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Original research article

Comparison of Wiltse and classical methods in surgery of lumbar spinal stenosis and spondylolisthesis

Murat Ulutaş [a], Can Yaldız [b,], Mehmet Seçer [c], Mehmet Ali İkidağ [d], Mehmet Ali Cüce [d], Onur Yaman [e], Sedat Dalbayrak [f]*

[a] *Department of Neurosurgery, Konukoglu Hospital, Sanko University, Gaziantep, Turkey*
[b] *Department of Neurosurgery, Sakarya University Training and Research Hospital, Sakarya, Turkey*
[c] *Department of Neurosurgery, Deva Hospital, Gaziantep, Turkey*
[d] *Department of Radiology, Konukoglu Hospital, Sanko University, Gaziantep, Turkey*
[e] *Department of Neurosurgery, Koç University, İstanbul, Turkey*
[f] *Department of Neurosurgery, Neuro Spine Academy, Istanbul, Turkey*

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ABSTRACT

Aim: Minimally invasive approaches to posterior lumbar surgery are available today that can enhance patient comfort by greatly reducing tissue damage and offer better clinical results. However, such methods have not yet gained widespread popularity despite their significant advantages. This study compares the Wiltse method and the classical method of lumbar surgery based a cohort, clinical study of 57 patients. The patients all had degenerative lumbar spinal stenosis and/or spondylolisthesis and had developed multifidus muscular atrophy.
Materials and methods: We enrolled 57 patients admitted to our clinic between April 2012 and September 2013 with a diagnosis of degenerative lumbar spinal stenosis and/or spondylolisthesis. These were treated with the classic posterior approach ($n = 26$) or the Wiltse method ($n = 31$).
Findings: In the classical method group, the ratio of female to male patients was 20/6 and the mean age was 58.19 ± 10.17 years. A comparison of preoperative and postoperative multifidus muscle cross-sectional measurements (average of right and left) revealed a 36.09% atrophy level in the classical method group and a 26.34% atrophy level in the Wiltse group ($p < 0.01$). However, atrophy development was 18.82% higher in the classical method group ($p < 0.05$) relative to the Wiltse group.
Conclusion: The Wiltse method is less invasive and causes less tissue damage. It reduces the change of hemorrhage and multifidus muscles and offers a shorter duration of hospitalization with less pain.

* *Department of Neurosurgery, Sakarya Training and Research Hospital, Adnan Menderes Cad. Sağlık Sok. No: 195 Adapazarı. 54010 Sakarya, Turkey. Tel.: +90 2642750090x1460; fax: +90 3643460101; mobile: +90 05053572222.*
E-mail address: drcanyaldiz@gmail.com (C. Yaldız).
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1. Introduction

Various techniques have been defined for intervention in the paraspinal region. In the classical method used since the nineteenth century, a skin incision is made along the spinous process and midline lamina followed by dissection and ecartation of the multifidus muscle [1–7].

This approach has a number of disadvantages: muscle and ligament damage; lack of access to the lateral section of the facet joints or muscle; ligament damage caused by trying to access joints; formation of a cavity in the inaccessible regions after surgery; frequent hemorrhage; postoperative pain; and long-lasting physical restrictions [1,5,6].

This retrospective study compares the classical posterior lumbar spinal approach and the Wiltse approach in terms of postoperative hemorrhage, duration of surgery, damage to the paravertebral muscles in the postoperative period, pain, and sagittal balance.

2. Materials and methods

We enrolled 74 patients who attended the Department of Neurosurgery between April 2012 and September 2013 with a diagnosis of primary degenerative lumbar spinal stenosis and/or spondylolisthesis. These were treated with either the classical posterior subperiostal dissection method or the laminectomy and paraspinal Wiltse method. Patients with radicular and/or back pain and neurogenic intermittent claudication problems that had not responded to treatment for a minimum of three months after diagnosis underwent one of these two different approaches. The goal was posterior decompression, interbody fusion and segmental stabilization.

