

**How to Cite:**

Patil, S. S., Singh, A. ., & Kour, A. (2022). Clinical and radiological assessment of adjacent segment degenerative changes in cervical spine after instrumentation in indian scenerio. *International Journal of Health Sciences*, 6(S1), 4035–4048. <https://doi.org/10.53730/ijhs.v6nS1.5743>

# Clinical and radiological assessment of adjacent segment degenerative changes in cervical spine after instrumentation in Indian scenerio

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**Abstract**---Objective: Over the last 50 years many authors have used cervical spine fusion as a treatment for degenerative spondylotic conditions, and it has become the standard of care for numerous pathologic conditions of the spine. However, since over the past two decades spinal fusion has been performed on younger patients and the rates of cervical spine surgery have increased. Here we have studied the incidence of the adjacent segment disease and the radiological changes of cervical cord at the level of previous operation and at the adjacent segment. Methods: Non randomised, open level study done at territory care centre for a period of three years a total 51 operated cervical spine patients were studied. MRI of cervical spine was done in symptomatic patients. All the patients were followed up clinically and radiologically. Results: Fifty one patients were followed up for minimum of 2 years (average 72.82 months) after cervical spine instrumentation. 23 patients had single or multiple co- morbidities. 29 (56.86%) patients developed adjacent segment degeneration following the primary surgery. Rate of re- surgery for the symptomatic ASD was 9.8%, Development of radiological or clinical ASD 54.9%. 28 out of 51 patients had hyperintensities on T2W images, Out of which 32.14% (9) patients improved radiologically after surgery and 64.28% (18) showed clinical improvement. All the patients with radiological

improvement had clinical improvement also. Out of the clinically improved patients, 35.17% (10) patients were radiologically unchanged. Conclusions: Rate of adjacent segment degeneration is 56.86% and the rate of adjacent segment disease is 13.7% .9.8% required re- surgery.

**Keywords---**Cervical spine fusion, spondylotic myelopathy, adjacent segment changes, fusion surgeries.

## **Introduction**

Cervical disc disease is one of the earliest known human ailments. The only modality to treat the disease was conservative till the mid of nineteenth century, when Sir Victor Horsley decompressed cervical spinal cord of a patient of progressive cervical spondylotic myelopathy. Spurling and Scoville described the posterior foraminal decompression in 1940. The anterior approach was described by Smith and Robinson in 1950 , It was thought that fusion is must to stabilise the spine, but in 1960 Hirsh described the anterior cervical decompression without fusion and concluded that stability can be achieved by only anterior decompression. In 1965 Robertson used the operating microscope for removing the cervical disc for the first time. Hankinson and Wilson removed the central disc material only using high speed drill. Dunsker described the extended decompression in 1977 .This includes removal of posterior inferior margin of upper vertebra and posterior superior margin of lower vertebra

Over the last 50 years many authors have used cervical spine fusion as a treatment for degenerative spondylotic conditions, and it has become the standard of care for numerous pathologic conditions of the spine. In the cervical spine, decompression and fusion have provided a greater than 90% likelihood of relieving radicular symptoms and stabilizing or improving myelopathy. However, since over the past two decades spinal fusion has been performed on younger patients and the rates of cervical and lumbar spine surgery have increased, concern regarding the effect on the mobility of adjacent segments has been increasing. And many times the patient may need another surgery for the adjacent segment disease. Here we will study the incidence of the adjacent segment disease and the radiological changes of cervical cord at the level of previous operation and at the adjacent segment.

## **Aims and Objectives**

- 1 To study the incidence of adjacent segment changes in cervical spine after instrumentation.
- 2 To study the signal changes in cervical cord on MRI in the patients with spondylotic myelopathy who have undergone surgery and its clinical relevance.

## Material and Methods

This is a non randomised, open level study done at territory care centre for a period of three years a total 51 patients were studied. Patients who were operated for their degenerative spine diseases were included in this study. MRI of cervical spine was done in symptomatic patients. All the patients were followed up clinically and radiologically.

### Inclusion criterion

All patients of cervical disc disease /spondylotic myelopathy with signal changes who needed cervical decompression and fusion (anterior or posterior) for degenerative disorders were included. The MRI and x - rays were reported by the senior consultants Neuroradiology. The Clinical examination was conducted by neurosurgeons with clinical related to the Nurick grading (table no 1) , motor power as modified Japanese Orthopaedic Association Scale and American Spinal Injury Association (ASIA) Score and sensory grading as shown in the figure 1.

