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Original Article

Approaching the interspace between multifidus and longissimus accurately in lumbar surgery: an anatomically based study of the Wiltse approach

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Abstract: *Background and aim:* The Wiltse approach is a common approach to the lumbar spine. However, it has remained difficult to approach the interspace, even while strictly following instructions and methods introduced by Wiltse et al. This is mainly due to the sacrospinalis aponeurosis covering the interspace between multifidus and longissimus. This study aimed to explore the anatomical basis and methods to improve the reliability and feasibility of lumbar Wiltse approach. *Methods:* Twenty embalmed cadavers were dissected, bilaterally, to observe anatomical characteristics and the relationship between sacrospinalis aponeurosis and the two muscles (multifidus and longissimus). *Results:* Multifidus was seen as independent from the sacrospinalis aponeurosis, although few fibers existed. Longissimus formed enthesis from sacrospinalis aponeurosis in the lumbar region. The enthesis extended from central-superficial to inferior-lateral and formed a septum stretching to facet joints and accessory process making up the native interspace between multifidus and longissimus. Taking this septum as an anatomical sign, successful blunt dissections were performed to expose facet joints directly in all cadavers. Other special anatomical signs to locate the interspace between multifidus and longissimus were not found, either on the surface or in the inferior part of sacrospinalis aponeurosis. In the interspace, segmental nerves and concomitant blood vessels could be seen inside the longissimus. *Conclusion:* The longissimus forms an enthesis and septum from sacrospinalis aponeurosis in the lumbar region. Making a sacrospinalis aponeurosis incision inside the interspace between multifidus and longissimus, the septum can easily be found after the sacrospinalis aponeurosis is pulled outside. The Wilste approach is feasible and safe if based on a comprehensive understanding and knowledge of the lumbar muscle septum.

Keywords: Lumbar spine approach, spine surgery, anatomy, erector spinae

Introduction

In 1968, Wiltse et al. published an original intermuscular and posterolateral approach to the lower lumbar spine [1]. In 1988, in one paper, they recommended a single cutaneous incision on the midline [2]. Following the anatomical avascular space lying between multifidus (medial) and longissimus (lateral) muscles, this procedure not only provides access to facet joints and the transverse processes to get easier instrumentation [3], but also prevents the erector spinae from injury by less dissection and traction [4, 5]. However, due to indirect exposure caused by the sacrospinalis aponeurosis, which covers the multifidus and longissimus, surgeons cannot precisely approach the interspace, even strictly following instructions and methods introduced by Wiltse et al. This has resulted in increasing operational difficulty and trauma. Additionally, this indicates that the Wiltse approach may not have enough support on an anatomical basis or the understanding of this approach is limited. If the first statement is true, this means that the Wiltse approach has insuperable defects while the second guess should encourage us to investigate and conduct further research to establish a correct method in clinical practice, making the Wiltse approach more anatomically reliable and consummate. In the literature, longissimus has enthesis on transverse process and accessory process [5]. In previous observations to the lumbar spine, it was found that

Figure 1. Thoracolumbar fascia was easy to detach from midline, except at the sites of ilium and sacrum (fused to sacrospinalis).

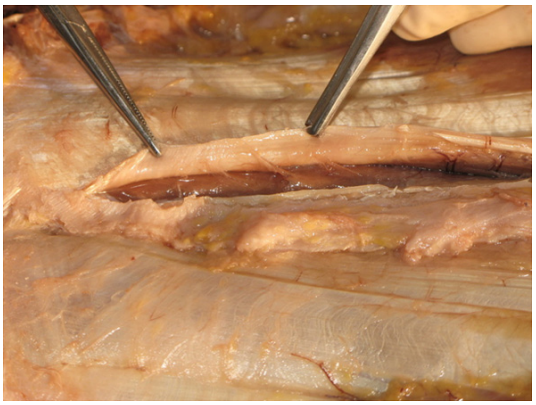

Figure 2. Few multifidus fibers existed as bridging with sacrospinalis aponeurosis.

sacrospinalis partly attaches with its aponeurosis, especially in the longissimus. It forms enthesis on sacrospinalis aponeurosis in the lumbar region. The enthesis extends from central-superficial to inferior-lateral and forms a septum stretching to facet joints and accessory process making up the native interspace between multifidus and longissimus. It was taken into consideration that the septum can be an anatomical sign identifying the interspace between multifidus and longissimus. The purpose of this study was to recognize the septum and its characteristics, justifying whether it could be a reliable anatomical sign for this approach.