Patients who had missed routine polyclinic controls were called and invited to attend the hospital, where they underwent a control examination and radiologic analysis. The patient files, surgery notes, anesthesia reports, and radiologic analyses taken in the polyclinic follow-ups were then retrospectively analyzed. Seventeen patients were excluded from the evaluation based on a history of lumbar surgery (such as lack of instrument, disc surgery, or revision surgery), need for sacrum stabilization and long-segment surgery, presence of systemic diseases, and/or antidepressant use. Data was compiled on the remaining 57 patients regarding age, gender, preoperative hemorrhage, duration of hospitalization, as well as the JOA and VAS values in the preoperative and postoperative mean 13 week controls. Right–left multifidus muscle area and intensity measurements were carried out in preoperative and postoperative lumbar spinal MRIs taken after an average of 13 (9–21) months. The results were then statistically evaluated and compared.

2.1. Patient group

The patients were divided into two groups. The first group included patients with degenerative lumbar spinal stenosis and/or spondylolisthesis who were treated using the classical posterior approach ($n = 26$). The second group consisted of patients with degenerative lumbar spinal stenosis and/or spondylolisthesis patients who were treated using the Wiltse technique ($n = 31$) (Table 1).

2.2. Surgical technique

Surgery used general anesthesia with a prone position on a radiolucent operating table with two supports placed between the chest and the pelvis. A skin incision was made under fluoroscopy to dissect the skin. After subcutaneous dissection, the lumbodorsal fascia was opened 2–3 cm laterally in parallel with the midline. The facet joints of the lumbar vertebrae were quickly and easily reached without hemorrhage. There was no tissue damage due to blunt dissection by finger from the loose cleavage line between the pars lumborum section of the longissimus muscle and the multifidus muscle.

A facetectomy was done following dissection in the area surrounding the facet joint intended for decompression and interbody fusion under microscope. A laminectomy and a bilateral facetectomy were performed under the multifidus muscle. A flavectomy was also done to patients who had spinal stenosis due to a hypertrophic flaval ligament. In suitable patients, the canal was decompressed using the opposite flaval ligament by gradually angling the microscope. A discectomy was made from the lateral of the intervention after enlargement of the foramen (bilateral decompression via a unilateral approach). Transforaminal interbody fusion (TLIF) was done using a PEEK cage packed with autograft after the spinal canal decompression was complete. Pedicle screws were placed between the muscles using a scopy control. The same intramuscle approach was used to place the pedicle

Table 1 – Patient characteristics according to surgical method.

	Classical Mean ± SD	Wiltse Mean ± SD	p
Age (years)	58.19 ± 10.17	52.48 ± 8.36	[a]0.024*
Follow-up period (month)	13.31 ± 2.81	13.00 ± 2.86	[a]0.685
Duration of surgery (minutes)	172.69 ± 29.84	174.52 ± 34.75	[a]0.834
Duration of hospitalization (day)	3.42 ± 1.27 (3.00)	2.26 ± 0.96 (2.00)	[b]0.001**

[a] Student's t test.
[b] Mann–Whitney U test.
* $p < 0.05$.
** $p < 0.01$.

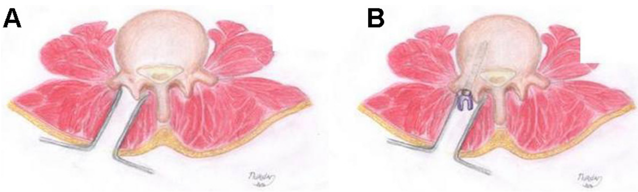

Fig. 1 – (A, B) An original drawing by Wiltse et al. describing the paraspinal sacrospinalis-splitting approach to the lumbar spine.

screws for the screws on the opposite side. Thus, interbody fusion, spinal canal decompression, and bilateral transpedicular stabilization were carried out on the midline using a single skin incision without dissection and ecartation. This is important because these can cause muscle denervation and circulation problems. This approach also protects the neurovascular structures of the muscle, the spinous process ligaments of the multifidus muscle, the spinous processes, the interspinous–supraspinous ligaments, and the lamina (Fig. 1).

