RISK FACTORS AND CONSERVATIVE MANAGEMENT OF SPONDYLOLYSIS AND SPONDYLOLISTHESIS GRADE I AND II

Ari Sami Hussain Nadhim [a,b], Nabaz M. Mustafa [b] and Seerwan O. Hasan [b]

Submitted: 27/7/2016; Accepted: 7/3/2017; Published: 1/6/2017

ABSTRACT

Background

Spondylolysis is a fracture of pars interarticularis without slippage of the vertebral bodies. Spondylolisthesis is anterior slippage of one vertebral body on to the immediate inferior vertebral body. The conservative treatment of spondylolysis and low-grade spondylolisthesis is preferable initial step in the management.

Objectives

The purposes were to find the risk factors for lumbar spondylolysis and spondylolisthesis and the plausibility of conservative management of them.

Materials and Methods

Prospective cohort study of a series of (100) patients performed. Each followed up for six consecutive months during 2012-2014. Failure of conservative treatment necessitated surgical intervention. Inclusion criteria for the patients to be included in the study were that the patient needed to be afflicted with Spondylolysis, and/or spondylolisthesis Meyerding grade I and II. We assessed the grades of slippage by Meyerding grading system

Results

Patients included in the study were 14% males and 86% females, and the mean and SD (Standard Deviation) age were (43.92±13.83) years. The Body Mass Index (BMI) of the patients were 55% overweight, and 17% obese, with a significant P-value of (<0.001). The mean±SD body height was (166.75±6.94 cm). There was history of trauma in 63% patients, and the level of pars fracture was L5 in 65%, L4 in 30%, and L3 in 4%. The degrees of vertebral slippage were 59% grade I, 34% spondylolysis, 7% grade II. Eleven (11%) of patients were indicated for surgery. Transpedicular screw fixation and fusion was performed for nine patients and two of them refused surgery.

Conclusion

Conservative treatment is preferable as an initial step in the management of spondylolysis and spondylolisthesis Grade I and II if there were no neurological deficits.

Keywords: *Meyerding grading; Spondylolisthesis; Spondylolysis.*

[a] Department of Surgery, College of Medicine, University of Sulaimani.
[b] Shahid Dr. Aso Neurosurgical and Ophthalmological Hospital and Surgical Emergency Hospital in Sulaymaniyah city, Kurdistan region, Iraq.
Correspondence: nabazneuro@yahoo.com

https://doi.org/10.17656/jsmc.10107

INTRODUCTION

Spondylolysis; an alternative term for isthmic spondylolisthesis, is a fracture or breakage of the pars interarticularis which results in a failure of neural arch without slippage of the vertebral bodies (Figure 1) [1, 2]. A number of causes of spondylolysis have been postulated, including genetic factors, mechanical and gravitational factors, which result in wear and tear with resultant fatigue fractures; trauma, or a combination of these factors [1].

Spondylolisthesis is anterior subluxation of one vertebral body on to the immediate next inferior vertebral body [1-5]. Slippage of vertebrae occurs if the facet joint locking mechanism fails e.g. due to a defect in pars, and will progress to a static or unstable condition over time [6, 7]. It is classified according to the cause into: congenital, isthmic, degenerative, traumatic, or pathologic [1, 2].

Congenital spondylolisthesis is characterized by dysplasia of the facet joints on the upper sacrum. Isthmic spondylolisthesis results from a lytic lesion of the pars interarticularis or by an elongated pars interarticularis due to repeated fracture and healing. Degenerative spondylolisthesis is secondary to long-standing intersegmental instability and rarely progresses beyond 50% anterior vertebral body subluxation. Trauma or surgery causes traumatic spondylolisthesis. Pathologic spondylolisthesis is the result of generalized bone disease [1].

Degenerative spondylolisthesis is more commonly seen in females and at the L4-5 level, whereas isthmic spondylolisthesis most commonly affects L5-S1 and is seen predominantly in pediatric age males. Hereditary factors play some role in the development of congenital and isthmic spondylolisthesis but environmental factors play a major role in the development and progression of spondylolisthesis. Being young, female gender, dome-shaped sacrum, dysplastic lumbosacral junction, meyerding grade more than grade II and slip angle of greater than 40-50 degree (with 0-10 degree being normal), are risk factors for progression of the degree of the slippage, but a diagnosis after the onset of adulthood associated with lower rate of progression. [1, 5].

