Original Article

Comparison of Nerve Root Direction of Lumbar Spine in Different Positions

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Background: Endoscopic surgery in lumbosacral spine has been a procedure for spine surgeons since 1999. The most common position for patients in prone position, but in some situation, it is impossible to proceed, such as in overweight patients or patients with associated injury. It is necessary to compare the anatomy of nerve roots in different positions such as supine, prone, and lateral decubitus position. Therefore, the magnetic radiography imaging is a proper tool for evaluating nerve roots.

Material and Methods: The authors designed a study where 14 patients would engage in the magnetic resonance imaging (MRI) process in three different positions. The first group, control group, would get the MRI at supine position while the second and the third group would proceed with MRI at prone and lateral decubitus position, respectively. Then, the authors would measure the values by drawing the line between upper border of the exiting nerves and the lateral border of traversing nerves. Hence, if the nerve root angle was different from the control group by more than 10 degrees, it would be clinically significant because of changes in the Kambin's triangle.

Results: The demographic data were not statistically significant for all population in the three groups. All of nerve roots direction, at the L3-L5 level, were not similar in supine, prone, and lateral decubitus positions.

Conclusion: The present study will help orthopedic surgeon be aware that the position of patients affected nerve roots direction. Pre-operative MRI must be done, and pathological level should be specified despite the above and below part. Even though the result showed no statistical difference, the angle of more than 10 degrees affected the increased area of Kambin's triangle. However, it would be favorable for the expansion of Kambin's area in prone and lateral decubitus.

Keywords: Position of MRI; Nerve roots direction in lumbar spine; Kambin's triangle and position

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Endoscopic surgery in the lumbo-sacral spine has become popular for spine surgeons. The advantages of endoscopic spine surgery are less tissue dissection, less muscular trauma, reduced blood loss, less damages to the epidural blood supply and consequent less epidural fibrosis and scarring, reduced hospital stay, early functional recovery, improvement in the quality of life, and better cosmetic results. With precise indication, proper diagnosis, and good training, endoscopic spine surgery can produce better results than open spine surgery. Initially, the endoscopic technique was restricted to the lumbar region, but now it also can be used for cervical and thoracic disc herniation[1].

The techniques and technical applications were developed in 1963 by Lymen Smith who started the minimally invasive spine surgery, including injected chymopapain intradiscally, which is called chemonucleolysis. In 1975, Hijikata et al designed the nucleotomy via posterolateral approach and developed cannulas, which was a 7 to 8 mm telescope. After that, Friedman and Jacobson started employing a far lateral approach for lumbar disc herniation. Today, spine surgeons are still developing and designing novel techniques. The most usual patient position is prone, but it is not always possible because of some patient's conditions such as overweight patients or patients having associated injury such as in blunt trauma chest injuries[1].

Shriver et al reported complications that could occur from a prone position procedure. Vision loss was the most commonly reported complication. For some surgeons, it is difficult to tolerate standing

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for long time during the surgery. It is preferable for them to sit to conduct the surgery in lateral decubitus position. For lateral decubitus, the surgeons have little knowledge about the anatomy of the nerve roots and is barely aware of when the patient is in the prone position. It is important to recognize the anatomical changes and compare the obtained data in the three different positions. Schenck reported about health and physiological effects of human exposure to whole-body for magnetic resonance imaging (MRI) is a proper and safety tool for evaluating nerve roots[2].

Shriver et al reported the lumbar spine surgery positioning complications in a systematic review in 2015. Twenty-four studies reported complications associated with use of the prone position, and seven studies investigated complications after knee-chest positioning. Complications associated with the knee-elbow, lateral decubitus, and supine positions were individually reported by a single study. Vision loss was the most commonly reported complication for both prone and knee-chest positioning. Other reported complications included conjunctival swelling, ischemic orbital compartment syndrome, nerve palsies, thromboembolic complications, pressure sores, lower extremity compartment syndrome, and shoulder dislocation, highlighting the assortment of complications following different surgical positions. For prone-position studies, the increased operation time was related to position complications. Only three prone-position studies reported complications following procedures of less than 120 minutes, while the seven studies reported complications following mean operative times of 121 to 240 minutes, and nine additional studies reported complications following mean operative times greater than 240 minutes. This relation was not observed for knee-chest and other surgical positions[3].

Lateral decubitus endoscopic spine surgical procedure is not common because it is difficult to perceive the nerve orientation and the anatomy of the spinal structure.