2.2.1. *Classical method*

Surgery used general anesthesia in a prone position on a radiolucent operating table with two supports placed between the chest and the pelvis. Levels were determined with the help of a scopy control. A midline skin incision was made between the proximal and distal ends of the lower and upper vertebrae that would undergo stabilization. The lumbodorsal fascia was opened bilaterally from the midline. Subperiostal dissection was performed on the facet joint laterals using a periosteal elevator and cautery by cutting the radial ligaments connecting the multifidus muscle to the spinous processes. Bleeding veins were cauterized, and the multifidus muscle was suspended from the midline by ecartation. Laminectomy was performed to decompress the spinal canal. Discectomy and interbody fusion were then carried out, and segmental stabilization was achieved using pedicle screws.

2.3. *Radiologic evaluation*

The patients participating in the study underwent lumbar MRI analyses carried out using a 1.5 Tesla MRI device (Siemens Magnetom® Symphony, Siemens Medical Solutions, Erlangen, Germany) before the procedure and for an average of 13 months after the procedure. The images were later transferred to a separate Radiologic Imaging Work Station (Siemens Leonardo Workstation System, Siemens Medical Solutions, Erlangen, Germany). This quantitative evaluation of multifidus muscle atrophy used axial T2-weighted images of the lower end plate of an upper vertebra that was not involved in stabilization (L2 in patients who underwent L3-4-5 segmental stabilization or L3 vertebrae lower end plate levels in those who underwent L4-5 segmental stabilization) as well as an S1 vertebra upper end plate. These plates were compared to avoid implant artifact. After appropriate adjustment of the magnification and windowing settings, the muscle borders were drawn by a freehand technique using the area intensity measurement software in the Leonardo device. The area and intensity values of the region of interest were then automatically calculated. Two independent radiologists assessed each section independently. The mean time between the assessments was one week (Figs. 2 and 3). Following the necessary magnification and windowing adjustments, the preoperative and postoperative cross-sectional area and signal intensity values were obtained by drawing the boundaries of the multifidus muscles on both sides.

2.4. *Statistical analysis*

The NCSS (Number Cruncher Statistical System) 2007 and PASS (Power Analysis and Sample Size) 2008 Statistical Software (Utah, USA) programs were used for statistical analysis. In addition to descriptive statistical methods (mean,