The Meyerding classification is the most widely used system for grading spondylolisthesis (Table 1). It involves the percentage of anterior translation relative to the adjacent level.

Figure 1. CT-Scan of lumbosacral spine (axial and sagittal views) shows spondylolysis of L5 (encircled).

Table 1. Spondylolisthesis grading, the Meyerding grading of subluxation in the sagittal plane [2, 5, 8].

Grade	% subluxation*
I (Figure 2)	<25%
II (Figure 3)	25-50%
III	50-75%
IV	75%-complete
Spondyloptosis	>100%

***% of the Anterior-posterior (AP) diameter of the vertebral body**

Low back pain (LBP) is the primary complaint in most symptomatic patients. It is described as worse with activity and improved with rest, thus alluding to its mechanical nature. Localized pain to the area of listhesis and is frequently worse on the side with spondylolysis if unilateral, hyperlordotic posture and tight hamstrings, worsening of symptoms with maneuvers involving hyperextension and rotation, such as standing on one leg while leaning backward [1, 9].

Magnetic resonance imaging (MRI) and computer tomography (CT) scans, basic plain films (anteroposterior, lateral, oblique, flexion-extension (Figure 4), and occasionally standing scoliosis views) are the standard for diagnosis of spondylolisthesis. Plain oblique films may demonstrate the so-called Scotty dog collar, which describes a fracture of the pars interarticularis [1].

The symptoms of degenerative spondylolisthesis are often intermittent in nature. Non-steroidal anti-inflammatory medications, bed rest, bracing, heat, exercise, and traction were found by Rosenberg to be unpredictable in their ability to treat a patient's symptoms. Although often used for their diagnostic and therapeutic utility, epidural steroid injections have not been shown to provide lasting results in most cases [1].

Uncontrolled pain, persistence or progression of symptoms despite modification of body activities, slippage of the vertebral body greater than 50% on first evaluation, progressive slippage from 25% to 50%, a slip angle (Figure 5) greater than 30%, and the presence of radiculopathy, scoliosis, or a progressive neurological deficit are all potential indications for surgical intervention (Figure 6) [1, 10-12].

The purposes of this study were to find out the risk factors for lumbar spondylolysis and spondylolisthesis and the plausibility of conservative management of them.

Figure 2. MRI (Sagittal view) of lumbosacral spine shows L3-4 spondylolisthesis Meyerding grade I (Arrow).

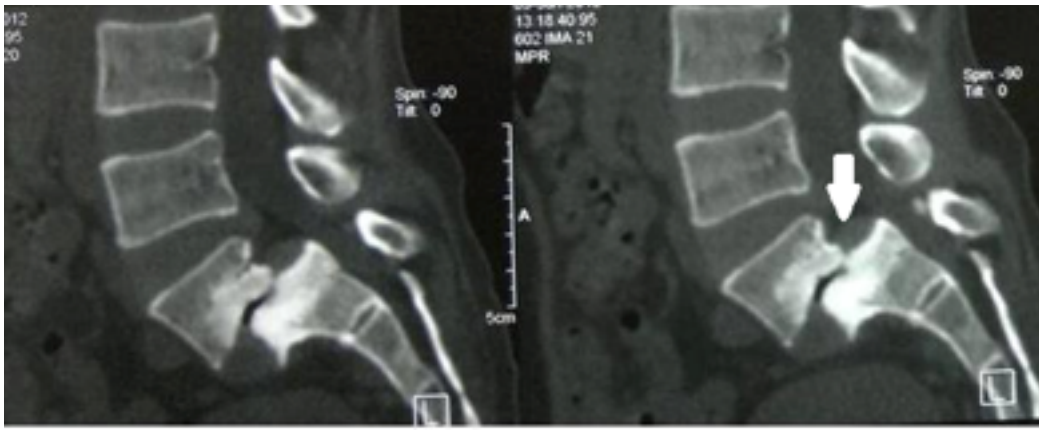

Figure 3. CT-Scan of lumbosacral spine (sagittal views) shows L5-S1 spondylolisthesis Meyerding grade II (arrow).