### Exclusion criterion

Patients admitted for spine trauma with pace maker and patients not willing to participate in the study.

Nurick classification—Table no 1

Table 1  
Nurick grade to assesses ambulatory status of the patients

Grade	Root signs	Cord involvement	Gait	Employment
0	Yes	No	No	Possible
1	Yes	Yes	No	Possible
2	Yes	Yes	Mild impaired	Possible
3	Yes	Yes	Severe	impossible
4	Yes	Yes	Only with assistance	Impossible

### Scale used for the assessment was

#### The modified Japanese Orthopaedic Association Scale”

Upper extremity function-

- Impossible to move hands (0)
- Possible to move hands, but not able to eat with spoon
- (1) Possible to eat with spoon, but not able to button shirt
- (2) Able to button shirt with great difficulty (3)
- Able to button shirt with slight difficulty (4)
- No dysfunction (5)

Lower extremity function-

- Complete loss of sensory and motor function (0)
- Sensory preservation without ability to move legs (1)

Able to move legs but can't walk (2)  
 Possible to walk on flat floor with walking aids(3)  
 Able to walk up and down stairs with hand rails (4)  
 Moderate to significant lack of stability but able to walk

up

and down stairs without hand rail(5)  
 Mild lack of stability but walk unaided with smooth  
 Reciprocation (6)  
 No dysfunction (7)

Sensory-

Complete sensory loss (0)  
 Severe sensory loss or pain (1)  
 Mild sensory loss (2)  
 No sensory loss (3)

Bladder function-

Inability to micturate voluntarily (0)  
 Marked difficulty with micturition (1)  
 Mild to moderate difficulty with micturition (2)  
 Normal micturition.(3)

Total score of 18.

**American Spinal Injury Association (ASIA) Score-**

0 1 2 3 4 5	C5 Biceps	Flex elbow	C5 0 1 2 3 4 5
0 1 2 3 4 5	C6 Wrist extension	Cock up wrist	C6 0 1 2 3 4 5
0 1 2 3 4 5	C7 Triceps	Extend elbow	C7 0 1 2 3 4 5
0 1 2 3 4 5	C8 Flex. Digitorum profundus; flex dis middle phalanx		C8 0 1 2 3 4 5
0 1 2 3 4 5	T1 Hand intrinsic	Abduct little finger	T1 0 1 2 3 4 5
0 1 2 3 4 5	L2 Iliopsoas	Flex hip	L2 0 1 2 3 4 5
0 1 2 3 4 5	L3 Quadriceps	Flex hip	L2 0 1 2 3 4 5
0 1 2 3 4 5	L4 Tibialis anterior	Dorsiflex foot	L4 0 1 2 3 4 5
0 1 2 3 4 5	L5 EHL	Dorsiflex big toe	L5 0 1 2 3 4 5
0 1 2 3 4 5	S1 Gastrocnemius	Plantarflex foot	S1 0 1 2 3 4 5

Sub total for right side

Sub total for left sides

## Sensory as per chart

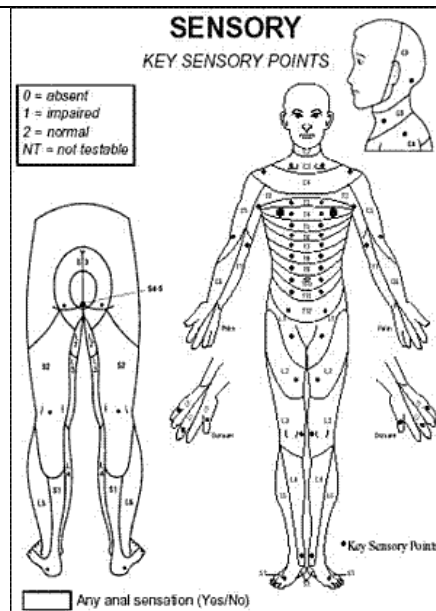


Figure 1 Standard neurological dermatomal localisation

### Research Hypothesis

The overall incidence of adjacent segment disease in cervical spine is around 25% (2 to 3 % of patient per year) and 9% of the affected patient required second operation for the symptomatic adjacent segment disease

### Statistical analysis

We evaluated the data and grouped the patients depending upon their clinical and radiological outcome. The statistical significance of various parameters to the radiological and clinical outcomes was measured using descriptive statistical tests as well as chi square test to compare the results. P value of less than 0.05 was considered significant.

