Research Article / Araştırma Makalesi

Can Lumbar Pedicle Thickness Be a Morphological Parameter in Predicting Lumbar Spinal Canal Stenosis?

Lomber Pedikül Kalınlığı, Lomber Spinal Kanal Darlığını Öngörmede Morfolojik bir Parametre Olabilir mi?

Ayşe Serap AKGÜN [1]

1 Istanbul Medipol University, Faculty of Medicine, Department of Radiology

Abstract

Background: Lumbar spinal canal stenosis (LSCS) is an important cause of morbidity in the elderly population. Many morphological abnormalities such as facet joint hypertrophy, ligamentum flavum hypertrophy, disc herniation combined with osteophytes associated with LSCS were investigated. Degenerative changes in all the elements of the vertebral bone such as lumbar pedicle thickness (LPT) has not evaluated clearly. The aim of this study to investigate whether LPT can be a morphological parameter to predict LSCS using magnetic resonance imaging (MRI).
Materials and Methods: 150 patients diagnosed clinical LSCS and 150 control subjects who did not have LCSC-related symptoms referred to radiology unit to undergo lomber MRI enrolled the study. LPT was measured at the most stenotic level of the L5 vertebra using axial T2-weighted images.
Results: The mean LPT value was 14.70±1.94 mm in the LSCS group and 14.23±2.00 mm in the control group and was higher in patient group than the controls but did not reach statistical significance (p=0.082).
Conclusion: LPT cannot be an effective factor to predict patients with LSCS.

Key words: Lumbar spinal canal stenosis, Lumbar pedicle, Lumbar pedicle thickness, MRI.

Öz.

Amaç: Lomber spinal kanal stenozu (LSKS) yaşlı popülasyonda önemli bir morbidite nedenidir. LSKS ile ilişkili faset eklem hipertrofisi, ligamentum flavum hipertrofisi, disk herniasyonuyla birlikte osteofitler gibi birçok morfolojik anormallik araştırılmıştır. Lomber pedikül kalınlığı (LPK) gibi vertebral kemiğin tüm elemanlarındaki dejeneratif değişikler net olarak değerlendirilmemiştir. Bu çalışmanın amacı LPK'nın LSKS ön görüsünde morfolojik bir parametre olup olamayacağını manyetik rezonans görüntüleme (MRG) ile araştırmaktır.
Materyal ve Metod: Lomber MRG için radyoloji ünitesine yönlendirilen klinik LSKS tanısı alan 150 hasta ve LSKS ile ilgili semptomları olmayan 150 kontrol grubu çalışmaya dahil edildi. LPK aksiyal T2 ağırlıklı görüntülerde en dar seviye olan L5 vertebra düzeyinde ölçüldü.
Bulgular: LSKS li grupta ortalama LPK değerleri 14.70±1.94 mm ve kontrol grubunda 14.23±2.00 mm idi ve hasta grupta kontrol grubuna göre yüksekti ancak istatistiksel öneme ulaşmadı (p=0.082).
Sonuç: LPK, LSCS' li hastaları öngörmede etkili bir faktör olamaz.

Anahtar kelimeler: Lomber spinal kanal stenozu, Lumbar pedikül, Lumbar pedikül kalınlığı, MRG

Sorumlu Yazar / Corresponding Author

Ayşe Serap AKGÜN

Istanbul Medipol University,
Faculty of Medicine,
Department of Radiology
34214 Istanbul, Turkey

