muscular disinsertions, leaving the supraspinous and interspinous ligaments intact. The distance of natural cleavage to the midline is different at T<sub>12</sub> and L<sub>4</sub> planes. By this approach, the facet joints can be explored easily and completely, and a clear surgical field will be available for the placement of pedicle screws. As a minimally invasive approach, it can be widely used in thoracolumbar spine surgery.

**Key words:** Fractures, bone; Lumbar vertebrae; Thoracic vertebrae; Surgical procedures, operative

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The original description of paraspinal posterior approach to the lumbar spine is for spinal fusion, especially regarding lumbosacral spondylolisthesis treatment. Although the technical details are described by Wiltse et al<sup>1</sup> and Vialle et al<sup>2</sup>, exact location of the area where the sacrospinalis muscle has to be split remains somewhat unclear (Figure 1). The aim of this study was to explore the accurate approach between the paraspinal muscles and the structure of ambient tissues, and analyze the re-

sults of clinical application of paraspinal approach.

## METHODS

## General data

In paraspinal approach group, 27 cases (17 males and 10 females) of T<sub>11</sub>-L<sub>5</sub> fractures underwent surgery using posterior paraspinal approach. There were 16 cases of T<sub>11</sub>-L<sub>2</sub> fractures, and 11 cases of T<sub>4</sub>-L<sub>5</sub> fractures. In traditional surgical approach group, 24 patients with thoracolumbar fractures (14 males and 10 females) were treated using traditional surgical approach. Traditional group included 15 cases of T<sub>11</sub>-L<sub>1</sub> fractures and 9 cases of T<sub>4</sub>-L<sub>5</sub> fractures. According to AO classification, all cases were type A with single segment vertebral fracture.

## Surgical methods

In paraspinal approach group, the patient was posi-

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tioned prone on a spinal frame and a midline skin incision was made centered over the involved lower lumbar segment (Figure 2). Dissect the lumbodorsal fascia, and retract the skin and subcutaneous tissue laterally on either side and make a fascial incision approximately 2-3.5 cm lateral to the midline according to the lumbar segment. After the fascial layers were divided, insert a natural cleavage plane between the multifidus and longissimus muscles. Use finger blunt dissection between the muscle groups and palpate the facet joints. Pay more attention to vessels between the muscle which was the symbol of the cleavage (Figure 3). Place self-retaining retractors between the two muscle groups, and then only expose part of the facet joints and denude soft tissue (Figure 4). In traditional approach group, position the patient prone and make a midline skin incision centered over the involved lumbar segment. Carry the dissection down in the midline through the skin, subcutaneous tissue, and lumbodorsal fascia to the tips of the spinous processes. Use self-retaining retractors to maintain tension on soft tissues during exposure. Subperiosteally expose the posterior elements from distal to proximal using electrocautery and periosteal elevators to detach the muscles from the posterior elements. If the procedure required exposure of the spine bilaterally, apply the same technique on each side.

#### Measurement and observation

Anatomical observations and measurements were carried out to precisely describe the anatomy and surgical method of the paraspinal approach. By measuring the distance of natural muscular cleavage between the multifidus and longissimus muscles to the midline at T<sub>12</sub> and L<sub>4</sub> to find the best incision and analyze the structural characteristics (Figures 5-6).

The parameters including incision length, operative time, blood loss, radiographs (preoperative and postoperative Cobb angle and the height of anterior vertebral edge on X-rays, etc) were analyzed to compare the paraspinal approach with the traditional approach in thoracolumbar fractures.

$$\text{Relative height of anterior vertebral edge} = \frac{\text{Actual height of injured anterior vertebral edge}}{\text{Average height of adjacent vertebral edges}} \times 100\%$$

Cobb angle measurement was done according to the following steps: (1) locating the superior end of fractured vertebra, (2) locating the inferior end of fractured vertebra, and (3) drawing intersecting perpendicular lines from the cranial endplate of the vertebra to the caudal endplate (Figure 7).

