Indian Journal of Orthopaedics Surgery 2022;8(1):32–38

Content available at: https://www.ipinnovative.com/open-access-journals

Indian Journal of Orthopaedics Surgery

Journal homepage: https://www.ijos.co.in/

Original Research Article

Overview of operative modalities and their functional outcomes for adult degenerative scoliosis: How to chose wisely!

Ketan S Khurjekar[1], Himanshu G Kulkarni[1,*], Siddarth Kothari[1], Shailesh R Hadgaonkar[1], Ajay R Kothari[1], Parag K Sancheti[1]

[1] *Dept. of Spine Surgery, Sancheti Institute of Orthopaedics and Rehabilitation, Pune, Maharashtra, India*

ARTICLE INFO

Article history:
Received 5-02-2022
Accepted 10-02-2022
Available online 24-03-2022

Keywords:
ADS
DeNovo Scoliosis
Degenerative scoliosis

ABSTRACT

Background: Adult degenerative scoliosis presents with various symptoms, including back pain, leg pain, claudication, and radiological findings like coronal / sagittal imbalance. So In our study, we have put forth an algorithm to categorise the patients for suitable operative management.
Materials and Methods: This was prospective study of 30 patients. Patients with age 50 and above and ones who had no relief/worsening of symptoms after 6 months of conservative management were included. Patients were categorised into 3 groups. Patients were either treated with Focal Decompression / Decompression and long instrumented fusion with correction of deformity /Decompression only. MODI and SF36 scores were compared at the end of 2 years.
Results: 11 patients were categorised into group A, 15 into group B and, 4 patients who had significant co-morbidities and had very high risk for surgery were categorised into group 3. There was significant ($p < .001$) improvement in average MODI scores in both group A and group B at the end of 2 years. Improvement was seen in average MODI scores of patients in group 3, but it was not statistically significant. SF-36 score showed significant improvement in Group A and group B at the end of 2 years ($p < .001$). Patients from group 3 also showed improvement in average scores, but that was not significant.
Conclusion: Not every case needs long stabilization, focal decompression only also gives satisfactory outcome in properly selected patients. In patients operated by Instrumented fusion, Sagittal balance also plays a crucial role in functional outcome.

1. Introduction

Adult degenerative (de novo) scoliosis occurs due to degenerative changes in the spine of the aging population who have no pre-existing spinal deformity. It is defined as spinal deformity with a scoliotic angle of over 10 degrees in skeletally mature patients. The aetiology is postulated to be the asymmetric disk space collapse and facet degeneration with subsequent lateral and/ or rotatory listhesis. [1] Another theory for development of Adult degenerative scoliosis (ADS) is that osteoporosis after menopause leads to it, as it is most prevalent in females over the age of fifty. [2] These changes are typically seen in the lumbar spine usually in and after the 6^{th} decade. In recent times, it has been effectively shown that it's not only the coronal imbalance, but the sagittal imbalance plays an important role too in the symptomatology. [3] It presents with various symptoms, including back pain, leg pain, claudication, and radiological findings like coronal and sagittal imbalance. The heterogeneous conditions and wide plethora of pathologies makes the management of the patient tricky. Conservative management often becomes insufficient over the time as the symptoms of stenosis

* *Corresponding author*.
E-mail address: hgkulkarni@gmail.com (H. G. Kulkarni).

https://doi.org/10.18231/j.ijos.2022.006

progress over the time and the back pain worsens with the progression of the curve due to muscle fatigue on the convexity of curve. When the conservative management fails, it is always a difficult decision to make for the surgeon regarding the type of operative modality to opt for. Patients of the age group where ADS develops often have various co-morbidities and an extensive deformity correction surgery for every patient can be very risky.[3] So in our study, we have put forth an algorithm to categorise the patients for suitable operative management according to their clinical and radiological features and have overviewed the functional outcomes of the operative modalities in the specifically selected patients. We believe such study will attempt to make some valuable contributions to the understanding of decision making for operative management of ADS.

