SHAFA ORTHOPEDIC JOURNAL, Vol. 1, No.1, Feb. 2014., p. 21-24
http://shafaorthoj.com

Original Article

The association between intermittent neurogenic claudication and spinal sagittal balance in patients with lumbar canal stenosis: a prospective study

Hasan Ghandhari[1], Ebrahim Ameri[2], Hosein Vahidtari[3], Bahram Mobini[4]
Hamid Behtash[5], *Afshin Ahmadzadeh Heshmati[6]

Department of Orthopedics, School of Medicine, Kerman University of Medical Science, Kerman, Iran.
Received: 24 Nov 2012 Revised: 10 Dec 2012 Accepted: 16 Jan 2013

Abstract

Background: Neurologic claudication (NC) is one of the most common clinical symptoms in patients with spinal canal stenosis. The patient feels pain and paresthesia in his lower extremity during walking that is relieved by stooping ahead. Sagittal balance of spine is one of the most important factors in treating patients with spinal stenosis. The study was conducted to determine if neurogenic claudication has any effect on spinal sagittal balance in patients with lumbar canal stenosis.

Methods: In this study we analyzed 47 patients with lumbar canal stenosis and divided them into two groups based on the presence or absence of neurogenic intermittent claudication. We put those patients without intermittent claudication in group1 (n=26; mean age: 48.3) and those who have intermittent claudication in group2 (n=21; mean age: 53.3). All patients had standing radiography of spine from C1 to S5 and sagittal C7 plumb line and distance between it and posterior superior corner of S1, kyphosis of thoracic spine and lordosis of lumbar spine were measured.

Results: Sagittal plumb line in group 2 was more anterior than group1 patients (+1mm vs. +24mm), although it was not significant (p=0.063). However, thoracic kyphosis (42.4 vs. 51.2; p= 0.003) and lumbar lordosis (27.9 vs. 43.8; p=0.00) were significantly lower in group 2.

Conclusion: Patients with intermittent neurogenic claudication had forward posture to relief their symptoms but they tried to maintain total sagittal balance as normal as possible by straightening thoracic spine.

Keywords: Sagittal balance, Thoracic kyphosis, Lumbar lordosis, Neurogenic claudication, Canal stenosis.

Introduction

Adult degenerative spinal stenosis is a common spinal disorder that usually begins with degeneration of intervertebral disc which decreases intervertebral space and leads to instability of spine segment motion. As consequence of instability, facet joints suffer more loads and may cause degenerative changes such as bony and capsular hypertrophy with result of narrowing spinal canal. Ligamentum flavum hypertrophy is another sequel of instability which could contribute to stenosis of the spinal canal and neural elements. Spinal stenosis present with a variety of symptoms and one of the most common is intermittent neurogenic claudication (1-3).The exact pathogenesis of claudication has not been fully understood yet, but it has become clear

1. MD., Assistant Professor of Orthopedics, Department of Spine Surgery, Shafa Orthopedic Hospital, Iran University of Medical Sciences, Tehran, Iran. drghandehari@yahoo.com
2. MD., Associate Professor of Orthopedics, Department of Spine Surgery, Shafa Orthopedic Hospital, Iran University of Medical Sciences, Tehran, Iran. ebrahim.ameri@yahoo.com
3. MD., Assistant Professor of Orthopedics, Department of Spine Surgery, Rasoul-e-Akram Hospital, Iran University of Medical Sciences, Tehran, Iran. dr_vahidtari@yahoo.com
4. MD., Assistant Professor of Orthopedics, Department of Spine Surgery, Shafa Orthopedic Hospital, Iran University of Medical Sciences, Tehran, Iran. bmobini77@hotmail.com
5. MD., Assistant Professor of Orthopedics, Department of Spine Surgery, Rasoul-e-Akram Hospital, Iran University of Medical Sciences, Tehran, Iran. hbehtash@yahoo.com
6. (**Corresponding author**) MD., Assistant Professor of Orthopedics, Department of Orthopedics, School of Medicines, Kerman University of Medical Sciences, Kerman, Iran. dr.heshmati@kmu.ac.ir

