Özgür, A, Mehmet, S and Nail, Ö. (2023) MAGNETİC RESONANCE IMAGİNG ANALYSİS OF THE FORAMEN AND DİSC SPACE İN PATİENTS WİTH L5 VERTEBRAL BODY HYPOPLASİA. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte vol. 23 (90) pp. 516-522
DOI: https://doi.org/10.15366/rimcafd2023.90.037

ORIGINAL

MAGNETİC RESONANCE IMAGİNG ANALYSİS OF THE FORAMEN AND DİSC SPACE İN PATİENTS WİTH L5 VERTEBRAL BODY HYPOPLASİA

Özgür Akşan[1], Mehmet Seçer[2], Nail Özdemir[1]

[1] İstanbul Aydın University, Deparment of Neurosurgery, İstanbul.
[2] Alanya Alaaddin Keykubat University, Department of Neurosurgery, Alanya.

Received April 10, 2022
Accepted June 14, 2023

ABSTRACT

Objective: We studied those results of calculating foramen diameter and intervertebral disc height in normal patients and L5 hypoplasia. **Design:** This study is observational. **Place & duration of study:** Alanya Alaaddin Keykubat University, Department of Neurosurgery, Alanya, Turkey between January 2017 January 2020 **Methodology:** We performed with MRI of 20 patients with L5 hypoplasia and 20 control group. Anteroposterior diameter of L5, foraminal sizes, spondylolysis, spondylolisthesis, and intervertebral disc degeneration were assessed. **Results:** When L5 hypoplasia and control groups were evaluated, a statistically significant difference was observed when L4-5 and L5-S1 AP diameters were compared. Both the right L5 and S1 foramen diameters and left L5 and S1 foramen diameters were significantly narrower in the patients with L5 hypoplasia compared with control group. Grade I true anterolisthesis was detected in 3 patients included in the L5 hypoplasia group. All patients with L5 hypoplasia had thinning of the pedicles and hypoplasia of the lower surfaces of the L5. Low-grade disc degeneration was observed in all patients at the L4-5 and L5-S1 levels of the L5 hypoplasia group. **Conclusion:** Physicians who detect vertebral body hypoplasia in radiological imaging studies such as MRI should definitely consider the possibility of spondylolisthesis, disc degeneration and foraminal stenosis that may develop in these patients. Even if such patients are asymptomatic, they should regularly follow up radiologically and clinically.

KEYWORDS: L5 hypoplasia; vertebral body hypoplasia; spinal stenosis; intervertebral disc degeneration; spondylolisthesis

1. INTRODUCTION

It is a well-known fact that the vertebral body sizes gradually increase from C1 to L5, and the largest vertebral body is L5 (Bagheri, Hosseini, & Foroughi, 2011; Legaye, 2018; Wilms et al., 2009). Vertebral body hypoplasia is defined as the sagittal diameter of the vertebra shorter than the upper vertebra (Coskun, Turan, Kaplanoglu, & Kaplanoglu, 2022; Kim, Lee, Moon, Park, & Hahm, 2000; Niggemann et al., 2012).

The most common level of vertebral body hypoplasia is L5 (Coskun et al., 2022). Intervertebral disc degeneration, spondylosis, and facet arthropathy may predispose to hypoplasia of the vertebral body (Legaye, 2018; Niggemann et al., 2012). The purpose of this retrospective study was to evaluate with Magnetic Resonance Imaging (MRI) of the foramen diameter and intervertebral disc height in the affected segment in patients with L5 vertebral body hypoplasia (L5 hypoplasia) and control group.

2. Methodology

We conducted a observational study including patients who had MRI scans because of low back pain from January 2017 to January 2020. The hospital files and electronic medical records of the patients were evaluated. A total of 2300 lumbar MRI scans due to low back pain between the period at our clinic were reviewed retrospectively. 20 patients with L5 hypoplasia were identified and included.