2. Materials and Methods

This was a prospective study of 30 patients who were diagnosed and treated operatively for the adult degenerative scoliosis at Department of Spine Surgery, Sancheti Institute for Orthopaedics and Rehabilitation, Pune, India between January 2015 to December 2017. This is one of the largest tertiary orthopaedic speciality referral institute in India.

Each patient's symptoms, medical history & findings were noted, physical examination was performed in out/in-patient department. Patients with age 50 and above and ones who had no relief/worsening of symptoms after at least 6 months of conservative management were included in the study. Patients with history of previous spine surgery, ones with congenital vertebral anomalies, ones with pre-existing scoliosis deformity and the ones with spinal infections and neoplasms were excluded from the study. Medical Co-morbidities of all patients were noted. All patients underwent MRI of the lumbar spine with whole spine screening, and a whole spine scanogram. The curves were then classified according to SRS-Schwab classification.[4]

For the classification, the end vertebrae of the curve were determined and Cobb's angle of the curve was measured. A plumb line was drawn from centre of C7 body to determine the sagittal balance. Pelvic index and the Pelvic tilt were also calculated on lateral radiograms. Evaluation of patient was done according to Modified Oswestry Disability Index (MODI) and SF 36 scores.

According to the symptoms, co-morbidities and the radiological findings, an algorithm was designed and patients were categorised into 3 groups and their treatment modalities were decided accordingly.

Post-operative rehabilitation was started immediately post operatively. Patients were reassessed with Modified Oswestry Disability Index (MODI) and SF 36 scores at 3 months, 6 months, 1 year and at 2 year. MODI and SF36 scores at the end of 2 years were compared with pre-operative scores for all three groups.

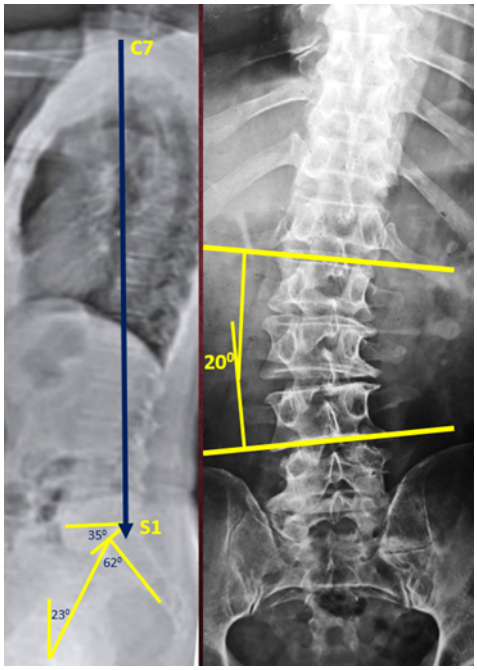


Fig. 1: Case 8: Group A: Pre-operative X-rays showing Cobb's angle of 20°, maintained sagittal balance and 23° pelvic tilt.)

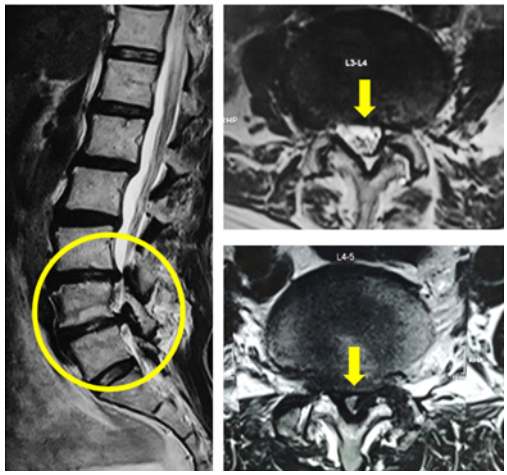


Fig. 2: Case 8: Group A: MRI showing Lumbar Canal stenosis at L3-4 and L4-5)

3. Results

During the duration of the study, 30 patients underwent operative management of adult degenerative scoliosis. Out of these, 12 patients were males and 18 were females. (Table 3)

Age of presentation ranged from 57 to 79 years, with a mean age of 65.8 years +/- 5.09 years. 12 patients (40%) were in the age group of 61-65 years, being the maximum number of patients in a specific age group.