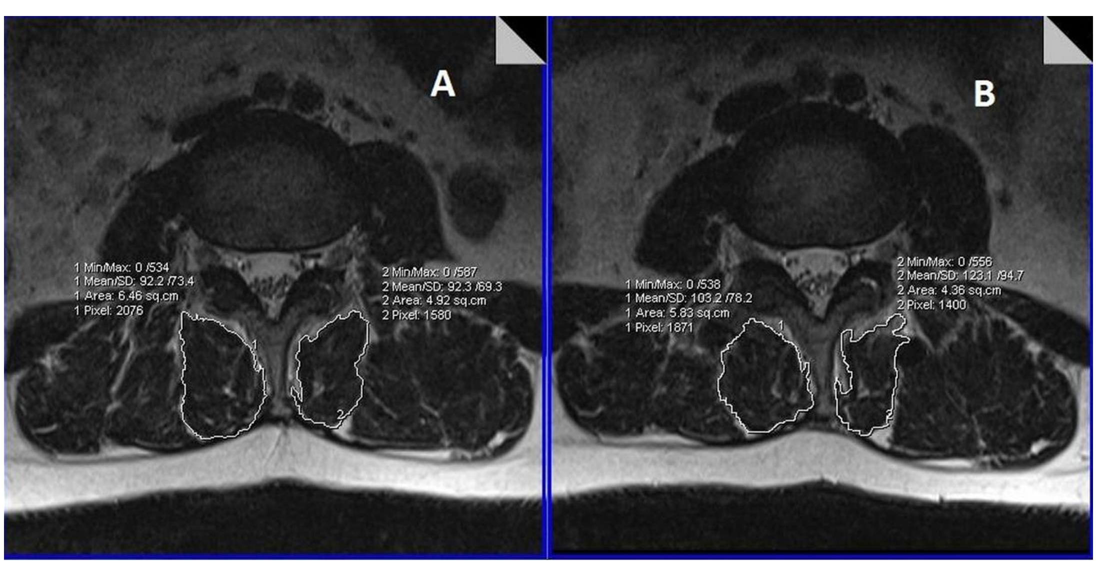

Fig. 2 – (A, B) Lumbar spinal MRI muscle measurements of pre- and postoperative patients operated on using the Wiltse method.

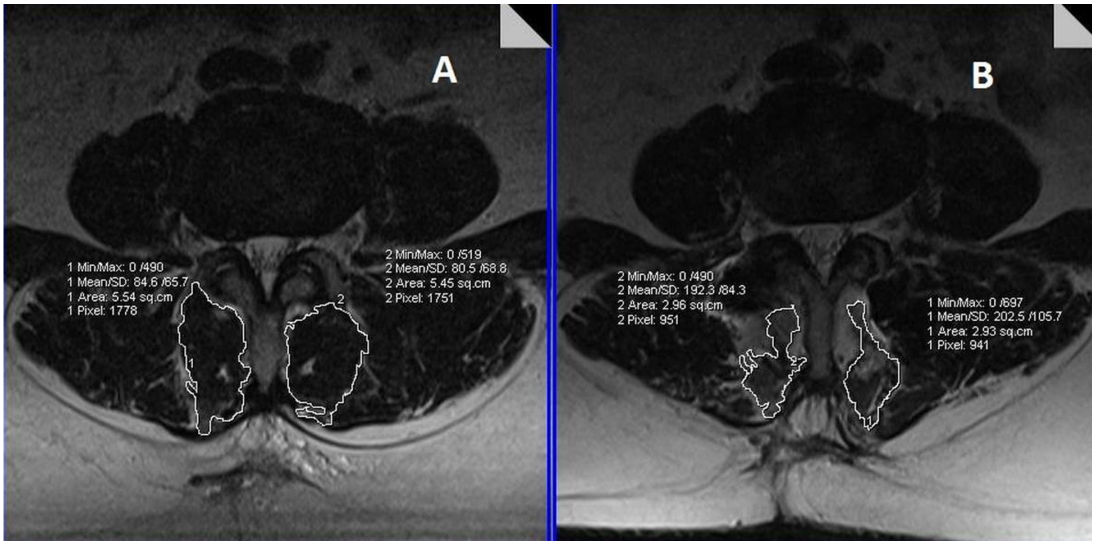

Fig. 3 – (A, B) Lumbar spinal MRI muscle measurements of pre- and postoperative patients using the classical method.

standard deviation, median, frequency, percentage, minimum, and maximum) to evaluate the study data, a Student's *t* test was used for an intergroup comparison of the normally distributed parameters to compare qualitative data. We used the Mann–Whitney *U* test for an intergroup comparison of the parameters and showed an abnormal distribution. The paired sample *t* test was used for an intragroup comparison of the normally distributed parameters, while the Wilcoxon signed-rank test was used for an intragroup comparison of the parameters showing an abnormal distribution. The repeated measures Friedman test was used to measure follow-up values for the parameters that were not normally distributed, and the Wilcoxon signed-rank test was used for paired comparisons. Values of $p < 0.05$ and $p < 0.01$ were considered statistically significant.