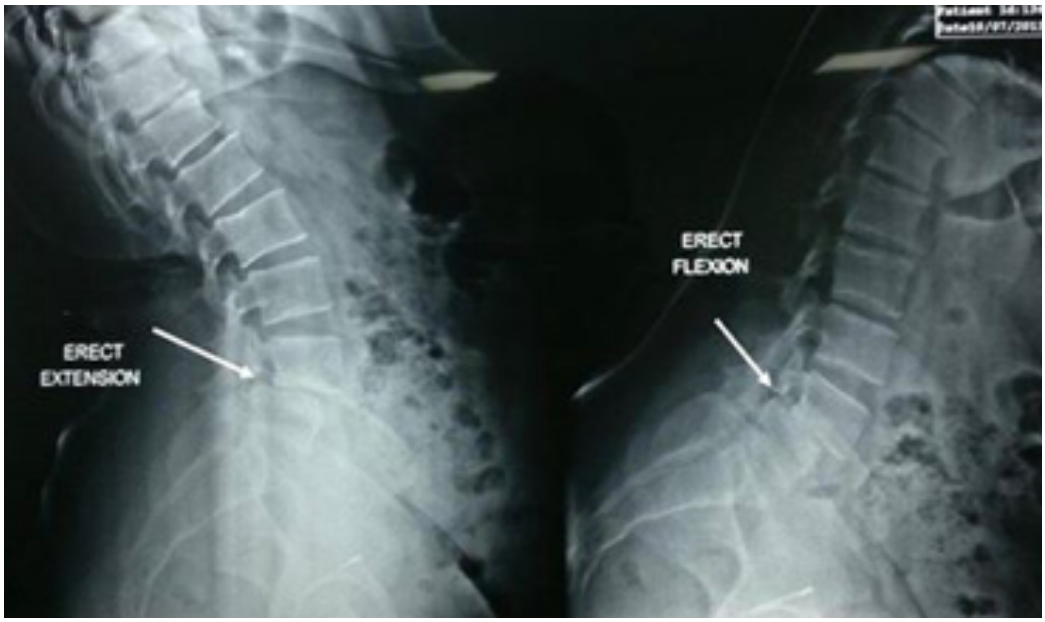

Figure 4. Flexion and extension views of plain X-Rays of lumbosacral spine showing spondylolisthesis of L4-5 (arrows).

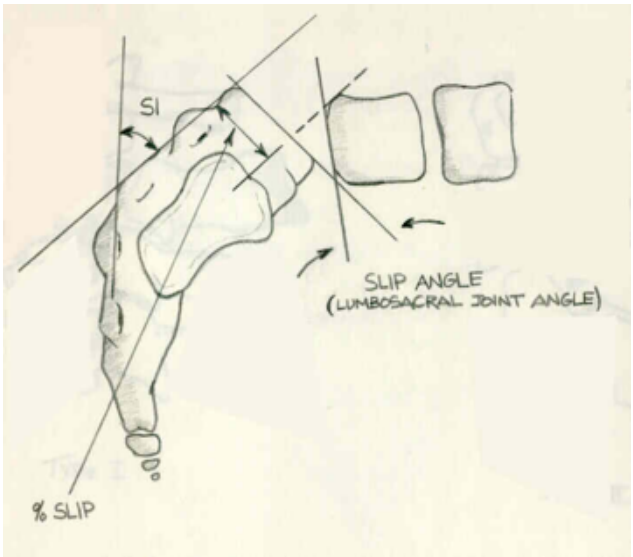

Figure 5. Slip or kyphotic angle [13].

Figure 6. Lateral view lumbosacral X-ray showing transpedicular screw fixation of L4-5.

MATERIALS AND METHODS

We performed a prospective cohort study of a consequent series of (100) patients who were treated conservatively by using NSAIDs, decreasing weight, bracing and physiotherapy. They were followed up for six consecutive months by their clinical features and radiological examinations during 2012-2014. Failure of conservative treatment necessitated surgical intervention.

