Original Article

Multilevel magnetic resonance imaging analysis of multifidus-longissimus cleavage planes in the lumbar spine and clinical application to the Wiltse approach

Han Wu[1], Chao Fu[2], Rui Jiang[3], Wei-Dong Yu[4]

ABSTRACT

Objective: To determine the anatomic location of the multifidus–longissimus intermuscular cleavage plane in a Chinese population and thereby to aid surgery by Wiltse's approach.

Methodology: Two hundred patients (100 males, 100 females) were enrolled. The distance between the midline and the intermuscular plane at each disc level between L1 and S1 was measured on axial T2-weighted magnetic resonance images (MRI). Age, sex and body mass index (BMI) were also recorded.

Results: The mean measured distance differed significantly between disc levels ($P<0.05$). At L5–S1, it was 33.56 mm; at L4–L5, 29.85 mm; at L3–L4, 24.97 mm; at L2–L3, 19.91 mm; and at L1–L2, 16.17 mm. Mean distances were significantly greater in males than in females (1 mm) at L1–L2, L2–L3 and L3–L4. There was no significant relationship between distance and height, weight or age.

Conclusions: The location of the intermuscular cleavage plane was related to disc level and not correlated with age, height or weight. Mean distances were slightly greater in males than in females at L1–L2, L2–L3 and L3–4, which was not consistent with a previous report. These findings may aid surgery by Wiltse's approach.

KEY WORDS: Paraspinal approach, Wiltse, Lumbar, Multifidus, Longissimus, MRI.

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INTRODUCTION

A posterior midline incision is the most common surgical approach used for treatment of lumbar vertebral fractures and other conditions.[1] This approach, however, promotes dissection, detachment of stabilizing ligamentous structures, and tissue retraction.[2, 3] In 1959, Watkins et al. first proposed the use of sacral and lumbar spine muscle cleavage for poster lateral spinal surgery, and successfully applied this technique to poster lateral lumbosacral fusion.[4] Based on this report, in 1968, Wiltse et al. described a paraspinal approach using the natural cleavage plane of the multifidus and longissimus muscles to gain entry for the treatment of extremely lateral lumbar disc herniation.[5] However, though some data have been obtained from anatomic studies in recent years, there is still no detailed description of the location of the intermuscular cleavage plane at each lumbar disc level.[2, 6, 7]

In the present study, we retrospectively analyzed measurements of the distance between the midline and the multifidus–longissimus intermuscular cleavage plane made by magnetic resonance imaging (MRI). The objective was to determine the precise anatomic location of the intermuscular cleavage plane to aid paraspinal Wiltse approach surgery.

METHODOLOGY

From January, 2010 to December, 2010, 200 subjects (100 females, 100 males) were recruited from patients attending The China-Japan Union Hospital of Jilin University, China. None of the selected patients had undergone previous spinal surgery or had a spinal structural anomaly such as scoliosis or spina bifida.

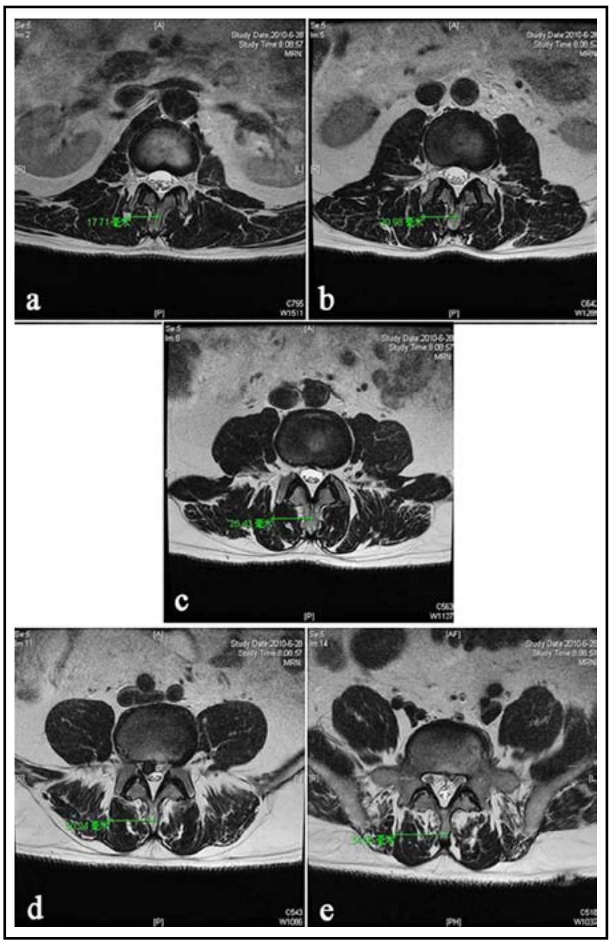

Fig.1: Axial T2-weighted magnetic resonance images (MRI) showing the distance between the midline and the intermuscular plane at each disc level between L1 (a) and S1 (e).