Tel: 4447044
Fax No:0212-5212377

e mail: drayserap80@gmail.com

Geliş tarihi / Received: 27.01.2020

Kabul tarihi / Accepted: 25.03.2020

DOI: 10.35440/hutfd.680299

Introduction

Lumbar spinal canal stenosis (LSCS) is an important cause of morbidity in the elderly population and the incidence has increased with increasing life expectancy (1). Its etiology is classified as congenital (developmental) or acquired (degenerative). Degenerative form is multifactorial and prevalence increases with age (2). Degeneration starts in the intervertebral disc, disc height decreases and the ability of absorb stress in the anterior column of the spine decreases. Thus, there is an abnormal power transfer to the posterior elements, resulting in increased stress throughout the facets, facet joint hypertrophy, osteophyte formation, ligamentum flavum (LF) hypertrophy (3). Clinic occurs when the neural canal and/or nerve roots are caused by compression. Patients typically come with leg or low back pain, weakness and neurogenic intermittent claudication (4). Many studies tried to show these structural abnormalities that causes narrowing of dural sac and the spinal canal. But degenerative changes in vertebral bone elements such as lumbar pedicle (LP) have not been so investigated in LSCS yet. However for effective and healthy lumbar stabilization LP morphology has been investigated in many studies and it has been proved that LP mostly shows anatomic variabilities (5-11). Base on these datas, we aimed to investigate the relationship of LP thickness (LPT) with LSCS using MRI.

Materials and Methods

This is a retrospective study and approval form of the local Institutional Review Board was obtained before the study (date of approval: 30.10.2018, approval no: 10840098-604.01.01-E.47623). This study was conducted in accordance with the principles of the Declaration of Helsinki. Between January 2016 and August 2019 patients older than 60 years of age and diagnosed with clinical LSCS (having clinical signs such as leg or low back pain and/or neurogenic intermittent claudication) and referred to radiology unit to undergo lumbar MRI selected for the study. Pertinent demographic and clinical history was obtained from the medical files. Radiological LSCS was accepted if the anteroposterior diameter of the spinal canal was less than 10 mm in at least one intervertebral disc. Inclusion criteria were defined as follows: MRI findings within 6 months of the diagnosis available for review and the most stenotic level was located at L4-L5. The exclusion criteria were as follows: patients who had suspicion of infection, history of lumbar spinal surgery, presence of a compression fracture, acute trauma, malignancy history and spinal deformities such as spondylolisthesis and scoliosis. 150 of 1578 individuals who met the criterias for inclusion were evaluated after the diagnosis of LSCS. 150 age- and sex- matched control subjects who did not have LCSC-related symptoms and radiographic evidence of LSS were enrolled the study. All MRI examinations were performed using 1.5Tesla scanner (Magnetom; Siemens, Erlangen, Germany). For all MRI data, we acquired axial T2- weighted images with 3 mm slice thickness, 0.4 mm intersection gap, 4010ms /112ms repetition time/echo time, 20-cm field of view, 166x256 matrix.

We used the picture archiving and communication system (PACS, General Electric, Chicago, IL, USA) to measure LPT using the axial T2-weighted MRI at the L5 vertebra for each patient data. At the midshaft of L5 pedicle we drew a line from across the tranvers diameter of the pedicle for maximum thickness (Figure 1). All MR images were assessed by the same radiologist experienced in spine MRI for ten years. Two measurements were made for each patient and the average value of these measurements was used for statistical purposes. For intraobserver reliability, all of the measurements were repeated by the same radiologist one month later.

Statistical analysis

The data were analyzed using the Statistical Package for the Social Sciences version 17 (SPSS Inc., Chicago, IL, USA). The data for the continuous variables was presented as the mean ± the standard deviation. Pearson chi-square test was used to compare groups for categorical variables and continuous variables were compared using unpaired t-tests. Mann Whitney U test were usedfor non-normal distributed continous data. In all of the comparisons, p-values of less than 0.05 were considered to be statistically significant.