The MRI is an imaging tool that is important for lumbosacral spine surgery, mostly in the supine position because patients just take 45 to 60 minutes per region to finish the process[4,5]. However, in some situations, the supine position process was impossible, hence the authors designed new positions for patients who had back problems or lateral decubitus for overweighed patients.

Therefore, a question related to the degree of angular change in nerve roots for different positions of the MRI is raised. If the angle changes, it is important to proceed approaching with the endoscopic spine surgery.

Materials and Methods

The present research is a prospective cohort study. The Research Ethics Committee had approved by protocol number is 68/2563. The samples according to the calculation were 14 patients who presented in a pilot study for the most common pathologic level in L4 nerves roots on both sides. These 14 patients were required to be given the preoperative MRI for lumbosacral surgical planning. The patients' age ranged between 20 and 70 years and were diagnosed with spinal stenosis and herniated nucleus pulposus (HNP).

The authors excluded patients who had contraindications for MRI such as Absolute contraindications in patients with cardiac pacemaker, metal in the body, aneurysm clip, automatic defibrillator, biostimulators, implanted fusion devices, or internal hearing aid. The relative contraindication was first trimester pregnancy, middle ear prosthesis, claustrophobia, ankylosing spondylitis, spine infection, spine tumor, or metathesis spine.

The authors designed the present study where 14 patients would be given the MRI in three positions. First was supine, which was the control group. Second was prone, and the third was lateral decubitus position, respectively. For the supine position group, there was no contrast, and we could perform the operation in 20 to 25 minutes. As to the prone and lateral decubitus groups, only T2 was conducted, and the mean time decreased to 15 minutes per position. In these three positions, the operation would finish in 45 to 55 minutes. MRI had no effects on patients, and the authors measured the angular direction of nerve roots for most common pathological level (lumbar 4-5) plus one level above and one below. After that, the authors compared the measured angle of nerve roots in coronal MRI of prone and lateral decubitus groups with the control group (Figure 1). The measurement was performed by drawing a line between the upper border of the exiting nerve roots and lateral border of the traversing nerve. In this regard, if the nerve root angle was more than 5-degree different from the control group, it would be clinically significant because of the change in Kambin's triangle (Figure 2). In the sagittal and axial MRI, the measurement was attempted, but it was impossible because of difficulties for intra/inter observation of measurements.

For the data findings, to test the difference in nerve roots among the different positions, including

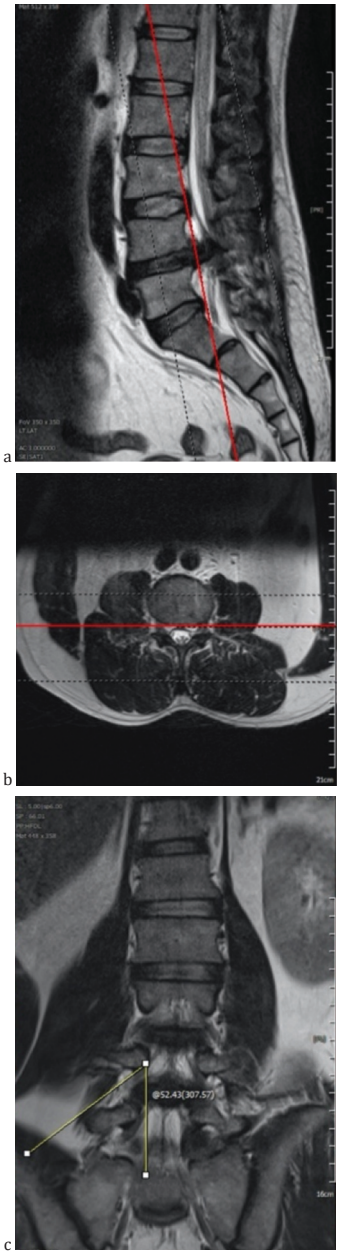

Figure 1. Lumbar spine MRI image that shows sagittal (a), axial (b), and coronal (c) to show nerve roots direction to measurement.

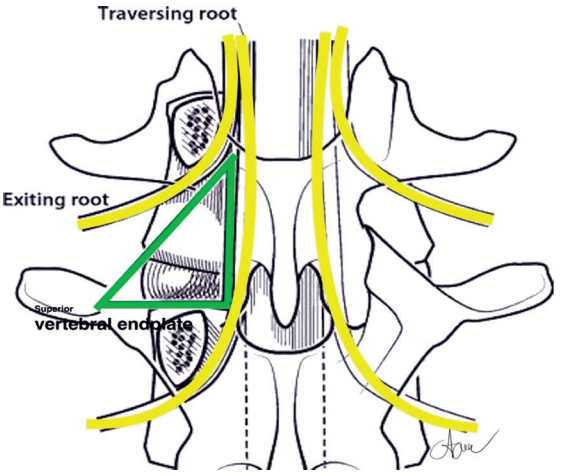

Figure 2. A lumbar spine that demonstrating PA view and green triangle as the Kambin's area.