The inclusion criteria were: Spondylolysis, and/or spondylolisthesis with grade I and II slippage degree. All of the patients assessed directly by the neurosurgeon in charge for their management. The grades of slippage of spondylolisthesis were assessed by lumbosacral plain X-rays, CT-scan, and/or MRI by using Meyerding grading system, bone densitometry for those individuals that suspected osteoporosis and BMI for assessment of obesity.

We used SPSS (version 21) to analyze the results and a P-value of ≤0.05 considered statistically significant.

RESULTS

Patients included in this study were 14 males (14%) and 86 females (86%), and the mean and SD age were (43.92±13.83) years at time of presentation (range 19-109 years). All the patients (100%) were having LBP without neurological deficit, 21% of them were having neurogenic claudication, and 18% were having radiculopathy.

The mean body height of the patients included in the study ± SD were (166.75 ±6.94 cm) which ranged (150-180 cm). There was history of trauma in 63 (63%) patients, in which 33 (52.3%) of them were fall on ground, 16 (25.4%) patients with fall from height, 4 (6.35%) patients after road traffic accident, 9 (9%) patients with miscellaneous trauma and 1 (1.9%) patient with history of previous laminectomy.

The levels of spinal fracture were bilateral pars fracture of L5 in 63 (63%) patients, 29 (29%) patients had bilateral pars fracture of L4, 4 (4%) patients had bilateral pars fracture of L3, 1 (1%) patient with bilateral

pars fracture of L3 and L5, 1 (1%) patient with left side pars fracture of L4, 1(1%) with right side pars fracture of L5, and 1 (1%) with right side pars fracture of L1.

A total of 34 (34%) of the patients were having spondylolysis, and the Meyerding degree of slippage were grade I in 59 (59%) of the patients, and grade II in 7 (7%) of the patients. The male to female ratio of spondylolysis and spondylolisthesis was (1:16.3).

The associated findings were as following: 57% spondylosis, 5% osteoporosis, 4% central canal stenosis, 1% L5 sacralization, 1% S1 lumbarization, 2% spondylolysis in another level and 1% retrolisthesis in another level.

The BMI of the patients were overweight (equal or more than 25) in 55 (55%) patients, normal range (18-24.99) in 26 (26%) patients, obese (equal or more than 30) in 17 (17%) patients, and underweight (less than 18.49) in 2 (2%) patients, with a significant P-value of (<0.001) which indicate an increase in body weight will increase the incidence of development of spondylolysis and spondylolisthesis. The male to female ratio of overweight and obesity was equal to (1:5.6).

Eleven (11%) patients were indicated for surgery. Transpedicular screw fixation and fusion were performed for nine of them and two refused surgery.

Table 2. shows significant relation of age, spondylolysis and Meyerding grade of spondylolisthesis.

Age groups	Spondylolysis and Meyerding grade of spondylolisthesis			Total	P-value
	Spondylolysis	Grade I	Grade II		
Patient aged 19 years old	2%	0%	0%	2%	<0.001
Young age (20-39 years old)	18%z	17%	1%	36%	
Middle age (40-59 years old)	14%	35%	2%	51%	
Old age (>60 years old)	0%	7%	4%	11%	
Total	34%	59%	7%	100%	

Table 3. shows significant relation between gender of patients, spondylolysis and Meyerding grade of spondylolisthesis.

Gender of patients	Spondylolysis and Meyerding Grade of spondylolisthesis			Total	P-value
	Spondylolysis	Grade I	Grade II		
Male	5%	8%	1%	14%	<0.001
Female	29%	51%	6%	86%	
Total	34%	59%	7%	100%	

Table 4. shows significant relation between body height (cm), spondylolysis and grading of spondylolisthesis.

Body height	Spondylolysis and Meyerding Grade of spondylolisthesis			Total	P-value
	Spondylolysis	Grade I	Grade II		
Less than 150 cm	0%	1%	1%	2%	<0.001
151-160 cm	7%	12%	2%	21%	
161-170 cm	19%	33%	3%	55%	
171-180 cm	8%	13%	1%	22%	
Total	34%	59%	7%	100%	

Table 5. shows significant relation of gender of patients and BMI (kg/m2).