The control group selected 20 patients without L5 hypoplasia. Patients with trauma, metastasis, infection, inflammatory disease or osteoporosis were excluded. This research application was reviewed by the Ethics Institution Committee of the Alanya Alaaddin Keykubat University (15062022-05-03) was conducted according to the 1964 Declaration of Helsinki and its later amendments. Informed consents were not obtained due to the study's retrospective design and fully anonymised data. All enrolled patients provided written informed consent to participate in this study. This study was writtenin accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) criteria (Von Elm et al., 2007).

We analyzed the images for the presence and absence of L5 hypoplasia. The L4 and L5 anteroposterior (AP) diameter of was measured at the middle section vertebral bodies. L5 hypoplasia was considered if there was a difference of at least 2 mm between L5 and L4. Patients who could not achieve this difference were selected as the control group. Disc heights of the L4-5 and L5-S1 and AP and vertical sizes of the right and left foramen at L5 and S1 levels of both groups were measured.

The presence or absence of spondylolisthesis spondylolysis was

evaluated. L4-5 and L5-S1 disc degeneration was evaluated by using modified Pfirrmann classification systems. Our patients were taken with 1.5 T MRI (Magnetom Symphony; Siemens, Forchheim, Germany). As the standart protocol for a lumbar MRI, we performed sagittal T1 and T2-weighted images with axial T2-weighted images. All measurements and evaluations were made by an independent observer using an electronic caliper in the picture archiving and communication system (PACS) (Impax-Climent; Agfa Gevaert, Mortsel, Belgium).

Statistical data were analyzed by using the Statistical package for the Social Sciences (SPSS) 15.0 software (SPSS Inc., Chicago, IL). The conformity of the data to the normal distribution was evaluated with the Shapiro-Wilk francia test. Descriptive statistics were used to summarize the demographics characteristics of the cases.

Normally distributed variables are expressed as mean ± standard deviation values, whereas nonparametric continuous variables are expressed as median values (interquartile range). Categorical variables are expressed as numbers (%). The Independent-Samples T test, which is one of the parametric tests, was used to compare the two independent groups with each other according to the quantitative variables, while the t-test, which is one of the nonparametric tests, was used. A p value of <0.05 was accepted as statistically significant.

3. Results

We identified 20 patients L5 hypoplasia (11 males, 9 females) and 20 patients (11 males, 9 females) control group. The mean age was 51.3±16 years (range, 27-80 years) for L5 hypoplasia group while the mean age was 41.7±8.2 years (range, 29-80 years) for control groups. When the male/female ratio and mean age were evaluated, it was seen that there was no statistically significant difference between the two groups (p>0.05).

When the L5 hypoplasia and control groups were compared considering the L4-5 and L5-S1 AP diameters, a statistically significant difference was detected. In addition, both L4-5 and L5-S1 AP diameters were found to be significantly higher in the L5 hypoplasia group than in the control group (p<0.001).

Statistically significant difference were noted between the L5 hypoplasia and control groups in the values of the right L5 foramen, right S1 foramen, left L5 foramen, and left S1 for foramen AP and vertical diameters (p<0.001). oth the right L5 and S1 foramen diameters and left L5 and S1 foramen diameters were significantly narrower in the patients with L5 hypoplasia compared with control group (p<0.001). (Table 1).

Table 1: Comparison of the L5 AP diameter, L4-5 and L5-S1 disc height, L4-5 right and left AP and vertical diameter and L5-S1 right and left AP and vertical diameter (mm) between the study groups

	CONTROL GROUP (N=20)	L5 HYPOPLASİA GROUP (N=20)	P
L5 AP DİAMETER *	30.18±2.2	21.2±2.33	<0.001
L4-L5 DİSC HEİGHT **	11.7 (10.7-13.2)	9.2 (8-10.75)	0.001
L5-S1 DİSC HEİGHT **	10.3 (9.4-11.7)	8.75 (6.75-9.95)	0.008
L4-L5 RİGHT FORAMEN AP DİAMETER *	9.94±1.1	6.12±2.0	<0.001
L4-L5 RİGHT FORAMEN VERTİCAL DİAMETER *	18.26 ±1.93	6.12 ±2.0	<0.001
L4-L5 LEFT FORAMEN AP DİAMETER *	9.52 ±1.38	6.45 ±1.93	<0.001
L4-L5 LEFT FORAMEN VERTİCAL DİAMETER *	16.3 ±2.04	12.0±3.82	<0.001
L5-S1 RİGHT FORAMEN VERTİCAL DİAMETER *	9.28 ±2.44	6.5 ±2.17	0.001
L5-S1 RİGHT FORAMEN AP DİAMETER *	16.3 ±2.04	12.0 ±3.8	<0.001
L5-S1 LEFT FORAMEN VERTİCAL DİAMETER *	15.4 ±1.88	12.1±3.4	<0.001
L5-S1 LEFT FORAMEN AP DİAMETER *	9.3 ±1.71	7.0 ±1.95	<0.001