Table 1: SRS schwab classification of adult degenerative scoliosis

	Coronal Curve Type		
T - Thoracic only, Lumbar Curve <30^0	L - TL/Lumbar Only, Thoracic curve<30°	D - Double curve, D- T and TL/L curve >30°	N - No major Coronal Deformity, All Coronal curves <30°
	Sagittal modifier		
0 : within 10^0	+ : Moderate 10°-20°	++ : marked >20°	
	Global alignment		
0 : SVA <4 cm	+ : SVA 4 to 9.5 cm	++ : SVA >9.5cm	
	PEVIC TILT		
0 : PT< 20°	+ : PT 20-30°	++ : PT > 30°	

Table 2: Algorithm to determine the type of operative management for patients with specific clinical and radiological findings

Groups	Symptoms and radiological parameters	Type of operative management
Group A	1. Small curves (<30^o) (SRS-Schwab type N) 2. No lateral subluxation 3. Predominant radicular symptoms 4. No sagittal imbalance 5. No Stenosis at the apex	Focal Decompression
Group B	1. Large curves (>30°) (SRS-Schwab type L & D)e 2. Lateral subluxation of apical vertebra 3. Predominant back symptoms with radicular symptoms 4. Loss of sagittal balance	Decompression and long instrumented fusion with correction of deformity
Group C	1. Significant medical comorbiditiese 2. ASA grade 4 or 5 3. Irrespective of curve type/ sagittal balance	Decompression only

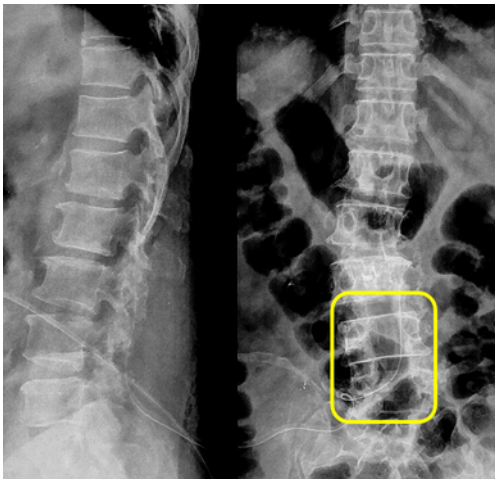


Fig. 3: Case 8: Group A: Post-operative X-ray showing decompression of L4-5 with undercutting of L3-4

Out of 30, Type L was the most commonly encountered curve type, with 17 patients having Lumber curve >30°. Type T curve was not encountered in any of the patients. (Table 4)

Table 3: Sex distribution

Sex	Number	Percentage
Male	12	40%
Female	18	60%
Total	30	100%

Table 4: Distribution of curves according to SRS schwab classification

Curve tupe	Number	Percentage
Type T	0	0%
Type L	17	57%
Type D	1	3%
Type N	12	40%

All patients were categorised into 3 groups according to the selection algorithm. According to their symptoms and radiological features, 11 patients were categorised into group A and were treated with focal decompression only. 15 patients were categorised into group B and were treated with Decompression, and long fusion with correction of deformity. 4 patients who had significant co-morbidities and had very high risk for surgery were categorised into group

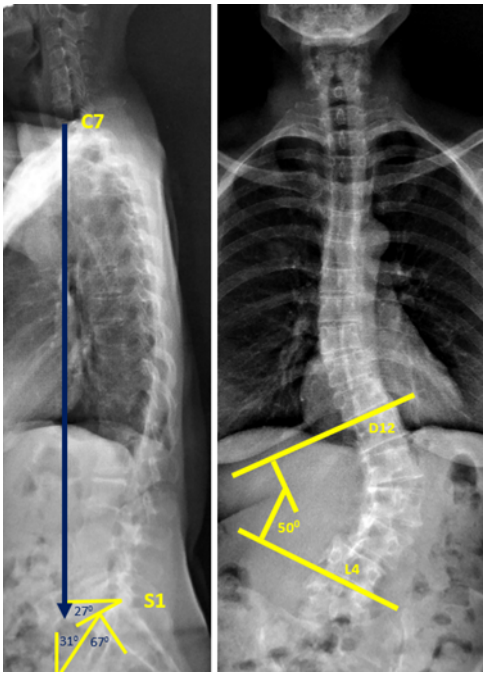


Fig. 4: Case 3: Group B: Pre-operative x-rays showing Cobb's angle of 50°, positive sagittal balance and 31° pelvic tilt