Gender of patients	BMI (kg/m2)				Total	p-value
	Underweight (less than 18.49)	Normal range (18-24.99)	Overweight (equal or more than 25)	Obese (equal or more than 30)		
Male	1%	2%	9%	2%	14%	<0.001
Female	1%	24%	46%	15%	86%	
Total	2%	26%	55%	17%	100%	

DISCUSSION

Lumbar spondylolisthesis is one of the causes of disabling low back pain and can lead to neurological deficits [14]. The causes of spondylolisthesis are multifactorial and include age, female gender, spinal malalignment, weakness of muscles of trunk, and disc degeneration [15, 16]. Repetitive microtrauma leading to spondylolysis and spondylolisthesis has been contributed to lumbar hyperextension combined with rotation and loading [7, 17]. There are also familiar predisposition to the disease and a family history of spondylolisthesis may raise clinical suspicion [18].

Dunn et al found that male to female ratio was 3:1 [19] and Haun et al 2:1 [17]. In this study, the incidence of spondylolisthesis was more in females with a male to female ratio of (1:16.3). The female gender in our province is subjected to microtrauma, with increased body mass and low bone density more than male.

Degenerative changes of lumbar spine were correlated with age [19] . But the typical onset of age is at childhood and adolescence because of stress fracture [17]. The current study shows an increase in the development of spondylolysis and spondylolisthesis and its grade of slippage with an increase in age, and it was a statistically significant relation (p-value <0.001).

Acute trauma is one of the rare causes of spondylosis but repetitive stress microtrauma is common [7, 17]. In this study, we found that there was history of trauma in 63 (63%) patients, in which 52.3% of them were fall on ground, 25.4% were fall from height, and 6.35% were road traffic accident. Spondylolisthesis following decompressive laminectomies for stenosis is rare and it is approximately about 1%. [2]. More active and younger patients are at higher risk to develop post-operative instability [2].

This study showed 1% of spondylolisthesis to be because of laminectomies, which is comparable to the literature.

The study of Niggemann et al., whom they took only patients with Spondylolysis and isthmic spondylolisthesis, found that 15.6% of the patients were spondylolysis, 52.5% were grade I, 30.5% were grade II, 0.7% were grade III and 0.7% were grade IV [8]. In our study, the degree of slippage assessed by Meyerding grading system were: Spondylolysis (34%), Grade I (59%), and Grade II (7%) with a greater tendency toward female gender (P-value <0.001).

Denard et al found that spondylolisthesis was related to increase in body weight; BMI, normal (19%), overweight (55%), obese (26%) and the prevalence of spondylolisthesis among men does not vary by height and BMI [20]. In this study, we found that the BMI of the patients were overweight in 55 (55%) patients, normal range in 26 (26%) patients, obese in 17 (17%) patients, and underweight in 2 (2%) patients with a significant P-value (<0.001). This indicates that with the increase in body weight, there is an increased incidence of spondylolisthesis. The study also showed that a male to female ratio of overweight and obesity was equal to 1:5.6.

In general population, the average body height of males was 68.2 inches (173.3 cm) and females were 63 inches (160 cm) [21]. Previous study showed prevalence of spondylolisthesis would not vary by body height. [20] .In our study, the mean body height ± SD was (166.75±6.94 cm), which ranged (150-180 cm) and Table (4) shows the relation of body height and the degree of spondylolisthesis with a significant P-value which means body height is a risk factor for development of spondylolysis and spondylolisthesis.

Gaetani et al found that L4-L5 was the most frequent level of instability [22]. Giudici et al showed the defect was 95.1% in L5 and 4.9% in L4 of the cases [23]. The prevalence of spondylolisthesis at any level was 31%,

and it was observed at L3/4, L4/5 and L5/S1, with the greatest prevalence at L4/5 [20]. In this study, we found that the most common level of spondylolysis and spondylolisthesis were at L5 (65%), followed by L4 (30%) and L3 (4%).

A prospective study of Matsunaga et al showed that conservative treatment may lead to progressive reduction of LBP and of radicular symptoms, and that surgical treatment is indicated when there is neurological deficit [24]. In five studies that compared non-operative treatment to surgical management found that conservative treatment was not as favorable as surgery. Another four studies found surgical intervention to be more successful than non-operative treatment for treatment of pain and functional limitation. Positive results with conservative treatment were observed in lower grade slippage (grades 0, 1, 2) [7].