### Ethical consideration

With the newer techniques and advances in neurosurgery over the last 50 years, spine surgeries for degenerative spinal diseases are done routinely. With time the long term complication of these fusion surgeries are being reported. The major data on this issue is from western countries and from far east. There are very few studies from India. This was our effort to know the exact incidence of the disease in Indian scenario.

Patients were informed the purpose and the benefits of the study. Confidentiality of the participants was maintained at all the levels. Informed consent was taken before the enrolment.

## Observations and findings

### Age

Total 51 patients were studied in this study. The mean age was 54.23 years. Median age of presentation was 56 years the age range was 28- 71 years. Out of 51 patients, 14 (27.45%) patients were of 50 years or below, 37 (72.54%) patients were above 50 years of age. The mean age of presentation for females was 54.57 years, where as it was 54.1 years for males. Median age for females was 63 years and for males it was 55 years. Age range for females was 28- 67 years and for males it was 33- 71 years.

### Sex

Out of 51 patients 14 (27.45%) were female and 37 patients were male (72.55%).

### Duration of symptoms

The average duration of symptoms was 23.21 months. The range of duration of symptoms was from 1 month to 17 years with mode of 1 year. Shown in Diagram no 1.

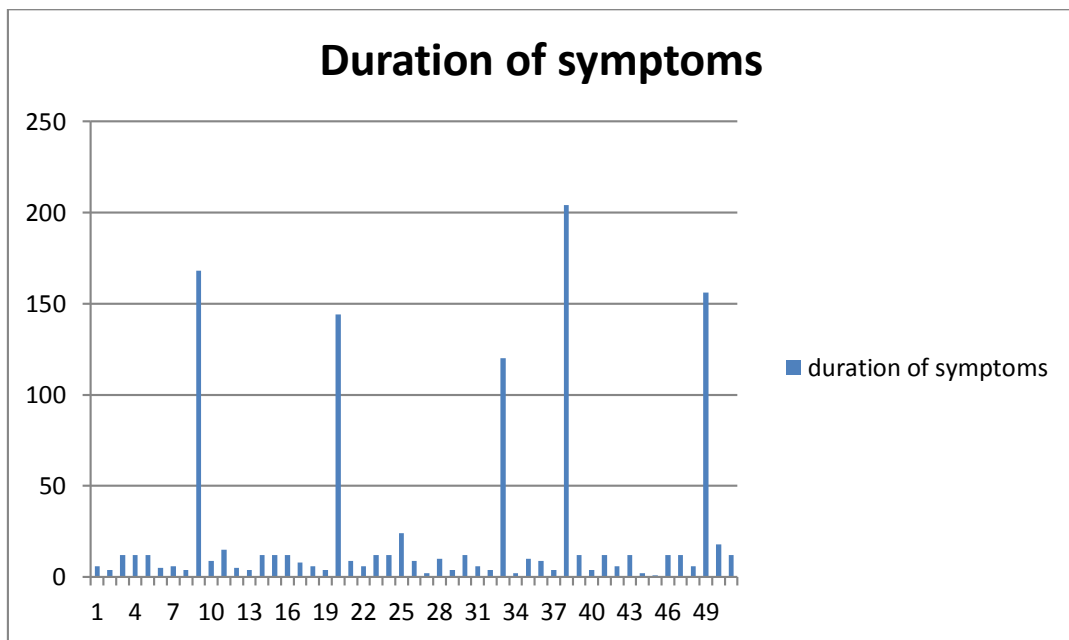


Diagram no 1.

### Comorbidities

Out of 51 patients, 23(45.1%) suffered from either single or multiple comorbidities. And 28 (54.9%) patients did not have any comorbidities. 14 patients had both hypertension and diabetes. 3 patients had hypertension and asthma. 2 patients had asthma and other 2 patient had diabetes with asthma. 2 patients had diabetes, hypertension and asthma.

### Duration of follow up

The average duration of follow up was 72.82 months. The range was from 2 years to 18 years as shown in Diagram no 2.