Results

There were 31 male (20.6 %) and 119 female (79.3 %) patients with the mean age of 68.70±7.17 years (range, 60 to 92 years) in the patient group. 39 male (26 %) and 111 female (74 %) patients with the mean age of 68.28±6.07 years (range, 60 to 87 years) in the control group. There were no statistically significant differences in mean ages or genders between the patient and control groups (p>0.05). In LSCS group, the average LPTs were 14,70±1,94 mm and 14,23±2,00 mm in the control group and was higher in the patient group than the controls but did not reach statistical significance (p=0.082) (Table 1).Subjects were divided into 3 groups according to age as 60-69, 70-79 and≥80 age in each group. The average LPTs in the LSCS group were 14,36±1,70 mm in subjects aged 60 to 69 years, 14,36±1,70 mm in those aged 70 to 79 years, and 14,46±1,79 mm in those aged 80 ≥ years. In the LSCS group, no statistically relationship was found between LPT and age and gender-related changes (Table 2). The average LPTs in the control group were 13,99±2,09 mm in subjects aged 60 to 69 years, 14,65±1,77 mm in those aged 70 to 79 years, and 14,43±2,06 mm in those aged 80 ≥ years. In the control group, no statistically relationship was found between LPT and age and gender-related changes (Table 3).

Table 1. Comparison of the analysises of lumbar spinal canal stenosis and control groups.

Parameter	LSCS group (n=150)	Control group (n=150)	p
Gender (male/female)	31/119	39/111	0,275[1]
Age, y	68,70±7,17	68,28±6,07	0,972[2]
LPT, mm	14,70±1,94	14,23±2,00	0,082[2]

[1] Chi-square test [2]MannWhitney U Test
LSCS : Lumbar spinal canal stenosis LPT : Lumbar pedicle thickness

Table 2. Comparison of with mean lumbar pedicle thickness of gender by age in lumbar spinal canal stenosis group.

Age	Male (31)	Female (119)	Total (150)	p
60-69	14,16±2,10 mm (16)	14,41±1,62 mm (75)	14,36±1,70 mm (91)	0,541
70-79	16,39±2,37 mm (12)	15,09±2,13 mm (34)	14,36±1,70 mm (46)	0,074
≥80	15,13±1,03 mm (3)	14,26±1,96 mm (10)	14,46±1,79 mm (13)	0,236

Table 3. Comparison of with mean lumbar pedicle thickness of gender by age in control group.

Age	Male (39)	Female (111)	Total (150)	p
60-69	14,64±2,47 mm (21)	13,80±1,94 mm (72)	13,99±2,09 mm (93)	0,129
70-79	15,15±1,97 mm (15)	14,44±1,66 mm (35)	14,65±1,77 mm (50)	0,185
≥80	14,60±1,23 mm (3)	14,30±2,73 mm (4)	14,43±2,06 mm (7)	0,724

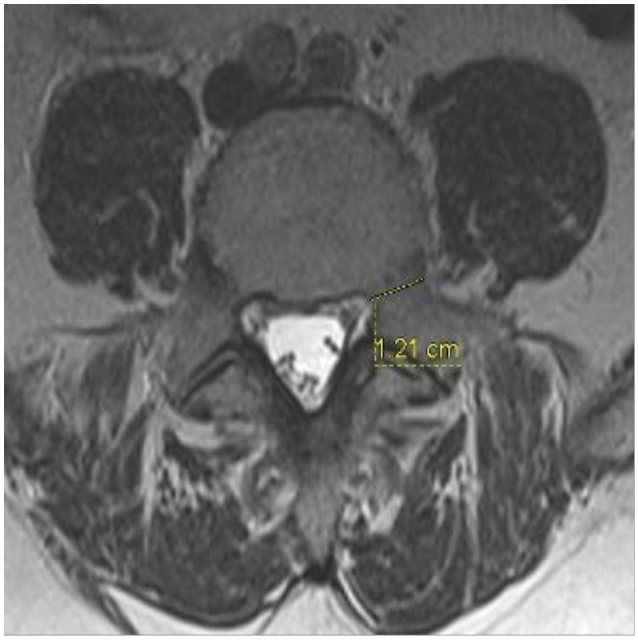

Figure 1.Description of LPT measurement on axial T2-weighted MR images at the L5 vertebra: LPT was the widest dimension of the pedicle at the midshaft of the pedicle.

