Original Article

Comparison between Standing and Supine Lateral Radiographs in Low Grade Spondylolisthesis

Dhakal GR, Basu S*, Biswas A*, Rathinavelu S*, Patel D, Kumar K**

**Department of Spine Surgery, Park Clinic, Kolkata, India*

Corresponding Author: Gaurav Raj Dhakal, Park Clinic, Kolkata 700017, West Bengal, India. Email: spinegaurav@gmail.com

Abstract

To analyze the differences between standing and supine plain film lateral radiographs of the lumbosacral region in low grade (grade I/II) spondylolisthesis using the Picture Archiving and Communication System (PACS) software. Demonstrable difference might be a parameter of instability which might be useful in planning surgical treatment when it is too painful for patients to undergo flexion/extension Xrays.Radiographs of 23 patients with low grade spondylolisthesis were analyzed for percentage slip, lumbar lordosis, disc height, sacral inclination and slip angle. These standing and supine lateral radiographs were taken at the same distance with the same magnification. Measurements obtained were statistically analyzed with the SPSS software using the student t test for statistical significance ($p<0.05$).A significant difference ($p < 0.05$) was found between the standing percentage slip (mean 36.85% +/-12.78%) and supine percentage slip (mean 27.39% +/- 11.14%) ($p = 0.01$). Similarly, standing lumbar lordosis (mean 37.74% +/- 10.96%) and supine lumbar lordosis (mean 30.96% +/- 12.76%) revealed a marginally higher p value ($p =0.06$). However, differences in the disc space height ($p=0.09$), sacral inclination ($p=1$) and slip angle ($p=0.55$) did not show any statistical significance.The standing radiographs effectively demonstrate the increase in slip percentage. This can have a significant impact on the grading of slip which can influence the treatment strategy. Also the increase of slip values on standing Xrays adds a parameter of instability which might be considered in the management strategy.

Keywords: Spondylolisthesis, Lateral Radiographs, Supine, Standing, PACS

Introduction

Spondylolisthesis is most commonly evaluated by flexion and extension radiographs. However, in symptomatic patients the pain may prevent adequate bending of the trunk and leads to an underestimation of the intervertebral motion[1]. The routine radiographic evaluation of these patients has been only a recumbent examination though their pain is increased by standing [2]. The supine views may not reveal the true saggital plane translation values in low grade listhesis. Therefore the values obtained from these radiographs can mislead the surgeon against the correct management strategy. There are no recent comparative studies on radiographs of low grade spondylolisthesis [3,4]. PubMed search revealed literature [2,5].Their study was done on measurements obtained from the analog films manually and included high grade listhesis patients. We hypothesized that standing radiographs reveals a better predictive value of the percentage slip, lumbar lordosis, disc height, sacral inclination and slip angle in low grade listhesis. Because, digital radiology has been replacing analog radiology in major centers, we decided to perform the measurements on digital radiographs with the aid of computer software.

Materials and Methods

We analyzed the plain film supine and standing radiographs of 23 patients with symptomatic low grade spondylolisthesis. These radiographs were taken at the same distance and similar protocol was utilized for them all. The percentage slip, disc height, sacral inclination, slip angle and lumbar lordosis measurements were obtained from the PACS system and recorded in the Microsoft Excel Data Sheet and statistical analysis was done with the SPSS Software using the student t test.

The amount of slip was measured as the horizontal distance from the posterior superior corner of the caudal vertebrae to the posterior inferior corner of the rostral vertebrae and converted into percentage value. The lumbar lordosis was measured according to Wiltse and Winter [6] as the angle between the planes of the cranial end plates of L1 and L5 (Fig 1). A line drawn from the posterior inferior corner of the superior vertebrae perpendicular to the superior end plate of the inferior vertebrae determined the disc space height. The angle subtended by the inferior end plate and the superior end plate of the adjacent listhetic vertebrae defined the slip angle (Fig 2). A straight line drawn along the posterior border of the body of the first sacral vertebrae forms an angle with the vertical plane. This angle was defined as the Sacral Inclination by Wiltse and Winter6 (Fig 3). All the measurements were done by the same individual.

Figure 1. The percentage slip is determined by the horizontal distance from the posterior superior corner of the caudal vertebrae to the posterior inferior corner of the rostral vertebrae and converted into percentage value.