[Cite this article as: Ghandhari H, Ameri E, Vahidtari H, Mobini B, Behtash H, Ahmadzadeh Heshmati A. The association between intermittent neurogenic claudication and spinal sagittal balance in patients with lumbar canal stenosis: a prospective study. Shafa Orthop J. 2014.1(1):21-24.

that mechanical and biochemical factors play a major role. These patients have pain and paresthesia in their lower extremity that become worse by walking (2,3). Patients try to stoop ahead in order to relieve their pain and this posture can affect sagittal balance of the spine. Sagittal balance is defined as the relationship of the head and neck to the sacrum when the patient is standing. For measuring sagittal balance, a vertical plumb line is drown from center of C7 vertebral body as sagittal vertical axis that usually passes through posterior superior corner of first sacral vertebra (4). Negative value means that sagittal vertical axis passes posterior to posterior superior corner of S1 and positive value means that sagittal vertical axis passes anterior to the corner (4). Neutral or slightly negative sagittal balance is the desired sagittal alignment (5). Sagittal alignment of spine is one of the most important factors in management of this kind of disease specially when surgical fusion is planed (1,2,5-7). Therefore, identification of this entity and related influencing factors are important. These factors include pelvic (6,8-13) and spinal parameters (8,9, 14, 12,15). Pelvic parameters have been investigated in many studies (6,16) but there are a few appeared articles about spinal stenosis as an important spinal parameter that can influence sagittal balance (14). We performed this study to determine alterations in sagittal balance in patients with lumbar canal stenosis.

Methods

The study was approved by institutional review board. We conducted a prospective study on all patients who referred to spine clinic of Shafa Orthopedic Hospital for any kind of low back pain during 1 October 2010 to 1 March 2011. We excluded patients without written consent, with any deformity in their spines such as scoliosis or kyphosis, any old fractures or deformities in spinal column or pelvis or lower extremities such as neglected or treated hip dysplasia, any limb length discrepancies, and any kind of spondylolysis and spondylolysthesis. To confirm the diagnosis we requested MRI for patients and then standing posteroanterior and lateral radiography from C1 to S5 was obtained. Finally, we had 47 patients that were divided into two groups including:

Group1. Patients without intermittent neurogenic claudication who had low back pain that might radiate along the lower extremities and aggravated by sitting or heavy working or bending. Nonetheless they showed high tolerance during walking.

Group 2. Patients with intermittent neurogenic claudication who could not tolerate walking. After a few minutes of walking they must stand with stoop posture or sit for some time to relieve symptoms and again start walking. This process might be repeated several times in one walking episode.

In lateral radiographies initially we drew sagittal plumb line and measured the distance between this line and posterior superior corner of S1 vertebra in millimeters as sagittal vertical axis. The distal reference point for measuring this sagittal vertical axis is different in various studies (4). Old references select anterior superior corner of S1 for measuring this axis because this corner is the most detectable landmark of S1 vertebra in lateral radiography (15). Recent studies prefer to select posterior superior corner because it is the location that the normal vertical axis passes through (4,14). We decided to use posterior superior corner for distal reference point. If vertical plumb line lied anterior to posterior superior corner of S1, sagittal vertical axis was identified as positive number and if it lied posterior to the corner, it was identified as negative number as described by Jackson et al (8). Then, we measured kyphosis of thoracic spine and lordosis of lumbar spine according to the Cobb method (17).

Data analysis was performed using SPSS version18 and independent sample t-test and Mann-Whitney U test.

Results

In group1 we had 26 patients (9 men and 17 women) with mean age of 48.3 years (18-65 years). The mean sagittal balance in this group was +1±41.4 mm (-64 to +96 mm), the mean kyphosis of thoracic spine 51.2°±9.3° (37° - 68°) and the mean lordosis of lumbar spine 43°± 7.5° (20° - 50°).