3. Results

This study was carried out between 2013 and 2014 on 57 patients whose minimum age was 30 and whose maximum age was 80 (mean age was 55.09 ± 9.58). Of the patients, 73.7% ($n = 42$) were female and 26.3% ($n = 15$) were male. The patients' follow-up periods varied between 9 and 21 months (13.14 ± 2.82 months). The duration of surgery varied from 95 to 255 min (173.68 ± 32.33 min), and the duration of hospitalization varied from one to eight days (2.79 ± 1.25 days). In both the classical method and Wiltse method, there was no statistically significant difference between patients' polyclinic follow-up duration and duration of surgery ($p > 0.05$) (Table 1).

The preoperative JOA scores of the patients in both groups improved significantly ($p < 0.001$) (Table 2); there was no difference between the groups ($p > 0.05$). The preoperative hemorrhage levels were much lower in patients who were operated on using the Wiltse method ($p < 0.001$) (Table 2). The postoperative hemovac drain measurements of patients in the classical method group varied between 40 and 250 mL (131.92 ± 60.50), and nine patients underwent blood transfusion (Table 2). All of the patients who underwent blood transfusion were operated on using the classical method. No hemovac or similar drain was used on any of the patients in the Wiltse group.

No major complications were observed during the surgeries in either group. However, there was a statistically significant difference between the groups in terms of duration of hospitalization and preoperative hemorrhage levels in the

Table 2 – Evaluation of hemorrhage, JOA, and other parameters according to surgery type.

	Classical Mean ± SD (median)	Wiltse Mean ± SD (median)	*p*
Preop hemorrhage	263.85 ± 75.77 (240.0)	129.84 ± 38.65 (120.0)	[a]0.001[**]
Preop JOA	5.31 ± 1.46 (5.50)	5.48 ± 2.03 (6.00)	[a]0.428
Postop JOA	12.15 ± 1.16	12.81 ± 1.35	[b]0.058
[c]*p*	0.001[**]	0.001[**]	

[a] Mann–Whitney *U* test.
[b] Student's *t* test.
[c] Wilcoxon signed ranks test.
[*] $p < 0.05$.
[**] $p < 0.01$.

Table 3 – Evaluation of preoperative, one-month postoperative, and six-month postoperative VAS (back) measurements of the patients according to surgery type.

	Classical Mean ± SD (median)	Wiltse Mean ± SD (median)	[a]p
Preop VAS (Back)	6.22 ± 1.30 (7.00)	6.55 ± 1.24 (6.00)	0.618
Postop 1. Month VAS (Back)	3.89 ± 0.78 (4.00)	2.89 ± 0.78 (3.00)	0.023*
Postop 6. Month VAS (Back)	2.44 ± 0.53 (2.00)	1.78 ± 0.67 (2.00)	0.039*
[b]p	0.001**	0.001**	
[c]Preop–Postop 1. Month VAS	0.011*	0.007**	
[c]Preop–Postop 6. Month VAS	0.007**	0.007**	
[c]Postop 1. AY–Postop 6. Month VAS	0.016*	0.004**	

[a] Mann–Whitney U test.
[b] Friedman test.
[c] Wilcoxon signed ranks test.
* $p < 0.05$.
** $p < 0.01$.

Table 4 – Evaluation of the multifidus area parameters of patients according to surgical technique.

		Classical Mean ± SD (median)	Wiltse Mean ± SD (median)	p
Right	Multifidus Area Preop	6.21 ± 1.31	6.51 ± 1.18	[b]0.371
	Multifidus Area Postop	3.91 ± 1.41 (3.87)	4.91 ± 1.45 (4.65)	[a]0.010*
[c]p		0.001**	0.001**	
Preop–Postop multifidus area difference		2.30 ± 1.02	1.60 ± 0.87	[a]0.009**
Left	Multifidus Area Preop	5.86 ± 1.17	6.33 ± 1.25	[b]0.150
	Multifidus Area Postop	3.80 ± 1.39 (3.82)	4.55 ± 1.15 (4.23)	[a]0.018*
[c]p		0.001**	0.001**	
Preop–Postop multifidus area difference		2.06 ± 0.79	1.79 ± 0.86	[a]0.042*

[a] Mann–Whitney U test.
[b] Student's t test.
[c] Wilcoxon signed ranks test.
* $p < 0.05$

case of the patients who were operated on using the Wiltse method ($p < 0.01$). The duration of hospitalization and preoperative hemorrhage levels were lower for the Wiltse method group (Tables 1 and 2).