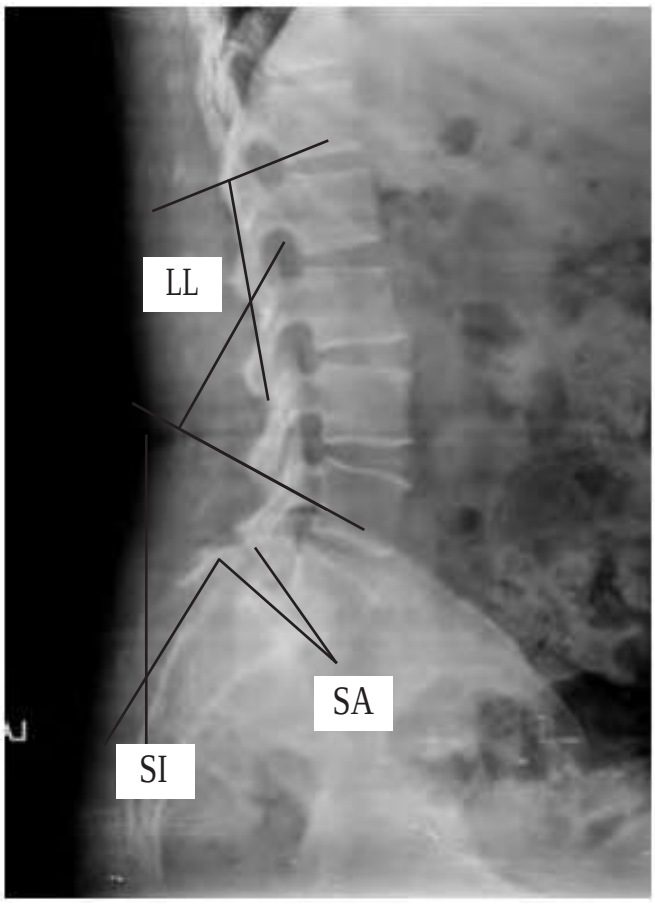

Figure 2: Measurement of the Lumbar Lordosis (LL), Sacral Inclination (SI) and Slip Angle (SA)

Results

Out of the 23 patients, 14 were female and 9 male. The mean age was 51.57 years. All of them had low grade spondylolisthesis. 10 patients had it at L4/L5, 12 patients had it at L5/S1 while 1 had both level involvement. The mean percentage slip in the standing radiographs was 36.85% with a standard deviation of + 12.78%. While the percentage slip in the supine position was 27.39% with a standard deviation of + 11.14%. Using the student t test, this difference was statistically significant ($p<0.05$) with a p value of 0.01. The mean standing lumbar lordosis was 37.740 ± 10.960, while the mean supine lumbar lordosis was 30.960 ±12.760. The p value obtained ($p=0.06$) was marginally higher than significant value ($p<0.05$). While the difference between the mean standing sacral inclination (37.860 ± 9.730) and the mean supine sacral inclination (37.870 ± 9.210) did not show any significance ($p=1$). Similarly the difference between the mean standing slip angle (4.490 ± 40) and the mean supine slip angle (5.040 ± 50) showed no significant difference ($p=0.55$). Also, there was no significance ($p=0.09$) between the means of standing disc height (0.15cm ± 0.16) and supine disc height (0·24cm ± 0.7).

Table 1: Summary of Measurements of the Study Population (n=23)

	Slip (%)		Lumbar Lordosis(°)		Disc Height (cm)		Sacral Inclination(°)		Slip Angle(°)	
	Standing	Supine	Standing	Supine	Standing	Supine	Standing	Supine	Standing	Supine
Mean	36.85	27.39	37.74	30.96	0.15	0.24	37.86	37.87	4.49	5.04
Median	33.33	27.59	40	34	0.13	0.25	38	40	4	5
SD	12.78	11.14	10.96	12.76	2.61	3.36	9.73	9.21	2.61	3.36

Table 2: Measurement of the Radiological Parameters (n=23)