Non-operative treatment should be the initial course of management in most cases of degenerative spondylolisthesis with or without neurologic symptoms [4].

Conservative managements like physiotherapy and bracing are the mainstay of the treatment of low grade isthmic spondylolisthesis and symptomatic spondylolysis in fine athletes, then surgical intervention if conservative treatments failed [25]. Bookhout MR recommended strengthening of abdominal and paraspinal muscles, deep-heat treatment, occupational modifications, avoidance of maximal flexion of lumbar spine, and bed rest in severely-suffered patients for three to four months as a trial of conservative management [26] .

The surgical treatment of spondylolisthesis has significant clinical benefit in the presence of cauda equina syndrome, progressive neurological deficits, radiological instability with neurological symptoms, progression of subluxation to more than 50%, and symptomatic grade II, III or spondyloptosis and failure of conservative therapy and non-resolving pain that disturbs quality of life [14].

The study of Kalichman et al showed that 76% of the patients who were initially neurologically intact did not deteriorate over time and these patients may be treated with non-surgical measures. In contrast, most patients (83%) with history of neurogenic claudication or vesicorectal symptoms deteriorate with poor final outcome and these patients should preferably have surgical intervention [4].

A trial of conservative management is reasonable when there is no severe neurological symptoms and unsafe component of instability, although surgical treatment is more efficacious to endure symptomatic relief and restoration of physical function [18].

This study showed 89 (89%) patients were improved with conservative management after 6 months.

In conclusion, the study showed that the incidence of spondylolysis and spondylolisthesis is more common among females, overweight or obese patients but can occur among normal or underweight groups. Trauma and older age have major role in development of spondylolysis and spondylolisthesis. The most common lumbar level to get spondylolysis and spondylolisthesis was L5 then L4. This study also shows that conservative treatment is the initial management of patients with spondylolysis and spondylolisthesis Grade I and II with no neurological deficit.

Conflict of interest

None

Abbreviations

AP (Anterior-posterior), BMI (Body Mass Index), cm (centimeter), CT (Computed Tomography), LBP (Low Back Pain), MRI (Magnetic Resonance Imaging), NSAID (Non-Steroidal Anti-Inflammatory Drug), SD (Standard Deviation), SPSS (Statistical Package for the Social Sciences).

REFERENCES

1. Winn HR. Youmans neurological surgery. 6th ed. Philadelphia, PA: Elsevier; 2011.

2. Greenberg MS. Handbook of neurosurgery. 7th ed. New York, NY: Thieme Medical Publishers; 2010.

3. Dantas FLR, Prandini MN, Ferreira MAT. Comparison between posterior lumbar fusion with pedicle screws and posterior lumbar interbody fusion with pedicle screws in adult spondylolisthesis. Arq Neuropsiquiatr. 2007;65(3-B):764-770.

4. Kalichman L, Hunter DJ. Diagnosis and conservative management of degenerative lumbar spondylolisthesis. Eur Spine J. 2008;17:327–335. DOI 10.1007/s00586-007-0543-3.

5. Lee HJ, Seo JC, Kwak MA, Park SH, Min BM, Cho MS, et al. Acupuncture for low back pain due to spondylolisthesis: study protocol for a randomized controlled pilot trial. Trials. 2014;15:105. doi: 10.1186/1745-6215-15-105.

6. Huang KY, Lin RM, Lee YL, Li JD. Factors affecting disability and physical function in degenerative lumbar spondylolisthesis of L4–5: evaluation with axially loaded MRI. Eur Spine J. 2009;18:1851–1857. DOI 10.1007/s00586-009-1059-9.

7. Garet M, Reiman, MP, Mathers J, Sylvian J. Nonoperative Treatment in Lumbar Spondylolysis and Spondylolisthesis: A Systematic Review. SAGE. 2013;5(3):225-232. DOI: 10.1177/1941738113480936.

8. Niggemann P, Kuchta J, Grosskurth D, Beyer HK, Hoeffer J, Delank KS. Spondylolysis and isthmic spondylolisthesis: impact of vertebral hypoplasia on the use of the Meyerding classification. The British Journal of Radiology. 2012;85:358–362. DOI: 10.1259/bjr/60355971.