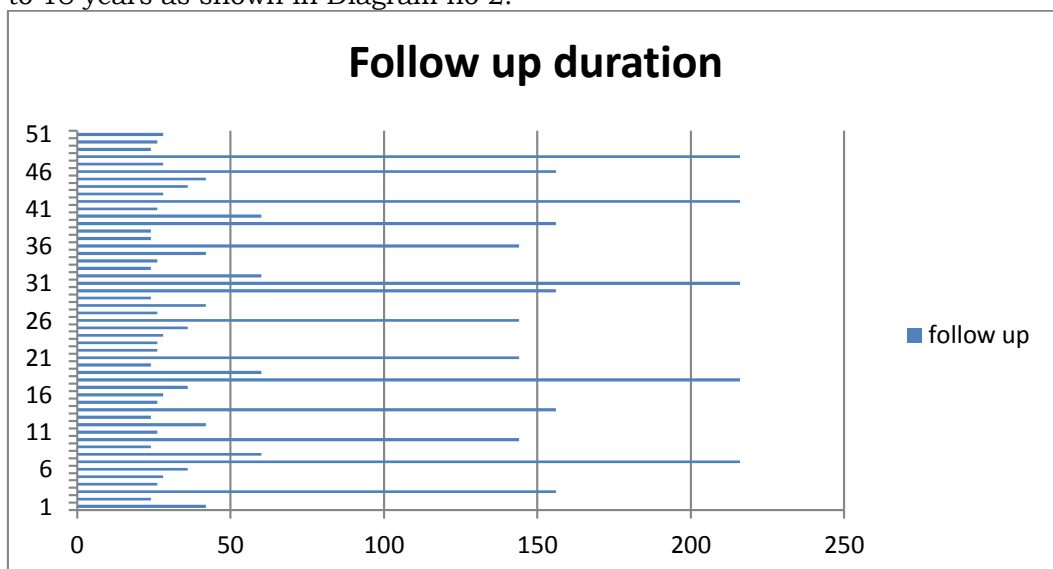


Diagram no 2.

### Clinical and radiological findings

The patients (table no 2) were grouped according to their radiological and neurological status compared to their pre operative status.

Table 2

reveals the radiological and neurological status compared to their pre operative status with respect to age and sex

Groups	Total	< = 50 years	>50 years	Male	Female
Neurologically better Radiologically deteriorated	14	4	10	10	4
Neurologically deteriorated Radiologically deteriorated	7	1	6	6	1
Neurologically better Radiologically unchanged	17	4	13	11	6
Neurologically unchanged	8	5	3	5	3

Radiologically deteriorated					
Neurologically unchanged Radiologically unchanged	4	0	4	4	0
Neurologically deteriorated Radiologically unchanged	1	0	1	1	0
Total	51	14	37	37	14

There were 29(56.86%) patients who deteriorated radiologically (p- 0.32). Out of these 29, 21 were male and 8 were females (p- 0.94). 17 patients showed no radiological deterioration. Out of the 29 patients with radiological deterioration, 10 patients were 50 years or younger and 19 patients were older than 50 years (p- 0.19). Out of these 29 patients 7 patients deteriorated clinically (symptomatic) (p- 0.005). Out of which 6 were males (p=0.36). 6 patients were more than 60 years of age (p-0.33)

Out of these 29 patients 13 showed changes at both ends, above and below the index segment. 7 patients had changes at the level below the segment already fused. 2 patients had changes level above the fused segment. 24 patients had changes in disc height, with or without the changes in canal diameter. Evident in the figure 2.

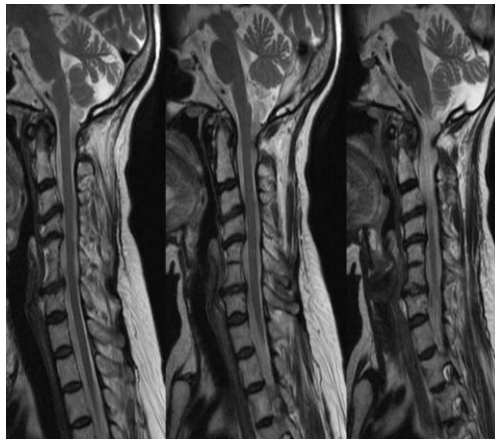


Figure 2. Anterior cervical discectomy and fusion (ACDF)of C5 and C6 vertebrae Follow-up postoperative MRI scans shows adequately calcification of the graft with adjacent segment disc bulges C6C7. Out of these 29 patients with adjacent segment changes, 5 (9.8%) required re- surgery. Rests were managed conservatively. (p=0.04) Out of 51 patients, 23 had other co- morbidities. Out of these 23, 13 had changes at the adjacent segment and 10 did not have. Out of 28



patients with no co- morbidities, 18 patients had adjacent segment changes. (p- 0.96) as shown in table no 3.