Table 1. Difference in nerve roots among the different positions in NR lumbar 3-5

Independent variable	Mean	SD	df	F	p-value	Partial eta square
NR lumbar 3: positions						
Supine	49.59	8.86	1.811	1.057	0.357	0.075
Prone	50.02	9.42				
Lateral decubitus	53.02	8.26				
NR lumbar 4: positions						
Supine	54.23	10.43	1.458	1.095	0.335	0.073
Prone	54.13	8.81				
Lateral decubitus	57.22	11.12				
NR lumbar 5: positions						
Supine	54.46	10.87	1.883	1.237	0.306	0.087
Prone	56.26	8.56				
Lateral decubitus	57.30	8.30				

NR=nerve root; SD=standard deviation

supine, prone, and lateral decubitus positions, the researcher decided to use one way analysis of variance (ANOVA) to the test the hypotheses.

Results

The findings could be divided into three main parts, according to the NR lumbars.

For NR lumbar 3, considering the means, lateral decubitus position has the highest nerve root degree, having the mean of 53.02±8.26 degree, followed by prone position and supine position respectively, having the means of 50.02±9.42 and 49.59±8.86. Even though the means indicated the difference in the nerve root degree among the different positions, the result generated by ANOVA indicated that there were no significant differences among the three positions at the 0.05 level (η^2_p=0.075, p=0.357) (Table 1).

For NR lumbar 4, considering the means, the lateral decubitus position had the highest nerve root degree, having the mean of 57.22±11.12 degree, followed by supine position and prone position, having the means of 54.23±10.43 and 54.13±8.81, respectively. However, the result generated by

ANOVA indicated that the difference among the three positions were not considered statistically significant at the 0.05 level (η_p^2=0.073, p=0.335) (Table 1).

For NR lumbar 5, according to the means, lateral decubitus had the highest nerve root degree, having the mean of 57.30±8.30, followed by prone position and supine position, having the means of 56.26±8.56 and 54.46±10.87 degree, respectively. However, according to the result generated by ANOVA analysis, the result indicated that the difference was not statistically significant at the 0.05 level (η_p^2=0.087, p=0.306) (Table 1).

From the above analyses, it could be concluded that the difference in the nerve root degrees among the different positions, including supine, prone, and lateral decubitus, in NR lumbar 3, 4, and 5 were not statistically significant at the 0.05 level.

Discussion

The Kambin is a safe zone on the posterolateral of the spinal canal, the annular surface in the Kambin's area at posteriorly to the exiting root, superiorly to the endplate of the inferior lumbar body, lateral to the Dural sac and the traversing root, and anteriorly to the facet joint. This area is the safe zone to approach and land instruments to the intervertebral disc and the spinal canal, both existing and traversing roots that form the lateral and medial boundaries of the Kambin. The procedure of endoscopic disc surgery is the proper positioning of the instruments that approach and placement of the tip of the inserted instruments on the annular surface in the Kambin. The fibers of the posterior longitudinal ligament extend laterally into the triangular working zone and extra foraminal region[6,7].

In the present study, the angle of nerve roots was changed from 5 to 15 degrees even though it is not statistically significant. However, for the clinical application, it was more effective to increase or decrease the triangular working zones. It may increase or decrease nerve damage. It is necessary to be concerned with this issue especially in transforaminal approach. Surgeons can prevent the damage with an awake surgery using local anesthesia or monitoring anesthetic control.

Conclusion

The present study finding could be used when considering the position of patients, which affect the nerve root direction. It is necessary to perform a pre-operative MRI and specify the pathological level even though the above and below parts are still a concern. Even though there is no statistical difference, the angles of more than 5 degree affected the increase of the area of Kambin's triangle. Therefore, it would be beneficial to increase the Kambin's area of the patient's position in both prone and lateral decubitus.

Limitation

The size of the experimental group was small because of the cost limitations of the authors' hospital.

What is already known on this topic?

Previous knowledge for Kambin's area in the safe zone and it is dependent on nerve direction[8].

What this study adds?

This study shows position of MRI did not difference in the direction of nerve roots.

Conflicts of interest

The authors declare no conflict of interest.

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