Materials and methods

Materials

Twenty embalmed cadavers were enrolled in this study. There were 13 males and 7 females as well as 40 sides, without macroscopic lesions or injuries in the lower thoracic and lumbar regions.

Methods

Skin dissection with subcutaneous tissue was performed in the lower thoracic and lumbar regions. The extent and texture of thoracolumbar fascia as well as its association with acrospinalis aponeurosis were observed. A dissection was then made upon thoracolumbar fascia enthesis from T_{10} to S_1 spinous process, exposed to the outer margin of sacrospinalis. At this time, the extent, texture, and morphous of sacrospinalis aponeurosis were observed. Finally, the sacrospinalis aponeurosis enthesis was detached from spinous process to the outside, carefully, to observe and measure as follows: (1) Relationship between sacrospinalis aponeurosis and multifidus, if there was definite multifidus enthesis deriving from sacrospinalis aponeurosis; (2) Relationship between sacrospinalis aponeurosis and longissimus; (3) Distance between spinous process and the interspace between multifidus and longissimus (IBML) from L_1-L_5; (4) Whether the interspace was clear between the two muscles; (5) If there was a special anatomical sign identifying the interspace and, thus, exposed to facet joints through it; and (6) If another anatomical sign existed in the surface or inferior part of sacrospinalis aponeurosis. How can we assure accuracy in exposure: according to what structure?

Results

Of the cadavers, the thoracolumbar fascia covered almost the entire sacrospinalis with a hard texture, providing attachment points to the latissimus dorsi muscle. It was fused to sacrospinalis at the sites of ilium and sacrum. In other areas, they were well-defined, while making a blunt dissection was easy (**Figure 1**).

The sacrospinalis aponeurosis was morphologically intact below L_3 spinous process, becoming wider gradually downward to cover the interspace between multifidus and longissimus. In contrast, it narrowed and became bunched above L_3 spinous process. Interspace between the multifidus and longissimus was located in a bunch covered with a little fat above L_2 spinous process.

Though few fibers existed as bridging, the multifidus was deemed independent from the

Table 1. Distance between spinous process and IBML at all lumbar segments demonstrated (mm)

Segment	Left	Right
L_1	15.7±1.7	14.8±1.7
L_2	20.5±18.4	19.8±2.4
L_3	25.9±2.9	24.3±2.3
L_4	28.6±3.2	27.3±2.8
L_5	31.2±3.5	30.2±3.4

IBML, interspace between multifidus and longissimus.

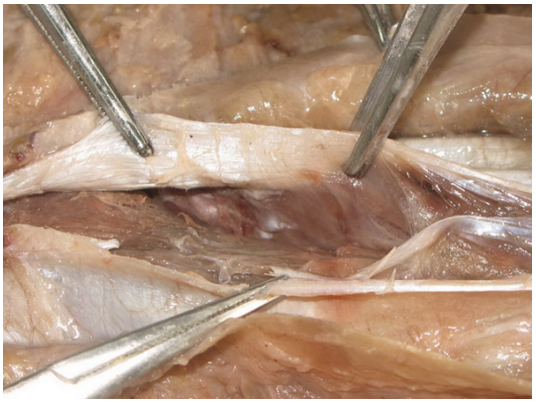

Figure 3. Septum of longissimus extended from central-superficial to inferior-lateral and forms a septum stretching to facet joints and accessory process, making up the native interspace between multifidus and longissimus.

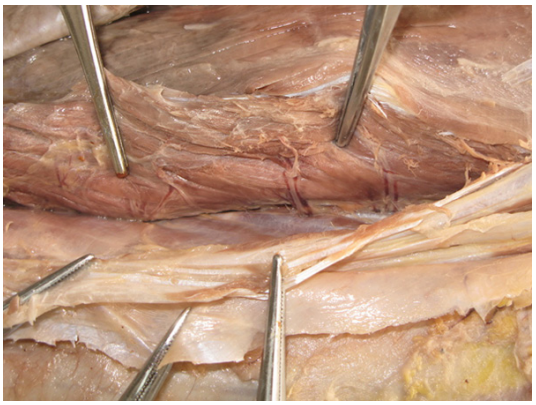

Figure 4. Taking the septum as anatomical sign, deep structures could be smoothly exposed.

sacrospinalis aponeurosis since the bridging was too weak to detach (**Figure 2**). Distances between spinous process and IBML at all lumbar segments are demonstrated in **Table 1**.