#### Statistical analysis

All measurements were performed by one observer and were expressed as  $\bar{x} \pm s$ . ANOVA test was performed by the statistic software SPSS 13.0.  $P < 0.05$  was considered as significant difference.

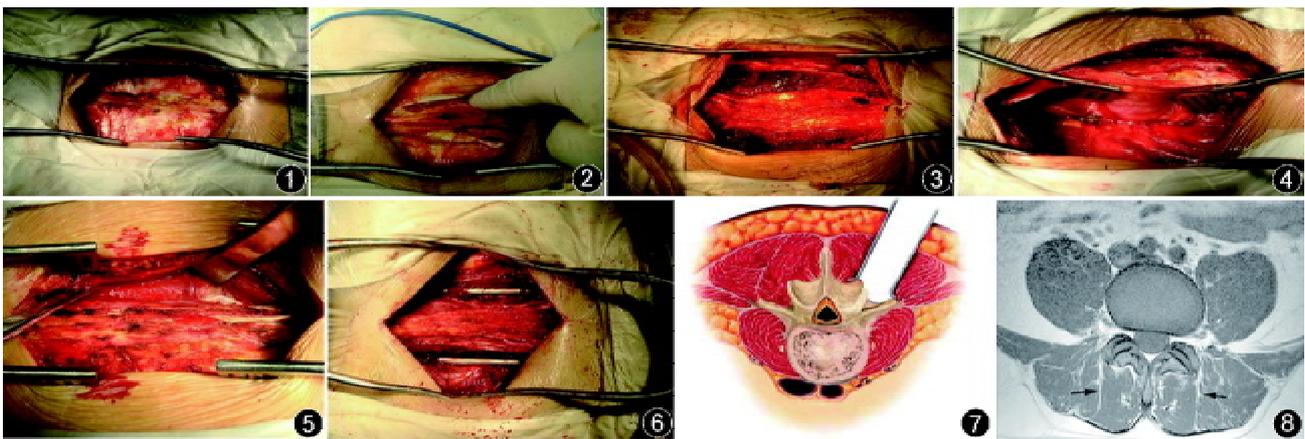
## RESULTS

#### Anatomical measurement

In all cases, there was a natural cleavage plane between the multifidus and longissimus muscles, which was the basis of paraspinal approach. Complete exposure of the facet joint from T<sub>10</sub> to S<sub>1</sub> could be easily identified through natural cleavage (Figure 8). The muscular cleft was (1.47±0.23) cm lateral to the midline for females, and (1.64±0.35) cm for males at T<sub>12</sub>. The mean distance was (3.32±0.65) cm lateral to the midline for females, and (3.66±0.95) cm for males at L<sub>4</sub>. The muscular aponeurosis of sacrospinalis muscle contained muscular fibers on its cranial superficial part and only fibrous tissues on its caudal superficial part. There was a fibrous separation between the two muscular parts. The fibrous separation was easily identified at the caudal part of the muscular cleft but disappeared gradually with the vertebral level increasing. The distance varied in men and women, but the difference was not statistically significant ( $P > 0.05$ ).

#### Comparison of clinical parameters

In paraspinal approach group, the operation time was (76.2±15.7) min, blood loss was (91.6±16.9) ml and incision length was (7.6±0.8) cm. In traditional approach group, the operation time was (121.4±19.6) min, blood loss was (218.7±32.3) ml and incision length was (17.4±2.1) cm. The operation time, blood loss and incision length were statistically different between paraspinal approach and traditional approach surgery ( $P < 0.05$ ) and there were no statistical significance on the Cobb angle and vertebral height restoration (VHR,  $P > 0.05$ , Table 1).



**Figure 1.** A natural cleavage plane between the multifidus and the longissimus part is well-visualized on this axial spin-echo T1-weighted MRI at L<sub>4</sub>/L<sub>5</sub> level. **Figure 2.** After incision of the skin, the back fascia is shown by the paraspinal approach. **Figure 3.** A group of symbolic vessels in the cleavage between the multifidus and the longissimus. If the vessels are ligated, bleeding would be reduced. **Figure 4.** On T<sub>12</sub> plane, the cleavage is superficial, close to the midline. **Figure 5.** On L<sub>4</sub> plane, the cleavage is deep, far from the midline. **Figure 6.** In the natural cleavage between the multifidus and the longissimus, the facet joints are well-explored, which are the entering points of the pedicle screws. **Figure 7.** After operation, using pedicle and rod system internal fixation in paraspinal approach, the composite of posterior column is reserved integrally. **Figure 8.** Transection by paraspinal approach.