**As presented mean ± SD, ** As presented median and IQR, T-test and Independent Samples t test*

Grade I true anterolisthesis was detected in 3 patients included in the L5 hypoplasia group. All patients with L5 hypoplasia had thinning of the pedicles and hypoplasia of the lower surfaces of the L5. According to the modified Pfirmann scoring system, low-grade disc degeneration was observed in all patients at the L4-5 and L5-S1 levels of the L5 hypoplasia group.

4. Discussion

Vertebral body hypoplasia, in which the AP diameter of the lower vertebra is smaller than the AP diameter of the upper vertebra (Coskun et al., 2022; Kim et al., 2000; Niggemann et al., 2012). Frank and Miller (Frank & Miller, 1979) defined it for the first time in the literature in 1979.The authors compared lumbar spine radiographs of 50 patients with spondylolysis and spondylolisthesis with 50 patients with normal radiographs. They stated that anterior vertebral shift was not observed in all patients with spondylolysis. They also suggested that shortening of the AP diameter of the L5 may not produce true spondylolisthesis and that the term pseudospondylolisthesis should be used in such images. In 2009, Wilms et al (Wilms et al., 2009) emphasized that bilateral spondylolysis should be suspected even if MRI is insufficient to detect

spondylolysis in patients with L5 hypoplasia on MRI. The authors stated that L5 hypoplasia and wedge may not necessarily cause true anterior vertebral slippage in patients with bilateral spondylolysis, and that this can be evaluated on the base of pseudospondylolisthesis. Bagheri et al (Bagheri et al., 2011) stated that there is a relationship between L5 hypoplasia and L5 spondylolysis, but it should not be concluded that this situation will always lead to true anterior vertebral slippage or spondylolysis. Bagheri et al (Bagheri et al., 2011) reported the frequency of L5 hypoplasia in asymptomatic patients undergoing lumbosacral MRI for any reason 2% (38 cases in 2000 MRI), while Coskun et al (Coskun et al., 2022) reported a similar rate of 1.8% (55 cases 3100 MRI). The frequency rate in our series was lower than the literature and was 0.87% (20 cases in 2300 MRI). In these our selected cases, 3 (15%) show true anterolisthesis grade I. Wilms et al. (Wilms et al., 2009) measured the AP diameter of the L4 and L5 corpuscles at the upper and lower endplates of the mid-sagittal region, at the entrance level of the basivertebral veins corresponding to the middle of the corpus, and at the upper endplates of the S1.at the level of entrance of basivertebral veins (at the mid part of the body), and superior endplate of S1. Niggemann et al. determined hypoplasia by measuring at the level of the inferior endplate at L5 and superior endplate of the S1 vertebra. In this our study, we measurements were as described by Wilms et al (Wilms et al., 2009) for the AP diameter of the L5 vertebra. We found a significant decrease in L4, L5, S1 AP diameters measured on MRI in L5 hypoplasia and normal groups, and a significant decrease in L4/L5 and L5/S1 ratios in L5 hypoplasia group. To our knowledge and review of literatures, the our study is the first on evaluation of the foraminal stenosis in the cases with L5 hypoplasia. We found bilateral stenosis in both L5 and S1 foramen in all of our patients with L5 hypoplasia. Also, hypoplasia of the inferior facets and thinning of the pedicles of L5 was present in all patients for L5 hypoplasia group. Disc degeneration in patients with L5 hypoplasia have been described previously (Coskun et al., 2022). Kim et al (Kim et al., 2000) presented the prevalence and pattern associated of disc degeneration in their vertebral hypoplasia type classification in the literature. The authors explained the pathophysiology of disc degeneration in vertebral hypoplasia. According to the authors, if there is a sudden reduction in the size of the lower vertebra, greater compressive forces per unit area occur on the disc surface. They also classified the types of vertebral hypoplasia as type containing a single vertebral body, type containing serial lower segment vertebral bodies, type containing a series of vertebral bodies, and type containing an upper segment vertebral body with sudden enlargement of a lower body. The authors emphasized that the most common type is type IIa, where the hypoplastic body is located anteriorly along the anterior spinal line, and this ripple covers approximately 85% of cases. They also emphasized that posterior disc herniation occurred in all cases, and all associated disc degenerations were posterior or diffuse. Apart from this, the authors stated that the least common type in their series was type Ia,