Serial No	Age	Sex	Listhesis level	Standing Lumbar Lordosis	Supine Lumbar Lordosis	Standing Slip (cm)	Supine Slip (cm)	Standing Sacral Inclination	Supine Sacral Inclination	Standing Slip Angle	Supine Slip Angle	Standing Disc height (cm)	Supine disc height (cm)
1	48	F	L4L5	24	8	0.41	0.28	34	41	2	4	0.22	0.34
2	54	F	L5S1	57	47	1.09	0.64	36	36	3	3	0.07	0
3	69	M	L4L5 L5S1	41	40	1.32	1.13	41	45	4	5	0	0
4	72	M	L4L5	16	12	0.66	0.41	25	35	3	5	0.2	0.48
5	45	F	L5S1	44	23	0.8	0.65	42	25	2	2	0.1	0.34
6	31	M	L4L5	42	25	0.62	0.36	49	38	4	4	0.25	0.39
7	6	M	L5S1	48	40	0.77	0.44	18	36	4	3	0	0
8	53	F	L5S1	35	40	0.71	0.71	50	50	5	5	0.11	0.11
9	74	M	L4L5	35	38	0.49	0.41	32	34	7	7	0.13	0.36
10	72	F	L5S1	50	35	0.86	0.41	39	51	0	0	0	0
11	52	F	L5S1	50	45	0.78	0.58	44	40	0	0	0	0.13
12	52	M	L4L5	24	15	0.38	0.25	41	40	8	8	0.16	0.16
13	27	F	L5S1	36	30	0.5	0.5	35	46	4	3	0	0
14	52	F	L4L5	39	34	0.42	0.42	36	34	12	16	0.19	0.38
15	58	F	L4L5	48	48	0.74	0.56	38	45	5	7	0.18	0.2
16	51	F	L5S1	52	51	1.09	0.96	63	44	3	3	0.2	0.1
17	67	F	L4L5	35	20	1.09	1.01	38	40	5	6	0.16	0.37
18	63	M	L4L5	40	34	0.47	0.33	22	16	6	6	0.8	0.54
19	30	M	L5S1	24	30	0.7	0.63	44	46	6	10	0.22	0.43
20	72	F	L5S1	40	42	1.06	0.85	44	48	3	5	0.05	0.16
21	51	M	L5S1	28	18	0.48	0.34	31	25	5.37	2.81	0.1	0.32
22	51	F	L4L5	40	27	0.8	0.36	40.87	35	5	5	0.1	0.25
23	36	F	L5S1	20	10	0.45	0.28	28	21	7	6	0.21	0.37

Discussion

Two classification systems are currently used: Wiltse-Newman-MacNab [7] and Marchetti – Bartolozzi [8]. Adult low grade spondylolisthesis are usually degenerative and isthmic according to the former, whereas in the latter, low grade spondylolisthesis can be developmental or acquired. However, the degree of slip was quantified by Meyerding [8,9] and this grading divides the inferior vertebral body into one fourth the widths to allow for five possible grades: I to V. The slip is graded based on the percentage of the inferior body superior end plate, which is uncovered as a result of the slip. A grade II slip would be 50% slip and a grade V slip would be a complete fall off. Low grade spondylolisthesis are the grade I and II slips.

There has been an increasing interest in the recognition of sagittal parameters in the evaluation of spino pelvic balance. Along with the spino pelvic balance and the pelvic incidence, the degree of slip is also one of the important determinants of surgical outcome[10].While the pelvic incidence remains constant inspite of the change in posture [11]; we were of the opinion that standing and supine postures would affect the lumbar lordosis, slip angle, sacral inclination and the degree of slip.

In our study of 23 patients with low grade spondylolisthesis with both standing and supine lateral radiographs there was a significant increase in the translational instability in the standing films. Boxall D et al [5]., found a change in the percentage slipping between the two roentgenograms ranged from an increase of 31% to a decrease of 10% and averaged a 5% increase in the standing versus supine roentgenograms. Our study also revealed a mean increase of 8% in the standing films compared to the supine films. This difference was significant such that it would influence the grading of the slip and its severity.

Though Boxall D et al, found an increase slip angle in the standing films, our study did not reveal any significant difference. This could be due to the measurements taken in patients with high grade slips in their study. The angle of slip in their patients varied directly with the contour of the first sacral vertebral body, lumbar index, lordosis and sacral inclination. In our study, there was no significant difference in the standing values of lumbar lordosis and sacral inclination hence the slip angle showed no significant increase.