Table 3  
Showing total no of the patients with and without co-morbidities in ASD and non ASD groups

	With co- morbidities	With no co- morbidities	Total	P value
ASD	13	16	29	P= 0.96
No ASD	10	12	22	
Total	23	28	51	

### Myelopathy

Out of 51 patients, 28 (54.9%) patients had hyperintensity on T2W images (p- 0.3). Out of these 28 patients 9 (32.14%) patients improved radiologically after surgery (p- 0.06) Out of these 28 patients 18 showed clinical improvement (p- 0.13) and 4 showed clinical deterioration. 6 patients were clinically as well as radiologically unchanged as shown in table no 4.

Table 4  
Showing status of the patients with clinical as well as radiologically changes postoperatively

Radiologically improved Clinically deteriorated	1
Radiologically unchanged Clinically deteriorated	3
Radiologically unchanged Clinically improved	10
Improved clinically as well as radiologically	8
Radiologically and clinically unchanged	6
Total	28

Out of these 28 patients with cord changes, 23 were male and 5 patients were female. 9 patients improved radiologically (p- 0.06) and 18 patients improved clinically (p-0.13). 3 males and 5 females improved after surgery, clinically as well as radiologically (p- 0.0007). 10 patients were radiologically unchanged but showed improvement neurologically (p- 0.63). 3 patients were radiologically unchanged and deteriorated neurologically. 6 patients remained unchanged, clinically as well as radiologically (Table no 5).

Radiological improvement (Difference between males & females) p= 0.002

Neurological improvement (Difference between males & females) p= 0.06

Table 5

Compares the radiological better and unchanged and neurological status of the patients with hyperintensities with references to sex

	Male	Female
Radiologically better Neurologically better	3	5
Radiologically better Neurologically deteriorated	1	0
Radiologically unchanged Neurologically better	10	0
Radiologically unchanged Neurologically deteriorated	3	0
Radiologically unchanged Neurologically unchanged	6	0
Total	23	5

Table 6

Compares the radiological better and unchanged and neurological status of the patients without hyperintensities with references to sex

	Male	Female
Radiologically better Neurologically better	59.67	65
Radiologically better Neurologically deteriorated	69	-
Radiologically unchanged Neurologically better	63	-
Radiologically unchanged Neurologically deteriorated	57.67	-
Radiologically and neurologically unchanged	59.67	-

## Discussion

Hilibrand et al, found that the symptomatic adjacent segment disease occurred at a relatively constant incidence of 2.9 % per year during the 10 years after the operation<sup>1</sup>. There were highly significant differences among the motion segments with regard to the likelihood of symptomatic adjacent segment disease, the greatest risk was at C5/6 and C6/7 interspaces. They found that the risk of new disease at an adjacent level was significantly lower following multilevel arthrodesis. The commonly observed MRI findings in patients with adjacent

disease are- Intervertebral disc herniations, changes in the disc height, formation of osteophytes, mal- alignment, hypertrophy of the ligaments and ossification of the PLL. The rate of radiologically significant adjacent segment degeneration was much greater than the rate of symptomatic adjacent segment disease <sup>2,3,4</sup>. The rate of radiological ASD range from 17 to 92 %<sup>2,5,6</sup> The rate of symptomatic ASD ranges from <1 to 25% <sup>1,7</sup>

In the present study, we found the incidence of radiological adjacent segment degeneration was 56.86%. The rate of symptomatic ASD was 13.7%, which was statistically significant (p- 0.005). This study also shows that not all radiological adjacent segment changes are symptomatic. Previous studies have shown that the rate of re- surgery for the symptomatic ASD ranging from 5.1 to 37% <sup>8,9</sup>

In the present study the rate of re- surgery for the symptomatic ASD was 9.8%, which is statistically significant (p-0.04). This is slightly more than the expected value. We too have observed that the occurrences of changes at the adjacent levels after spinal fusion are of significance. The rate of symptomatic ASD was statistically significant and the rate of re- surgery was also significant.