Longissimus formed enthesis from sacrospinalis aponeurosis in the lumbar region. The enthesis extended from central-superficial to inferior-lateral, forming a septum stretching to facet joints and accessory process, making up the native interspace between multifidus and longissimus (**Figure 3**). Taking this septum as an anatomical sign, successful blunt dissections were made to expose facet joints, isthmus, and transverse process, directly, in all cadavers (**Figure 4**).

No other special anatomical signs were found to locate the interspace between multifidus and longissimus, neither in the surface nor in the inferior part of sacrospinalis aponeurosis (after dissection of sacrospinalis aponeurosis, no significant signs were found on the surface of multifidus and longissimus). In the interspace, segmental nerves and concomitant blood vessels could be seen inside the longissimus (**Figure 5**).

Discussion

Trending in minimal invasion spine surgery, the Wiltse approach has been more and more widely used [6-9]. Nevertheless, how to approach the interspace between multifidus and longissimus, precisely, especially in the lower lumbar region, has remained a major concern of surgeons for years. The procedure was initially described by Wiltse, in 1968, and reformed in 1988. Since then, researchers have done many studies on relative anatomical basis [5, 10, 11]. Generally, the way to find the interspace between multifidus and longissimus consists of two different methods, as follows: 1) Distance method (locate by certain vertical distance to transverse process), introduced by Wiltse and accepted by most surgeons. However, the limitation of this method is obvious, as the correct distance varies a lot in different lumbar levels and different individuals. Practices have shown that in the lower lumbar region, it is difficult to locate the interspace between multifidus and longissimus alone by a certain distance to midline, as the sacrospinalis aponeurosis covers almost the whole region; 2) Vessel sign method, which takes the perforating vessels as a locating sign [12]. However, there are no significant vessels or nerves on the surface of sacrospinalis aponeurosis, as with the surface of multifidus and longissimus. Vessels could be seen only when the interspace was open. In other words, they could only deemed as a sign ensuring that you have

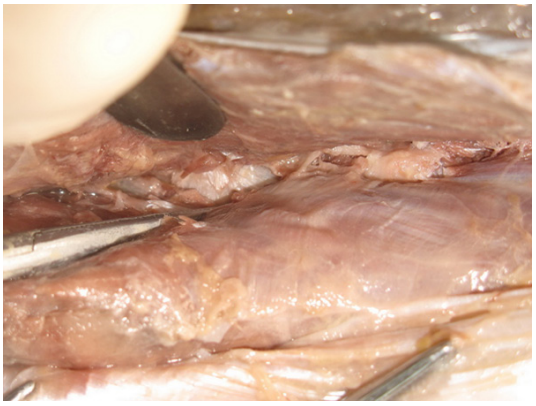

Figure 5. Segmental nerves and concomitant blood vessels inside the longissimus.

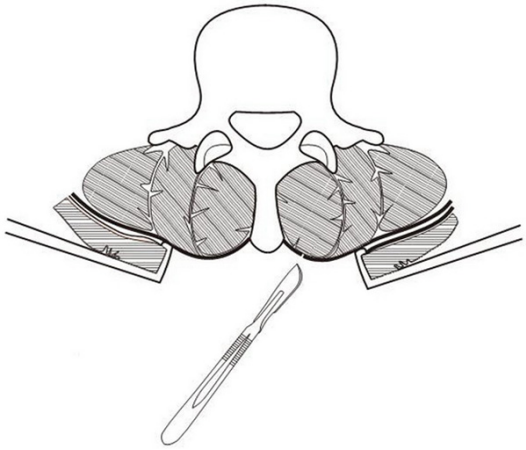

Figure 6. A sacrospinalis aponeurosis incision was made inside the interspace between multifidus and longissimus.