constituting approximately 9% of the cases, which described hypoplasia involving a single vertebral body. They reported that diffuse disc degeneration and posterior disc herniation were observed at both the upper and lower disc levels in type I a patients. In our series, all patients were in type Ia category and, as stated by Kim et al (Kim et al., 2000), all patients had degeneration of the L4-5 and L5-S1 disc levels.

There are some limitations to this study: The limitations of this study include its observational nature. The small sample size as well as patient selection might have contributed to a certain selection bias.

5. Conclusion

Physicians who detect vertebral body hypoplasia in radiological imaging studies such as MRI should definitely consider the possibility of spondylolisthesis, disc degeneration and foraminal stenosis that may develop in these patients. Even if such patients are asymptomatic, they should regularly follow up radiologically and clinically.

Funding Sources

The authors declared that there was no funding used in this study.

Ethical Approval

This study was approved by the Ethics Institution Committee of the Alanya Alaaddin Keykubat University (IRB No:15062022-05-03).

Patients'Consent

Informed consents were not obtained due to the study's retrospective design and fully anonymised data.

Competing Interest

The authors declared no competing interest.

Authors' contribituons

Özgür Akşan: Literature search, collected data and writing the manuscript. Mehmet Seçer: Literature search, collected the data, revised the manuscript. Nail Özdemir: Revised the manuscript.

Reference

Bagheri, M. H., Hosseini, M. M., & Foroughi, A. A. (2011). Pseudolisthesis secondary to small L5. *European journal of radiology, 80*(3), 802-804.

Coskun, H., Turan, A., Kaplanoglu, H., & Kaplanoglu, V. (2022). Frequency of

Hypoplasia of the Vertebral Body at L5, and Its Relationship with Degeneration in Patients with Low Back Pain. *Turkish Neurosurgery, 32*(4).

Frank, D. F., & Miller, J. E. (1979). Hypoplasia of the lumbar vertebral body simulating spondylolisthesis. *Radiology, 133*(1), 59-60.

Kim, S. K., Lee, S. R., Moon, W. J., Park, D. W., & Hahm, C. K. (2000). Regional disc change in segmental hypoplasia of the lumbosacral vertebral bodies: MR findings. *Journal of the Korean Radiological Society, 43*(1), 25-30.

Legaye, J. (2018). Radiographic analysis of the listhesis associated with lumbar isthmic spondylolysis. *Orthopaedics & Traumatology: Surgery & Research, 104*(5), 569-573.

Niggemann, P., Kuchta, J., Grosskurth, D., Beyer, H., Hoeffer, J., & Delank, K. (2012). Spondylolysis and isthmic spondylolisthesis: impact of vertebral hypoplasia on the use of the Meyerding classification. *The British journal of radiology, 85*(1012), 358-362.

Von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., & Vandenbroucke, J. P. (2007). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *The lancet, 370*(9596), 1453-1457.

Wilms, G., Maldague, B., Parizel, P., Meylaerts, L., Vanneste, D., & Peluso, J. (2009). Hypoplasia of L5 and wedging and pseudospondylolisthesis in patients with spondylolysis: study with MR imaging. *American journal of neuroradiology, 30*(4), 674-680.