Previous studies have shown that the best treatment for the adjacent segment disease is arthroplasty, and the procedure is gaining acceptance among neurosurgeons. The exact etiology of adjacent segment disease is not known. Pre operative myelopathy and disc protrusion at the adjacent level have been found to be the risk factors for the subsequent adjacent segment disease <sup>10,11</sup>. It has also been reported that the incidence of ASD increases with the duration from the primary surgery<sup>12</sup>. Pierce D Nunley et al found that the incidence of adjacent segment degeneration was higher in females (probably because of osteopenia) and concluded that osteopenia and lumbar degenerative disc disease at the time of cervical surgery were the risk factors for the development of adjacent segment degeneration<sup>13</sup>. However Jaewan Soh et al, in their study found that the 7 males and 14 females developed adjacent segment degeneration following cervical fusion. This was not statistically significant<sup>14</sup>. They found that incidence of adjacent segment degeneration was not statistically significant between patients below 50 years and above 50 years of age. There was no significance of concurrent lumbar disc disease in the development of adjacent segment degeneration. Jan Goffin et al also found no relation between the age of the patient and development of adjacent segment disease<sup>5</sup>. In a study done by Hirokazu et al, out of total 19 patients that developed adjacent segment disease, 12 were males and 7 were females, this difference was not significant<sup>11</sup>. They studied various factors and found no relationship between age at surgery, sex of the patient or number of levels fused with the development of adjacent segment disease. It is concluded by many authors that development of ASD is independent of patient's age, sex, co- morbidities and nature of surgery<sup>13</sup>. The present study shows no statistical significant relationship between patient's age, sex or co- morbidities and development of adjacent segment changes. As the incidence of adjacent segment disease increases with time, long term follow up of patients is suggested to further delineate the influencing factors. Yasutaka et al, has reported that the pre- op hyperintensity on T2W images in patients with myelopathy has poor outcome as compared to those with no signal changes. Patients who had improvement in the signal changes showed better recovery than

those with no improvement in signal changes<sup>15,16</sup> Jan Goffin et al also found correlation between radiological and clinical changes<sup>3</sup>. Many previous studies reported that low T1W intensity and high T2W intensity has worse prognosis<sup>17,18,19</sup> The high intensity on T2W images is attributed to myelomalacia or chord gliosis secondary to long standing compression on the cord<sup>20</sup> Yasutaka Matsuda et al in their study found that 12 patients had pre operative hyperintensities on T2W images, out of which 5 had radiological improvement (decreased intensities). They also showed clinical improvement in these patients and concluded that post operative improvement in the signal changes on MRI leads to clinical improvement<sup>15</sup>.

In the present study, 54.9% patients had hyperintensities on T2W images. Of these 32.14% patients improved radiologically after surgery and 64.28% showed clinical improvement. Out of the clinically improved patients 35.17% were radiologically unchanged. Females showed statistically better radiological outcome, though clinical outcome was same in both males and females. Further studies are suggested to validate this finding. This study shows that clinical improvement may not always be associated with radiological improvement. The study also shows that patients with radiological improvement will show clinical recovery.

### **Summary and Conclusions**

This study was conducted at Indraprastha Apollo Hospital, New Delhi. Fifty one patients were followed up for minimum of 2 years (average 72.82 months) after cervical spine instrumentation. 23 patients had single or multiple co- morbidities. 29 (56.86%) patients developed adjacent segment degeneration following the primary surgery. And the rate of symptomatic ASD was (7 out of 29) 13.7%, which was statistically significant. Rate of re- surgery for the symptomatic ASD was 9.8% (5 out of 29), which was statistically significant. Development of radiological or clinical ASD is not related statistically to the patient's age, sex or co- morbidities. 54.9%.

28 out of 51 patients had hyperintensities on T2W images, which was not statistically significant. Out of which 32.14% (9) patients improved radiologically after surgery and 64.28% (18) showed clinical improvement. All the patients with radiological improvement had clinical improvement also. Out of the clinically improved patients, 35.17% (10) patients were radiologically unchanged, which was statistically not significant.

### **In conclusion**

1. Rate of adjacent segment degeneration is 56.86% and the rate of adjacent segment disease is 13.7%. Significant number of patients with adjacent segment disease required re- surgery (9.8%).
2. Twenty eight patients (54.9%) had hyperintensity of cord on pre operative MRI scan, out of which 9 patients improved radiologically who improved clinically also.

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