9. Mizuno J, Nakagawa H. Threaded Fusion Cage for Lumbar Spondylolisthesis. Neurol Med Chir (Tokyo). 1998;38(3):155-160.

10.Baksi DP. Sacrospinalis muscle-pedicle bone graft in posterolateral fusion for spondylolisthesis. International Orthopaedics. 1998;22(4):234-240. doi:10.1007/s002640050249.

11. Ka-Siong Kho V, Chen W-C. Posterolateral fusion using laminectomy bone chips in the treatment of lumbar spondylolisthesis. International Orthopaedics. 2008;32(1):115-119. doi:10.1007/s00264-006-0274-9.

12. Zagra A, Giudici F, Minoia L, Corriero AS, Zagra L. Long-term results of pediculo-body fixation and posterolateral fusion for lumbar spondylolisthesis. Eur Spine J. 2009;18 (Suppl 1):S151–S155. DOI 10.1007/s00586-009-0997-6.

13. Duke Orthopedics. Angular Slipping in Spondylolisthesis. Weblog. Available from: http://www.wheelessonline.com/ortho/angular_slipping_in_spondylolisthesis; 2011, [accessed 15th May 2014].

14. Alfieri A, Gazzeri R, Prell J, Röllinghoff M. The current management of lumbar spondylolisthesis. J Neurosurg Sci. 2013;57(2):103-113.

15. Kim NH, Lee JW. The relationship between isthmic and degenerative spondylolisthesis and the configuration of the lamina and facet joints. Eur Spine J. 1995;4(3), 139–144.

16. Leone A, Guglielmi G, Cassar-Pullicino VN, Bonomo L. Lumbar intervertebral instability: a review. Radiology. 2007;245(1):62–77. DOI: http://dx.doi.org/10.1148/radiol.2451051359.

17. Haun DW, Kettner NW. Spondylolysis and spondylolisthesis: a narrative review of etiology, diagnosis, and conservative management. JOURNAL OF CHIROPRACTIC MEDICINE. 2005;4(4):206-2017. 0899-3467/Clinical Update/1002-049$3.00/0.

18. Metz LN, Deviren V. Low-grade spondylolisthesis. Neurosurg Clin N Am. 2007;18(2):237-248.

19. Dunn AS, Baylis S, Ryan D. Chiropractic management of mechanical low back pain secondary to multiple-level lumbar spondylolysis with spondylolisthesis in a United States Marine Corps veteran: a case report. J Chiropr Med. 2009;8(3):125–130. doi: 10.1016/j.jcm.2009.04.003.

20. Denard PJ, Holton KF, Miller J, et al. Lumbar spondylolisthesis among elderly men: prevalence, correlates and progression. Spine (Phila Pa 1976). 2010;35(10), 1072–1078. doi:10.1097/BRS.0b013e3181bd9e19.

21. U.S. department of health, education, and welfare public health service. Weight, Height and Selected Body Dimensions of Adult, United States, 1960-1962. Washington, D.C. National center for health statistics; 1965.

22. Gaetani P, Aimar E, Panella L, Levi D, Tancioni F, Ieva AD, et al. Functional disability after instrumented stabilization in lumbar degenerative spondylolisthesis: a follow-up study. Funct Neurol. 2006;21(1):31-37.

23. Giudici F, Minoia L, Archetti M, Corriero AS, Zagra A. Long-term results of the direct repair of spondylolisthesis. Eur Spine J. 2011;20 (Suppl 1):S115–S120. DOI 10.1007/s00586-011-1759-9.

24. Matsunaga S, Ijiri K, Hayashi K. Nonsurgically managed patients with degenerative spondylolisthesis: a 10- to 18-year follow-up study. J Neurosurg (Spine 2). 2000;93:194-198.

25. Bouras T, Korovessis P. Management of spondylolysis and low-grade spondylolisthesis in fine athletes. A comprehensive review. Eur J Orthop Surg Traumatol, 2015;25(Suppl 1):S167-75. doi: 10.1007/s00590-014-1560-7. Epub 2014 Nov 14.

26. Bookhout MR. Evaluation and conservative management of spondylolisthesis. J Back MusculoskeletRehabil. 1993;3(4):24-31. doi: 10.3233/BMR-1993-3406.