**Table 1.** Relevant parameters of radiographs in two groups ( $\bar{x} \pm s$ )

Groups	n	Cobb angle (°)		VHR (%)	
		Pre-op	Post-op	Pre-op	Post-op
Traditional approach	24	14.6±5.3	1.1±2.1	64.4±13.7	95.6±2.2
Paraspinal approach	27	15.4±6.2	1.0±2.5	63.8±14.3	94.9±2.8

## DISCUSSION

The paraspinal approach to the lumbar spine surgery goes between the lateral border of the sacrospinalis muscles and the quadratus lumborum muscle. In 1959, Wiltse et al<sup>1</sup> firstly described a modified transmuscular paraspinal approach consisting of a longitudinal separation of sacrospinalis muscle between its multifidus and longissimus parts. The original description was for spinal fusion, especially regarding lumbosacral spondylolisthesis treatment.<sup>1-3</sup> By this approach, a one-level or a multilevel fusion could be performed. In spite of the technical details described by Vialle et al,<sup>4,5</sup> exact location of the area where the sacrospinalis muscle has to be split remains somewhat unclear.

A natural cleavage plane between the multifidus and the longissimus part of the sacrospinalis muscle could be easily identified at T<sub>12</sub>. Firstly the superficial muscular fascia was opened near the midline, which exposed the posterior aspect of sacrospinalis muscle. At L<sub>4</sub> level, blunt dissection was made from outer sacrospinalis muscle to expose the muscular cleft. Because the muscles in lower lumbar spine were more thewy, mus-

cular cleft was relatively difficult to identify, so the fingers could be plunged for probing. In Wiltse's study, the fascial incision was made only 2 cm lateral to the midline,<sup>1,4,5</sup> and the cleavage plane was clearly shown in MRI. In our study, distance of the fascial incision to the midline was about 2 cm at T<sub>12</sub> and 3.5 cm at L<sub>4</sub>. In all cases, we noted the presence of small arteries and veins at the level of the cleavage plane. The vessels were staunched with cautery to expose these vessels in order to avoid bleeding. The facet joint and the transverse process could be clearly exposed from T<sub>10</sub> to S<sub>1</sub> by this paraspinal approach.<sup>6,7</sup> It could be widely used for the diseases such as thoracolumbar fractures, lumbar disc herniation and revision, lumbar spinal stenosis, lumbar spondylolisthesis, etc.<sup>8-10</sup> It showed great advantage in thoracolumbar vertebral fracture surgery without decompression. The approach was simple and allowed reaching the articular and transverse processes. Through this approach, either a one-level or multilevel fusion combined with screw fixation could be done, without wide muscular disinsertion and leaving the supraspinous and interspinous ligaments intact, as well as providing a clear surgical field for pedicle screw fixation. In our study, after incision of the erector spinae aponeurosis near the midline, the fibrous separation between the multifidus and longissimus muscles can be easily revealed. Clinical application should be performed by surgeons who were familiar with the anatomical structure of the paraspinal muscles. It showed obvious advantages in operative time, blood loss, incision length,

etc. However, there was no statistical significance in the Cobb angle and vertebral height restoration.

In conclusion, compared with traditional approach, paraspinal approach has some advantages in following aspects. It has smaller incision and less bleeding, less operative time, without wide muscular disinsertions, leaving the supraspinous and interspinous ligament intact,<sup>11</sup> as well as avoiding injury to posterior ramus of the lumbar nerve<sup>12</sup>. To provide a clear surgical field for pedicle screw fixation, it can be widely used for thoracolumbar fractures, in line with the concept of minimally and practically invasive surgical approach.

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