Discussion

The main reason of LSCS is entrapment of the cauda equina roots by degenerative hypertrophy of the osseous and soft tissue elements surronding the spinal canal by the aging. (12,13) Therefore, it is necessary to investigate the contribution of all spine components (14). Spinal canal is bounded laterally by the pedicles. We speculated that thickening of the pedicles can reduce the transversal diameter of the spinal canal and by the way can compress the nerve foots and contribute the clinical symptoms.

It has been shown that stenosis of the spinal canal is mainly due to changes in the LF, facet joint hypertrophy or a combination of both. Several studies showed the role of LF thickness in patients with LSCS than asymptomatic (15-17). Altınkaya et al. showed that LF hypertrophy is associated with the contraction of the ligament secondary to disc height loss rather than thickening (15). Similarly degenerative and hypertrophic changes of facet joints leads to LSCS (18-20). While focusing on the reasons of the narrow spinal canal, few studies has been conducted on LP so mean lateral elements of the vertebra. Knowledge of pedicle anatomy is important for healthy spinal stabilization and manage pedicle screw fixation. Therefore various researchers have studied pedicle morphology in studies with different methodologies and especially with cadavers. Yu et al, Kim et al. and Mitra et al. examined the pedicle anatomy by cadaveric, Marchesi et al. by plain graphy, Gulec et al, Makino et al, Acharya et al. with CT data (5-11). They demonstrated that significant differences value of LP between variability including ethnicity, age, gender, height and weight and vertebral levels. Makino et al. demonstrated that the shape of the coronal section of lumbar pedicles is oval at the lower lumbar spine especially at the L5 vertebra in patients with degenerative lumbar disorders (10). This feature can contribute to the hypertrophy of LP with degeneration. Firstly, Sang et al. based on this hypothesis evaluated the contribution of LPT in LSCS on MRI (20). They measured LPT on axial T2–weighted MRI at the L5 vertebra in 136 patients aged over 50 years diagnosed with LSCS. They measured greater LPT values in LSCS group compared to the control group and found a statistically significant relationship betweeen LPT and LSCS. In this study contrary to Sang et al. we did not find statistically significant differences in LPT values between the LSCS and the control group. This result can be explained by the fact that the anatomical structure of LP is not constant and show individual and structural differences.

This study has some limitations. First, physical characteristics of the patient population such as height, weight and body mass index were in a wide range. Secondly we measured LPT only in the axial planes at the most stenotic level of the L5 body and we did not measure multiplanar and with all the levels to compare. Additionally we did not include pedicle height, interpedicular distance or pedicle angles and possible effects were not evaluated.

In conclusion, LPT can not be an effective factor to predict LSCS because of the variable morphology. Future researches are required to evaluate the LP three-dimensionally with larger population with all lomber levels and to clarify the effect of LP with other morphological components in LSCS.

Acknowledgements

Ethics Committee Approval: *Ethics committee approval was received for this study from the ethics committee of Istanbul Medipol University, date 30/10/2018, No:10840098-604.01.01-E.47623.*

Declaration of Conflicting Interests: *The authors declare that they have no conflict of interest.*

