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Original Research Article

Early Outcome of Lumbar Instability withAccompanying Intervertebral Disc Prolapse, A Clinical and Radiological Follow-Up

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Abstract

Background: Identify lumbar instability and intervertebral disc prolapse, in patients presenting to the outpatient clinic with chronic lower back ache and sciatica using functional flexion and extension radiography and MRI, and secondly, to follow up these patients undergoing posterior decompression, stabilisation and postero-lateral fusion, over a post-operative period of 6 months and assess clinical and radiological outcome and compare the pre-operative and post- operative variables.

Materials and methods: The study was conducted at Nalanda medical college and Hospital, Patna. Study duration of two years. and 38 patients who fulfilled the inclusion criteria were included in the study. The pre-operative and post-operative functional status of the patient was assessed using the Japanese Orthopaedic Association (JOA) score. The patients then underwent functional radiography and MRI of the lumbosacral spine, as well as routine pre-operative blood investigations. Following this, the patients underwentsurgery and were reviewed with clinical examination and repeat functional flexion- extension radiographs of the lumbosacral spine, 6 months after the surgery. The pre- and post-operative lumbar mobility was quantified on functional radiography by an independent observer. Tests of statistical significance were then applied on the data ofthe variables in the study, gender, occupation, smoking status, chief complaint, end plate changes and type of instability, and the pre- and post-operative JOA scores were compared.

Conclusion: Adequate decompression of the structures causing nerve root compression can be carried out through the posterior approach along with instrumentation. Reduction of any abnormal lumbar mobility in the post-op functional radiographs, is an objective method of assessing stabilisation and fusion. The type of abnormal lumbar mobility, and the presence or absence of end plate changes did not affect the outcome.

Keywords: Lumbar instability, Spinal fusion, Spondylolisthesis, Radiography.

Introduction

Low back pain is the most common orthopaedic problem worldwide. According to some estimates approximately 60-80% of the general population will suffer from low back pain at some point in their lifetime and 20-30% are suffering from low back pain at any given time. [1] Cross-sectional data demonstrate that initial onset of lower back pain commonlyoccurs around the age of 30 and peaks in occurrence between the ages of 45 and 60 years. [2,3] In addition to physical infirmity, the psychological impact of lower back pain is profound. There is a high prevalence of anxiety and depression in Indian low back pain patients. [4] It also poses an economic burden to society, mainly in terms of the large number of work days lost. [5] Lumbar spine instability has been considered by many to represent an important subgroup of those experiencing lower back pain. [6,7] Intervertebral instability of the lumbar spine is a possible patho-mechanical mechanism underlying low back pain and sciatica and is often an important factor in determining surgical indication for spinal fusion and decompression. Instability of the lumbar spine, however, remains a controversial and poorly understood topic. Even at present, controversy exists regarding the proper definition of the condition, the best diagnostic methods, and the most efficacious treatment approaches. [8] It thus follows that recognising and treating these patients is important. This study aims to define the role of surgical decompression and fixation of the spine by a posterior approach, followed by posterolateral fusion of the spinal segments and its early outcome as evidenced by clinical follow-up and imaging.

Aims

To identify intervertebral instability of the lumbar spine, in patients presenting to the outpatient clinic with chronic lower back ache and sciatica using functional flexion and extension radiography and MRI scan.

Review of Literature

The concept of lumbar spinal instability is a recently proposed and constantly evolving entity.Spinal fusion as a treatment for back pain was in vogue from the beginning of 1900, but little thought was given to what the pain source might be. None of the papers dealing with fusion until the nineteen-fifties mention abnormal movement as a cause of Pain. [9,10,11,12,13,14] The concept of lumbar instability was poorly understood till 1951, when Barr put forth the view that the degenerative disc was responsible for a proportion of the genesis of low back pain. [15] The loss of disc height subsequently decreased space between lumbar facet joints and adjacent vertebral bodies, placing additional stress on articular cartilage. Augmented contact coupled with increased segmental motion was thought to adversely affect the joints and contribute to low back pain. These views were brought to light between 1957 and 1971 by various authors. [16,17,18] A mathematical model of spine muscle function was discussed in 1977. Musclefunction around the lumbar spine of a weight lifter was calculated using a mathematical model developed by Farfan and Gracovetsky. Based on the model, it was suggested that the passive structures of the lumbar spine were better designed to resist compression and much less resistant to segmental shear forces. [19] Kirkaldy-Willis presented his concept of the degenerative cascade of the spine. Subsequently in his influential book ‘‘ManagingBack Pain’’ in 259 pages, just one page is devoted to the rationale of lumbar fusion.The only reason for fusion appeared to be that, other treatments had failed, that it was reasonable from the psychological viewpoint, and that instability was present. [20] Muscle function around the lumbar spine of a weight lifter was calculated using a mathematical model developed by Farfan and Gracovetsky. Based on the model, it was suggested that the passive structures of