There was no statistically significant difference between the preoperative to postoperative JOA scores ($p > 0.05$) in patients who were operated on using the classical method or the Wiltse method (Table 2). The mean postoperative back VAS values of the patients who were operated on using the Wiltse method were significantly lower than in the patients operated on using the classical method ($p < 0.05$). There was no statistically significant difference between the mean leg VAS scores between groups ($p > 0.05$) (Table 3).

There was no statistically significant difference between intragroup right and left cross-sectional measurements for the multifidus muscle (preoperative and postoperative) between groups ($p > 0.05$). In the postoperative cross-sectional measurements for the multifidus muscle, a 37.03% ($p < 0.01$) decrease was found in the right muscle and a 35.15% decrease was found in the left muscle ($p < 0.01$) in the classical method group versus the preoperative measurements. In the Wiltse group, however, the multifidus muscle cross-sectional area measurements showed a 24.57% ($p < 0.01$) decrease in the right muscle and a 28.12% ($p < 0.01$) decrease in the left muscle relative to preoperative measurements. However, the right multifidus muscle had a volume decrease of 20.36% and the left multifidus muscle had a volume decrease of 16.48% in the classical method group versus the Wiltse group ($p < 0.05$) (Table 4). A comparison between the assessments of both radiologists showed no statistically significant difference.

Fatty degeneration and fibrosis increased in the muscle and was markedly increased in the postoperative right and left multifidus muscles of both groups relative to preoperative measurements. However, the classical method group was 74.45% higher in the right multifidus muscle and 92.2% higher in the left multifidus muscle than the Wiltse group ($p < 0.001$). There was no statistically significant difference in intragroup intensity measurements (preoperative and postoperative) for the right and left multifidus muscle for either the classical group or the Wiltse group ($p > 0.05$) (Table 5).

4. Discussion

In the last decade, minimally invasive approaches have become increasingly popular in lumbar surgery. One of these

Table 5 – Evaluation of the multifidus intensity parameters of patients according to surgery type.

		Classical Mean ± SD (median)	Wiltse Mean ± SD (median)	p
Right	Multifidus Intensity Preop	121.65 ± 27.95 (114.67)	118.86 ± 23.61 (113.50)	[a]0.962
	Multifidus Intensity Postop	247.11 ± 55.37 (233.57)	190.77 ± 50.01 (179.73)	[a]0.001**
[b]p		0.001**	0.001**	
Preop–Postop multifidus intensity difference		125.45 ± 53.10	71.91 ± 39.01	[a]0.001**
Left	Multifidus Intensity Preop	122.60 ± 24.49 (114.85)	120.80 ± 23.46 (118.50)	[a]0.943
	Multifidus Intensity Postop	265.81 ± 70.40 (253.33)	195.32 ± 53.84 (195.32)	[a]0.001**
[b]p		0.001**	0.001**	
Preop–Postop multifidus intensity difference		143.21 ± 64.17	74.51 ± 43.80	[a]0.001**

[a] Mann–Whitney *U* test.
[b] Wilcoxon signed ranks test.
* $p < 0.05$.
** $p < 0.01$.

methods is Wiltse splitting that has been applied to the lateral paraspinal region. This method was first defined by Watkins in 1959 and was modified by Wiltse in 1968 [2,4,5]. The Wiltse technique was first developed for use in fusion surgery, neoplasm surgery, and lumbar disc hernias. It is also currently used for far lateral discs, decompression in far lateral syndrome, in pedicle screw systems, and in spinal canal decompression [4,5]. Although the Wiltse technique originally used double-skin incision, this was improved to one-skin incision since 1988. This modification also made the Wiltse method more attractive than its initial version in terms of cosmetics [1,2].