Financial Disclosure: *No financial support was received.*

References

1. Deyo RA, Gray DT, Kreuter W, Mirza S, Martin BI: United States trends in lumbar fusion surgery for degenerative conditions. Spine 2005; 30(12):1441–5.
2. Baptista JS, Fontes RBV, Liberti EA: Aging and degeneration of the intervertebral disc. Coluna/Columna 2015; 14(2): 144-8.
3. Schroeder GD, Kurd MF, Vaccaro A: Lumbar spinal stenosis: How is it classified. J Am Acad Orthop Surgery 2016; 24(12): 843-52.
4. Manchikanti L, Kaye AD, Manchikanti K, Boswell M, Pampati V, Hirsch J. Efficacy of epidural injections in the treatment of lumbar central spinal stenosis: A systematic review. Anesth Pain Med 2015; 5: e23139.
5. Yu CC, Yuh RT, Bajwa NS, Toy JO, Ahn UM, Ahn NU. Pedicle morphometry of lumbar vertebrae: male, taller, and heavier specimens have bigger pedicles. Spine 2015; 40(21):1639–46.
6. Kim NH, Lee HM, Chung IH, Kim HJ, Kim SJ. Morphometric study of the pedicles of thoracic and lumbar vertebrae in Koreans. Spine 1994; 19:1390–4.
7. Mitra SR, Datir SP, Jadhav SO. Morphometric study of the lumbar pedicle in the Indian population as related to pedicular screw fixation. Spine 2002; 27:453–9.
8. Marchesi D, Schneider E, Glauser P, Aebi M. Morphometric analysis of the thoracolumbar and lumbar pedicles, anatomo-radiologic study. Surg Radiol Anat. 1988;10(4):317–22.
9. Güleç A, Kaçıra BK, Kütahya H, Ozbiner H, Ozturk M, Solbar ÇŞ, et al. Morphometric analysis of the lumbar vertebrae in the Turkish population using three-dimensional computed tomography: correlation with gender, age, and height. Folia Morphol (Warsz). 2017; 76(3):433–9.
10. Makino T, Kaito T, Fujiwara H, Yonenobu K. Analysis of lumbar pedicle morphology in degenerative spines using multiplanar reconstruction computed tomography: what can be the reliable index for optimal pedicle screw diameter? Eur Spine J. 2012; 21(8):1516–21.
11. Acharya S, Dorje T, Srisvastava A. Lower dorsal and lumbar pedicle morphometry in Indian popülation. A study of four hundred fifty vertebrae. Spine 2010; 35(10):378-84.
12. Benoist M. Natural history of the aging spine. Eur Spine J 2003; 12(2):86-9.
13. Sırvancı M, Bhatia M, Ganiyusufoglu KA, Duran C, Tezer M, Ozturk C, et al. Degenerative lumbar spinal stenosis: correlation with Oswestry Disability Index and MR imaging. Eur Spine 2008; 17: 679-85.
14. Alvarez JA, Hardy RH Jr. Lumbar Spine Stenosis: A Common Cause of Back and Leg Pain. Am Fam Physician. 1998; 57(8):1825-34.
15. Altinkaya N, Yildirim T, Demir S, Alkan O, Sarica FB. Factors associated with the thickness of the ligamentum flavum: is ligamentum flavum thickening due to hypertrophy or buckling? Spine (Phila Pa 1976) 2011; 36(16):E1093-97.
16. Duran S, Cavusoglu M, Gunaydın E, Sakman B. Ligamentum flavum hypertrophy in elderly patients with low back pain: A mri study. Turkish Journal of Geriatrics 2016; 19(2):107-112.
17. Kolte VS, Khambatta S, Ambiye MV. Thickness of the ligamentum flavum :correlation with age and its asymmetry- an magnetic resonance imaging study. Asian Spina J 2015; 9(2):245-53.
18. Little JW, Grieve TJ, Cramer GD, Rich JA, Laptook EE, Stiefel J.P.D. et all: Grading osteoarthritic changes of the zygapophyseal joints from radiographs: a reliability study. J Manipulative Physiol Ther 2015; 38:344–51.
19. Ohba T, Ebata S, Fujita K, Sato H, Devin CJ, Haro H. Characterization of symptomatic lumbar foraminal stenosis by conventional imaging. Eur Spine J 2015; 24(10):2269–75.
20. An SJ, Seo MS, Choi SI, Lim TH, Shin SJ, Kang KN, et all: Facet joint hypertrophy is a misnomer: A retrospective study. Medicine 2018; 97:e11090.