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During the same conference, Pope and Panjabi defined instability, from a biomechanical perspective, as a loss of stiffness in the spine. The loss of stiffness wasthought to allow increased motion to occur at each vertebral segment. Flexion andextension radiographs could be used to identify and quantify increased end-range motion at lumbar spinal segments. [21] In 1985, Dupuis, in his paper, wrote that a lumbar motion segment is considered unstable when it exhibits abnormal movements. [20] In a cadaveric study done by Gertzbein et al. in 1985, it was showed that in mildlyand moderately degenerated spinal segments, motion was not thought to be excessive but rather erratic. These degenerated spinal segments demonstrated excessive range ofmotion on flexion and extension radiographs and changes in instantaneous axis of rotation throughout flexion and extension. [22] Panjabi presented his concept of spinal stability in two articles in the early 1990s. This article discussed the idea that stability of various joints in the body is maintained by a combination of the structural (passive) system, muscular (active) system, and the neural control system. An interplay between these systems is necessary to maintain stability. Panjabi suggested that loss of osseoligamentous integrity would result inlack of stability of the spine if the muscular and neural control systems were unable to adequately compensate. [23,24]

The normal intervertebral disc is the primary load-bearing structure in the spinal motion segment and can be divided into nucleus pulposus and annulus fibrosus. The annulus fibrosus consists of a complex system of fiber bundles called lamellae, which become progressively more compact centrifugally with differentiation into Sharpey fibers, whereby there is a direct bony anchorage at the peripheral attachment of the annulus with the vertebral body rim. These collagen fibers blend with the anterior and posterior longitudinal ligaments and act together to stabilize the vertebral motion segment. The nucleus with its high water content has hydrostatic properties, acts as a fulcrum for spinal movement, and provides for the radial transmission of forces. The flaval ligaments are thick, broad structures that connect the laminae of adjacent vertebrae. These ligaments, owing to their high elasticity, exert a contracting force on the vertebral arches, pressing the vertebrae together and keeping them aligned. [8] The interspinous ligaments are thin membranous structures that connect adjacent spinous processes. The interspinous ligaments make very little contribution to the clinical stability of the lumbar spine in the adult.[8] In contrast, the supraspinous ligaments appear to play a major role in the lumbarspine. Myklebust et al.

Material and methods

The study was a prospective type of study and was conducted, the study was conducted at Nalanda medical college and Hospital, Patna, Bihar.and help of pmch, patna. Study duration of two years. and 38 patients who fulfilled the inclusion criteria were included in the study. The pre-operative and post-operative functional status of the patient was assessed using the Japanese Orthopaedic Association (JOA) score. The patients then underwent functional radiography and MRI of the lumbosacral spine, as well as routine pre-operative blood investigations.

Inclusion criteria

All patients in the study were diagnosed to have IVDP with evidence of lumbar instability on functional radiographs, and included, Age group between 30 and 70 years of age, All cases of spondylolysis and spondylolisthesis (grade 1 to grade 3, MRI proved cases of lumbar intervertebral disc prolapse (single level,two levels or three levels), Those patients with lumbar disc bulge who have undergone epiduralsteroid injection earlier.