We were of the opinion that the disc height would decrease more in the standing films than the supine films. Measurements revealed a mean disc height of 0.24 cm in the supine films and 0.15cm in the standing films. Statistical analysis revealed that the difference was marginally higher ($p=0.06$) than the value of significance ($p<0.05$).

Literature review has revealed that there is a change in the severity of the slip between the standing and supine lateral radiographs. Lowe et al., studied fifty patients with spondylolisthesis and found an increase of two millimeters or more in the standing versus supine roentgenograms in thirteen (26 percent) of their patients. Their study also included different grades of listhesis. Based on the study Boxall et al., and Lowe et al. and our study we recommend that roentgenograms in spondylolisthesis patients be made in the standing position. It becomes more important in low grade listhesis because in the recumbent position the low grade listhesis may spontaneously reduce. Also, degenerative listhesis is commonly associated with spinal stenosis and when the stenosis is dynamic in nature, supine imaging may not reveal the true degree of stenosis. This difference can only be appreciated in the upright or standing imaging of the axially loaded spine.

Computer aided software was used to measure the above mentioned parameters. The software allowed the observer to adjust contrast, brightness, manipulate the images for better clarity and make direct measurements. Bolesta et al. [12] concluded that measurements of anterior displacement, saggital rotation and lumbar lordosis in degenerative lumbar spondylolisthesis made with commercially available software were comparable with the same measurements made on film prints of the same size. The images stored and retrieved electronically also saved space, time and the manpower required for filing purposes.

Conclusion

The standing radiographs in spondylolisthesis effectively demonstrate the increase in slip percentage. This increase is due to the loading of the spine, which exacerbates the deformity and thus can give an idea of instability. This can have a significant impact on the grading of the slip

which can influence the treatment strategy especially in patients with symptomatic low grade spondylolisthesis. This also has a role in defining symptomatic instability on patients too painful to undergo the flexion/extension radiographs. The digitalization of the radiographs and measurements from the software eliminate the need for manual retrieval and calculations.

DISCLOSURES

No conflicts of interest were declared by the authors.

References

1. Mario Cabraja, Ellafi Mohamed, Daniel Koeppen,Stefan Kroppenstedt. The analysis of segmental mobility with different lumbar radiographs in symptomatic patients with a spondylolisthesis. Eur Spine J. 2012;21:256-261.

2. Robert W Loe,T David Heyes,Jeremy Kaye,Raymond J Bagg,C A Luekens.Standing Roentgenograms in Spondylolisthesis. Clinical Orthopedics and Related Research .June 1976- Volume 117:80-84

3. Leone A, Guglielmi G, Cassar-Pullicino VN, Bonomo L. Lumbar intervertebral instability: a review. Radiology.2007; 245(1):62–77

4. Leone A, Cassar-Pullicino VN, Guglielmi G, Bonomo L. Degenerative lumbar intervertebral instability: what is it and how does imaging contribute? Skeletal Radiol.2009; 38(6):529–533
5. Boxall D, Bradford DS, Winter RB. Management of severe spondylolisthesis in children and adolescents. J Bone Joint Surgery. 61A:479,495,1979
6. Wiltse LL, Winter RB. Terminology and measurement of spondylolisthesis.J Bone Joint Surg Am. 1983;65:768–72.
7. Wiltse LL, Newman PH, Macnab I. Classification of spondylolysis and spondylolisthesis. Clinical Orthopedics Related Research . 1976(117):23-29.
8. Marchetti PC, Bartolozzi P. Classification of spondylolisthesis as a guideline for treatment. In Bridwell KH, De Wald RL, Hammerberg KW, et al (eds). The textbook of spinal surgery, 2nd ed. Philadelphia, PA: Lippincott-Raven, 1997:1211-1254.
9. Meyerding HW. Spondylolisthesis. Surg Gynecol Obstet. 1932;54:371-7
10. Mac-Thiong J M, Labelle H, Parent S, et al. Reliability and development of a new classification of lumbosacral spondylolisthesis. Scoliosis .2008;3:19
11. Bridwell K H, DeWald R L The Textbook of Spinal Surgery 3rd Edition
12. Bolesta M J, Winslow L, Gill K A comparison of film and computer workstation measurements of degenerative spondylolisthesis. Intraobserver and Interobserver Reliability Spine Volume 35: 1300-1303