In group 2 we had 21 patients (6 men and 15 women) with mean age of 53.3 years (28-71 years). Their mean sagittal balance was +24 ± 40.7 mm (-48 to +95), mean thoracic kyphosis 42.4°± 9.7° (27° -65°) and mean lumbar lordosis 27.9 ± 9.7 mm (0 - 48 mm). The mean duration of claudication in this group was 25.3 ± 8.7 months (12-38 months).

There was no significant difference in age between the two groups (p=0.632). Kyphosis of the thoracic spine in group 2 was significantly smaller than group1 (p=0.003). The lordosis of the lumbar spine was significantly smaller in group 2 (p=0.00). However, the sagittal vertical axis between the two groups was of marginal significance (p=0.063).

Discussion

One of the most important topics in spine surgery is biomechanics of spinal column and alignment of the spine which plays the most important role in this topic. From anteroposterior view, spinal column is a straight column but in lateral view, it has lordotic and kyphotic curvatures (15). The cervical spine has lordosis and below it, the thoracic spine has kyphosis and then lumbar spine has lordosis and sacrum has kyphosis. The normal alignment of spine in sagittal plane is in order that the gravity line passes from odontoid process of C2 vertebra and then behind the cervical spine (because of its lordotic configuration) and then passes through the center of the body of C7 vertebra and then from anterior of thoracic spine and posterior of lumbar spine and finally it passes from posterior superior corner of S1 vertebra that is also a part of pelvis. For clinical purpose because C2 vertebra usually is not seen in routine standing lateral view, the sagittal vertical axis is drown as a vertical line from center of the body of C7 vertebra (8,4,14,13). Hence, alteration in sagittal vertical alignment of the spine may result from alteration of lordosis and kyphosis of spinal column or alteration in sacrum and other pelvic parameters. Because normal sagittal balance of spine is essential for normal biomechanics of spine, any change in one part must compensate to restore normal alignment and biomechanics (18).

Although the exact mechanism of neurogenic intermittent claudication in spinal stenosis has not been fully understood, contribution of both inflammatory and mechanical factors is suggested. These factors could be mechanical pressure on spinal cord and nerve roots by degenerated and bulged intervertebral disc anteriorly and hypertrophied facet joints and ligamentum flavum posteriorly (3). With extension of the spinal column, this ligament buckles into the spinal canal and exert more pressure. Thus, patients with spinal stenosis tend to stoop or forward bending posture to stretch the ligament and eliminate this extra pressure (3). This forward posture cause decrease lordosis of the lumbar spine and anterior displacement of sagittal vertical axis. Thus the body tries to restore sagittal balance with variety of mechanism such as decrease kyphosis of thoracic spine.

Our study depicts that in patients with lumbar canal stenosis and neurogenic claudication, lumbar lordosis and thoracic kyphosis decrease significantly in comparison to nonclaudicant group but sagittal balance shows no significant difference. Suzuki et al (14) performed similar study on sagittal balance of patients suffering from spinal stenosis and emphasized pelvic parameters and lumbar lordosis. They concluded that in claudicant patients, sagittal vertical axis has significant difference with nonclaudicant group but they did not consider the kyphosis of thoracic spine as a significant parameter in sagittal balance (14). This difference partly may be due to small number of subjects in our study. The mean duration of claudication in our patients in claudicant group was 25.3 months but Suzuki et al (14) in their study did not notice duration of claudication their patients. This difference partly may be due to ethnic aspect reported in several studies as effective factor in spinal disorders (18- 20).

The relatively small sample size was the study limitation. Review of the literature revealed that more prospective studies with larger samples should be designed to clarify exact relationship between above mentioned parameters in patients with lumbar canal stenosis.

Conclusion

This study indicated that the patients with spinal canal stenosis and neurogenic intermittent claudication try to remove pressure on neural elements by decreasing lordosis of lumbar spine but the torso spares much effort to maintain overall spinal sagittal balance as near normal as possible.