Exclusion criteria

Patients diagnosed with degenerative lumbar canal stenosis, Severe grades of spondylolisthesis (grade 4), Age less than 30 years and above 70 years, Patients having associated spinal tuberculosis, Acute traumatic lumbar intervertebral disc prolapse, Patients who have undergone surgery for lumbar intervertebral disc prolapse in the past, ie. iatrogenic instability.

Patients were assessed clinically, with a thorough history and physical examination. The symptoms and signs elicited were recorded in a proforma. The pre-operative and post-operative functional status of the patient was assessed using the Japanese Orthopaedic Association (JOA) score. It is a clinical symptom score for a patient with a herniated lumbar disc. The variables were compared before and after surgery, with the pre- and post- operative JOA score and the percentage improvement after surgery. The variables were also analysed as to whether there was any association between the variable and greater than 80% improvement after surgery. A p value of <0.05 was considered as significant.

Results

A total number of 38 patients were operated and followed up between Nmch, Patna. The follow-up duration for each patient was 6 months after the surgery. The age of the patients ranged between 32 years to 65 years. There were a total of 18 males (47.4%) and 20 females (52.6%) in the study. Occupation of the patients

Table 1: Smoking status

Occupation	Frequency	Percent
Deskjob	10	26.3
Housewife	16	42.1
Manual labour	12	31.6
Total	38	100.0

5 patients were smokers, while the rest were non-smokers.

Table 2: Chief complaints

Symptom	Frequency	Percent
Lower back pain	2	5.3
Lower back pain with radiculopathy	36	94.7
Total	38	100.0

Out of the 38 patients, 36 patients presented with lower back pain radiating to thelower limbs, while 2 patients presented with isolated lower back pain.

Table 3: Instability levels

Instability level	Frequency	Percent
L4-5	19	50.0
L5-S1	19	50.0
Total	38	100.0

19 patients each had instability (as evidenced on flexion-extension radiographs) at L4-5and L5-S1 levels

Table 4: Type of instability

Type of instability	Frequency	Percent
Only translational	5	13.2
Only rotational	19	50.0
Both translational and rotational	14	36.8
Total	38	100.0

5 patients had only translational instability, 19 patients had only rotational instability,while 14 patients had both ie. translational and rotational instability.

Table 5: Level of disc prolapse

Level of disc prolapse	Frequency	Percent
L4-5	17	44.7
L5-S1	3	7.9
More than 1 level	18	47.4
Total	38	100.0

In 17 patients, intervertebral disc prolapse occurred at L4-5 level only. In 3 patients,the same occurred at L5-S1 level only. 18 patients had intervertebral disc prolapse atmore than one level (upto three levels).

Table 6: A comparison of the pre-operative and post-operative JOA score

Variable	Mean	N	Std. Deviation	p value
Pre-op JOA score	14.00	38	2.932	<0.001
Post-op JOA score	26.37	38	1.762	

A significant p value ($p<0.001$) was obtained on comparing the pre-op and post-opJOA scores.

Table 7: Comparison between the pre- and post-operative JOA scores andthe percentage improvement in JOA score, and the type of lumbar instability

Variable	Type of instability	N	Mean	Std. Deviation	p value
Pre-op JOA score	Only trans	5	15.80	2.775	0.094
	Only rota	19	14.42	2.854	
	Both	14	12.79	2.778	
	Total	38	14.00	2.932	
Post-op JOA score	Only trans	5	27.40	.548	0.376
	Only rota	19	26.26	1.759	
	Both	14	26.14	1.994	
	Total	38	26.37	1.762	
Improvement	Only trans	5	88.11	2.392	0.398
	Only rota	19	81.21	10.885	
	Both	14	82.68	10.110	
	Total	38	82.66	9.963	

Non-parametric tests

Table 7: The analysis between the quantity of pre- and post-operativelumbar instability (using Wilcoxon Signed Ranks test)

	Post-op flexion sagittal anterior translation – Pre-op flexion sagittal anterior translation	Post-op flexion sagittal rotation – Pre-op flexion sagittal rotation	Post-op extension sagittal posterior translation – Pre-op extension sagittal posterior translation	Post-op extension sagittal rotation – Pre-op extension sagittal rotation
Z	-3.824[a]	-5.232[a]	-2.023[a]	-5.373[a]
p value	**<0.001**			

(a. Based on positive ranks.)A significant p value (p<0.001) on quantitative assessment of post-operativecompared with pre-operative lumbar instability was obtained.