Wiltse splitting has profound advantages due to its midline single incision procedure and its approach to the bilateral paravertebral region—both involve minimal tissue dissection and ecartation with minimal hemorrhage. The transverse process, pedicle, and lumbar disc can be reached directly and smoothly using this method. In this procedure, a dorsolumbar fascia incision is made in parallel with a skin incision at 3–4 cm laterally to the midline by subcutaneous dissection. The sacrospinal muscle between the longissimus muscles is longitudinally separated, and the supraspinatus and interspinatus ligaments are protected [2,4,5]. The ratio of hemorrhage and complications is also reduced when this technique is used [2].

The multifidus muscle begins in the lumbar region. It starts from the spinous processes and adheres to the mammillary apparatus of the facet joint and iliac crest. Postoperative lumbar spinal MR images in the study of Tsutsumimoto et al. [3] showed that atrophy in the multifidus muscle increased as muscle dissection was closer to the medial end. Similarly, hyperintensity was observed in the L5, LS region of the multifidus muscle, while atrophy was observed in the muscles in the L3-L4 region. This was attributed to trauma due to surgical splitting. In our study, the postoperative multifidus muscle area decreased in all of the patients operated on using either method ($p < 0.01$). However, the cross-section of multifidus muscle was larger in the Wiltse group ($p < 0.05$). The intensity due to fibrosis and fat degeneration was significantly lower versus the classical method ($p < 0.001$). While there was no difference in the postoperative leg pain VAS evaluation ($p > 0.05$), the back pain VAS evaluation showed significantly lower values in Wiltse group patients versus the classical method group.

Three different methods have been defined in paraspinal area surgeries. The first two of those methods are performed between the sacrospinal muscle and the quadratus lumbar as defined by Ray and Watkins. The third is the paraspinal splitting of the Wiltse procedure, which is currently the preferred and most common method [1–5]. All three splitting methods enable decompression [4,5]. According to cadaver studies carried out by Vialle et al., such methods are preferred for spondylolisthesis surgery in pediatric patients and adolescents due to easy access to the L5 and S1 articular and transverse processes as well as minimized hemorrhage [4,5].

The results for Wiltse splitting in our study are similar to the results of Tsutsumimoto et al. [3] and Oliver et al. [1] in terms of preoperative hemorrhage, multifidus muscle damage in the postoperative radiologic analyses, and cleavage area. Palmer et al. [2] reported similar multifidus muscle damage and cleavage areas in patients who were evaluated by means of postoperative MRI.

Vialle et al. [4,5] compared two modes related to the Wiltse method. The same study also defined all vascular and muscular structures in the region and reported that Wiltse is the most advantageous approach of all the splitting methods in terms of the risk of preoperative hemorrhage while excluding anatomic variations. In a cadaver study, Oliver et al. [1] measured the intensity of vascular veins in the skin as 10.3 mm from the right and 11.1 mm from the left. In our study, an average of 264 mL of hemorrhage occurred in the classical method group and 130 mL of preoperative hemorrhage occurred in the Wiltse group ($p < 0.001$). Similar to the studies of Viale and Oliver, our study indicates that Wiltse splitting is superior to the classical splitting method.

A literature review shows that previous studies used MR imaging of the lumbar area to evaluate the paravertebral muscles as well as levels of hemorrhage across both methods. We were unable to find any clinical studies on postoperative pain scores. Our study showed that the Wiltse method offers lower hemorrhage levels, decreased duration of surgery and hospitalization, and lower VAS scores.

5. Conclusion

We conclude that the Wiltse method is a more comfortable surgical method than the classical method. It produces less postoperative pain, less hemorrhage, and a shorter duration of hospitalization. The Wiltse technique also causes less damage to the multifidus muscle than the classical method.

Conflict of interest

None declared.

Acknowledgement and financial support

None declared.

Ethics

The work described in this article has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; Uniform Requirements for manuscripts submitted to Biomedical journals.

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