All patient identifiers were removed from the images before analysis by a single observer. Images were obtained with a 1.5 T scanner (Philips Corporation, Holland) during the course of patient care. Axial T2-weighted images were used to determine the horizontal position of the cleavage plane between the multifidus and longissimus muscles at the level of the lumbar discs. The morphology of the plane was also observed. In the axial plane, the multifidus and longissimus muscles were curved, as was the cleavage plane in general. The concave side was toward the spinal process and the convex side toward the paravertebral skin. We used a radiology information system/picture archiving and communication system (RIS/PACS) software to measure distances on the images (Fig.1). A fat line on each image was used as a marker of the gap between the multifidus and longissimus muscles, and the greatest distance from the midline of the spinous process to the fat line was measured bilaterally at each disc level from L1 to S1. Differences at each level with sex, weight and age were analyzed by independent *t*-tests. All statistical analyses were conducted using SPSS l6.0 software. (Chicago, IL, USA).

RESULTS

The mean age of the female and male subjects was 49.6 ± 14.4 years and 50.2 ± 10.5 years, respectively. Mean body mass index (BMI) was 28.2 ± 6.3 kg/m^2 in females and 28.9 ± 4.1 kg/m^2 in males (Table-I). The differences in age and BMI between females and males were not statistically significant ($P>0.05$). Distances from the intermuscular cleavage plane to the midline at levels L1–S1 are shown in Table-II. The mean distance was 33.56 ± 3.97 mm at L5–S1, 29.85 ± 3.45 mm at L4–L5, 24.97 ± 2.96 mm at L3–L4, 19.91 ± 2.38 mm at L2–L3 and 16.17 ± 1.87 mm at L1–L2. A statistically significant correlation was found between distance and level ($P < 0.05$). Mean distances were slightly greater in males than in females (1 mm) at L1–L2, L2–L3 and L3–L4, but were almost the same at L4–L5 and L5–S1. No statistically significant correlation was found between the measured distance and age or BMI at any level.

Table- I: The mean age, BMI in the female, male, overall groups.

	No.	*Age (year)*	*BMI (kg/m2)*
Females	100	49.6 ± 14.4	28.2 ± 6.3
Males	100	50.2 ± 10.5	28.9 ± 4.1
Overall	200	49.8 ± 12.2	28.5 ± 5.0

Table-II: Summary of statistics for the distance at each level. Values are mean ± SD, if applicable.

	L1-2 (mm)	*L2-3 (mm)*	*L3-4 (mm)*	*L4-5 (mm)*	*L5-S1 (mm)*
Females (n=100)	15.64±1.58*	19.17±2.02*	24.18±2.52*	29.56±3.60	33.89±4.37
Males (n=100)	16.70±1.99	20.64±2.49	25.75±3.17	30.15±3.29	33.23±3.52
Overall (n=200)	16.17±1.87**	19.91±2.38**	24.97±2.96**	29.85±3.45**	33.56±3.97**

*, $p<0.05$, significant difference compared with male groups.
**, $p<0.05$, significant difference compared with different disc levels.

DISCUSSION

Until now, only one article has been published concerning the precise location of the multifidus–longissimus intermuscular cleavage plane determined by MRI.[3] In the present study, we retrospectively reviewed 200 cases in which patients underwent MRI at each of the five disc levels between L1 and S1. The aim was to determine the location of the intermuscular cleavage plane in a Chinese population, and thereby aid selection of the optimal incision site for the Wiltse approach.

Our study found no statistically significant correlation between the distance between the midline and the multifidus–longissimus intermuscular cleavage plane and height, weight or patient age. Mean lateral distances were 33.56 mm, 29.85 mm, 24.97 mm, 19.91 mm and 16.17 mm from L5–S1 to L1–L2, respectively. This finding corresponds with the increasing distance between facet joints from L1 to L5, suggesting that disc level is the principal factor determining the location of the multifidus–longissimus intermuscular cleavage plane and the optimal incision site for the Wiltse approach, which is in agreement with a previous report.[3]

There was a statistically significant correlation between measured distance and sex. Palmer *et al.*[3] reported that the mean distance in females was significantly greater than that in males (2 mm) at L5–S1 only, whereas in the present study, the mean distances in males were slightly greater than those in females (1 mm) at L1–L2, L2–L3 and L3–L4. This difference can be explained by differences in patient selection criteria, as well as ethnic variations.

The Wiltse paraspinal approach is not complex and is convenient for implantation of instruments, avoids detachment of the paraspinal muscles, is quicker than other approaches and results in less blood loss, in accordance with the concept of minimally invasive surgery; it can replace the posterior approach in most procedures.[5,8,9] The segmental gap between the lumbar multifidus muscle and the longissimus muscle is the anatomic location for entry in the Wiltse paraspinal approach.

In conclusion, disc level is the main factor of clinical significance in determining the location of the multifidus–longissimus intermuscular cleavage plane. Mean distances between the midline and the cleavage plane were slightly greater in males than in females at L1–L2, L2–L3 and L3–L4, which is not consistent with a previous report. The results of this study may aid surgery by Wiltse's approach.

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