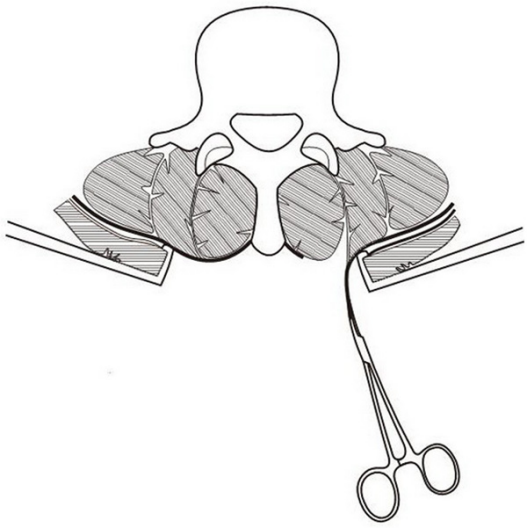

Figure 7. Pulling outside, fibers of the multifidus were carefully detached until the septum of longissimus was seen.

already exposed into the interspace. Concerning the Wiltse approach, the issue of locating the interspace between multifidus and longissimus has not been resolved yet, especially in the lower lumbar region. Essentially, none of the abovementioned methods provide a reliable anatomical sign to fix the interspace.

This study resolves the problem of anatomical signs concerned with locating the interspace between multifidus and longissimus in the Wiltse approach. This study reveals that the longissimus forms enthesis from the sacrospinalis aponeurosis in the lumbar region. The enthesis extends from central-superficial to inferior-lateral, forming a septum stretching to facet joints and accessory process, making up the native septum between multifidus and longissimus. In this study, the septum could be clearly seen in both sides of the 20 cadavers. Therefore, taking this as an anatomical sign, approaching into the interspace between multifidus and longissimus is relatively reliable.

Based on results of this anatomical study, it is recommended that the following steps are followed in manipulation of the Wiltse approach (**Figures 6**, **7**). Make a posterior approach midline incision, after subcutaneous tissue is broken through. Cut the thoracolumbar fascia enthesis, superficially, at the appressed part with the spinous process and dissociate outside about 3 cm. To protect the blood supply of skin, do not dissociate subcutaneous tissue on the surface of thoracolumbar fascia. In addition, the thoracolumbar fascia and sacrospinalis aponeurosis are connected just with the synovial membrane, thus, it is easy to make a blunt dissection by fingers while the midline enthesis is cut. For T_2-L_2 levels, the interspace is easy to find through the fat sign in the bunches of sacrospinalis aponeurosis within 1 cm vertical to midline. For L_2-S_1 levels, especially L_4-S_1, the sacrospinalis aponeurosis needs to be cut open. The sacrospinalis aponeurosis can be cut from spinous process and pulled outside. However, to decrease the tension of pulling, it is recommended that dissection is made on a certain distance vertical to the spinous process, before pulling outside. This distance is not strict. Referring to measurement, it is about 3 cm at the level of L_5 and 2.5 cm at L_4, decreasing as the level goes up. It is important that the incision is inside the interspace between multifidus and longissimus. After the sacrospinalis aponeurosis is open, attention

should be paid to the course of outside pulling, that there are a few fibers of the multifidus connected with sacrospinalis aponeurosis. Surgeons should be careful to detach the fiber until the septum of longissimus is seen. Here, the septum of longissimus is apparent but not tough enough and may be missed if manipulated roughly. When the inside part of longissimus septum is found, the interspace between multifidus and longissimus presents at the same time. Then, it is easy to extend the interspace to a deep and parallel direction until an operation area long and wide enough appears. At this time, accuracy can be ensured by the neurovascular bundle which is inside the longissimus. Finding the interspace between multifidus and longissimus downward in L_5-S_1 operation in suggested, as the longissimus enthesis on sacrospinalis aponeurosis extends from central-superficial to inferior-lateral. The present research has successfully approached into the right interspace between multifidus and longissimus more than 100 times with this method.

In conclusion, approaching the interspace between multifidus and longissimus is relatively difficult due to the sacrospinalis aponeurosis covering. This present study delivers a method of finding a stable anatomical sign between multifidus enthesis and longissimus, making the Wilste approach procedure more reliable and practical on an anatomical basis.

Disclosure of conflict of interest

None.

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