References

1. Thomas SA. Spinal stenosis: history and physical examination. Phys Med Rehabil Clin N [Am]. 2003; 14: 29–39.

2. Yates DA. Spinal Stenosis. J R Soc Med. 1981; 74(5): 334–342.

3. Garfin SR, Herkowitz HN, Mirkovic H. Spinal stenosis instructional course lectures, the American academy of orthopaedic surgeons. J Bone Joint Surg [Am]. 1999; 81: 572-786.

4. Roussouly P, Nnadi C. Sagittal plane deformity: an overview of interpretation and management. Eur Spine J. 2010; 19:1824–1836.

5. Bridwell KH, Lenke LG, Lewis SJ. Treatment of spinal stenosis and fixed sagittal imbalance. Clin Orthop Relat Res. 2001; 384: 35–44.

6. Barrey C, Jund J, Noseda O, Roussouly P. Sagittal balance of the pelvis-spine complex and lumbar degenerative diseases. A comparative study about 85 cases. Eur Spine J. 2007; 16:1459–1467.

7. Mac-Thiong JM, Transfeldt EE, Mehbod AA, Perra JH . Can C7 plumb line and gravity line predict health related quality of life in adult scoliosis? Spine. 2009; 34(15): E519–E527.

8. Jackson RP, McManus AC. Radiographic analysis of sagittal plane alignment and balance in standing volunteers and patients with low back pain matched for age, sex, and size: a prospective controlled clinical study. Spine.1994; 19:1611–1618.

9. Smith A, O'Sullivan P, Straker L. Classification of sagittal thoraco-lumbo-pelvic alignment of the adolescent spine in standing and its relationship to low back pain spine. 2008; 33:19, 2101–2107.

10. Roussouly P, Gollogly S, Berthonnaud E, Dimnet J. Classification of the normal variation in the sagittal alignment of the human lumbar spine and pelvis in the standing position. Spine. 2005; 30(3): 346–353.

11. Jackson RP, Peterson MD, McManus AC, Hales C. Compensatory spinopelvic balance over the hip axis and better reliability in measuring lordosis to the pelvic radius on standing lateral radiographs of adult volunteers and patients. Spine. 1998; 23(16): 1750-1767.

12. Berthonnaud E, Dimnet J, Roussouly P, Labelle H. Analysis of the sagittal balance of the spine and pelvis using shape and orientation parameters. Spine. 2005; 18(1):40-47.

13. Schwab F, Lafage V, Patel A, Farcy JP. Sagittal plane considerations and the pelvis in the adult patient. Spine. 2009; 34(17): 1828–1833.

14. Suzuki H, Endo K, Kobayashi H, Tanaka H, Yamamoto K. Total sagittal spinal alignment in patients with lumbar canal stenosis accompanied by intermittent claudication. Spine. 2010; 35(9): 344–346.

15. Gelb DE, Lenke LG, Bridwell, Keith H. an analysis of sagittal spinal alignment in 100 asymptomatic middle and older aged volunteers. Spine. 1995. 20(12):1351-1358.

16. Van Royen BJ, Toussaint HM, Kingma I, Bot SD, Caspers M, Harlaar J, et al. Accuracy of the sagittal vertical axis in a standing lateral radiograph as a measurement of balance in spinal deformities. Eur Spine J. 1998; 7(5):408–412

17. Cobb JR. Outline for the study of scoliosis; American Academy of Orthopedic Surgeons. Instr Course Lect. 1948; 5: 261-275.

18. Jang JS, Lee SH, Kim JM, Min JH, Han KM, Maeng DH. Can patients with sagittaly well-compensated lumbar degenerative kyphosis benefit from surgical treatment for intractable back pain? Neurosurgery. 2009; 64:115–121.

19. Kebaish KM, Neubauer PR, Voros GV, Khoshnevisan MA, Skolasky RL. Scoliosis in adults

aged forty years and older prevalence and relationship to age, race, and gender. Spine. 2011; 36(9):731–736.

20. Alosh H, Riley LH III, Skolasky RL. Insurance status, geography, race, and ethnicity as predictors of anterior cervical spine surgery rates and in-hospital mortality. Spine. 2009; 34(18):1956–1962.