Table 8: The relationship between the percentage improvement in JOAscore and the chief complaint of the patient

			Percentage improvement in JOA score		Total	p value
			>80%	<=80%		
Chief complaint	lower back pain	Count	0 (0)	2(14.3%)	2(5.3%)	0.057
	lower back pain + radiculopathy	Count	24(100.0%)	12(85.7%)	36(94.7%)	
Total		Count	24(100.0%)	14(100.0%)	38(100.0%)	

(Percentages in parentheses)

All of the patients who had more than 80% improvement in the JOA score, had presented with complaints of lower back pain and radiculopathy. Neither of the 2 patients who presented with only lower back pain had an improvement of more than 80%.

Discussion

In our study, there was a statistically significant improvement in the post-operative JOA score as compared with the pre-operative JOA score ($p<0.001$). The pre-op JOA scores ranged between 6 and 19, while the post-op JOA scores ranged between 21 and the percent improvement at the end of 6 months after the surgery ranged between 59%-95%. The relief in symptoms is likely due to the decompression of the nerve roots by the offending intervertebral disc, ligamentum flavum and osteophytes as well as stabilization of the instability component by the pedicular screws and rods. At the end of 6 months, the stability of the operated segment is likely to be due to the hardware construct and less likely due to bony fusion [25]. Bony fusion is better assessed using a CT scan. Our study also showed a significant quantitative reduction in the post-operative sagittal translation/rotation as compared to the pre-operative sagittal translation/rotation (**$p<0.001$**), which were seen on functional radiography. The stabilization construct prevents abnormal translation and rotation between the lumbo- sacral segments. This reduction in abnormal mobility between the motion segments correlates with the improved post-operative JOA scores. The outcome of surgery was found to be independent of the following subjective variables among the patients: sex, occupation, smoking status, chief complaints. These did not determine whether the outcome was good or poor. The p value for each of these analyses was >0.05. All of the patients who had more than 80% improvement in the JOA score, had presented with complaints of lower back pain and radiculopathy. Neither of the 2 patients who presented with only lower back pain had an improvement of more than 80%. Most of the patients were non smokers (86.8%). Among the 5 smokers in our study, 4 of these had post-operative percentage improvements as 85.71%, 81.81%, 73.33% and 81.81% while 1 of these had an improvement of 58.82%. Although previous studies conducted in subgroups of spine surgery patients have showed a deleterious effect for smoking on long-term outcomes in patients undergoing spine surgery [26],other studies did not find smoking to be associated with early (30 days) peri-operativemorbidity [27]. In our study, the smoking status of the patient did not affect the outcomeof surgery ($p>0.05$). End plate changes have been typically associated with lumbar instability. Their characterisation into Modic types 1,2 and 3 suggest the degree of disc degeneration and associated end plate sclerosis [28]. In our study, end plate changes were seen in the MRI scans of 12 patients (31.6%). However, this presence, or absence of end plate changes on the MRI scans, did not influence the outcome of the surgery ($p>0.05$). The most common type of lumbar instability in our study was rotational instability (50%). The rest of the patients had either only translational instability (13.2%) or both, translational and rotational instability (36.8%). [29] However, the type of instability did not influence the outcome of surgery. This is due to the fact that, during instrumented stabilisation, both components of instability, ie. translational and rotational components are stabilised. Therefore, the type of pre-exisiting instability is unlikely to affect early outcome.

Conclusion

This is more pertinent in the case of lumbar instability with accompanying intervertebral disc prolapse. Adequate decompression of the impinging structures can be carried out through this posterior

approach along with instrumented postero-lateral fusion. With instrumented postero-lateral fusion, good subjective and objective results are obtained. The patient benefits from this surgery in terms of, earlier return to activities of daily living, including the patient's occupation. This reduces the economic burden of the patient in terms of absenteeism from the workplace. Reduction of any abnormal lumbar mobility in the post-op functional radiographs, is an objective method of assessing stabilisation and fusion.

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