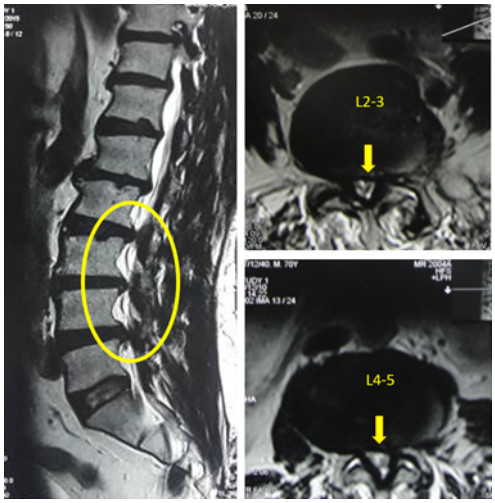


Fig. 5: Case 3: Group B: MRI showing lumbar canal stenosis at L2-3. L3-4, L4-5 with L4-5 facetal arthropathy

3 and were treated with only decompression only to reduce the surgical time. (Table 5)

Table 5: Categorization of patients into 3 types of treatment modalities according to the algorithm

Groups	Number	Percentage
Group A	11	36%
Group B	15	50%
Group C	4	14%

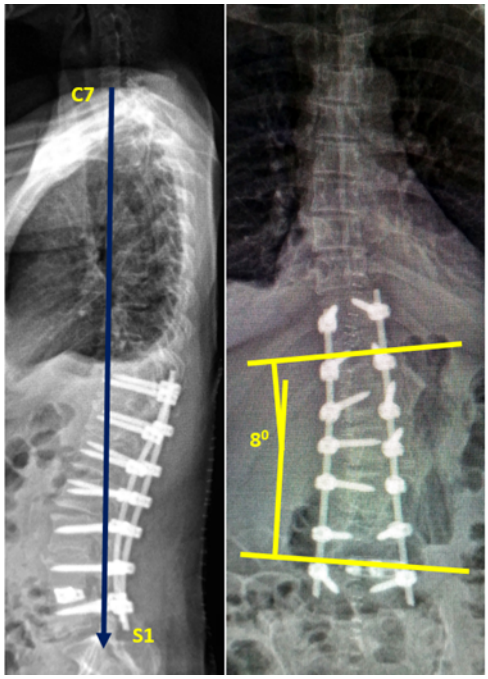


Fig. 6: Case 3: Group B: Post operative X-ray showing L3-L5 decompression, Posterior instrumented stabilization from D11 to L5, correction of deformity and sagittal imbalance with L4-5 fusion

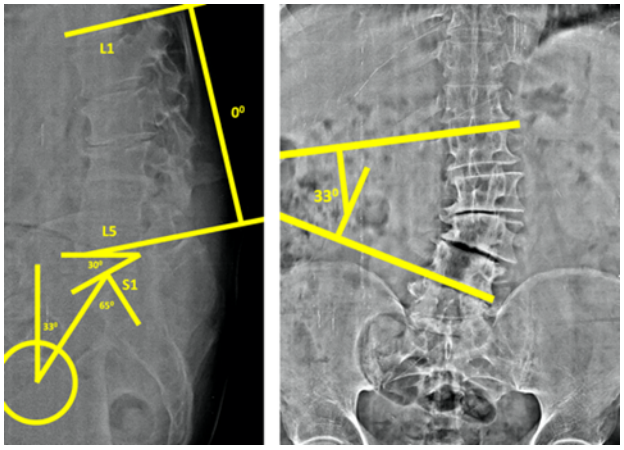


Fig. 7: Case 5: Group B: Pre-operative x-rays of previously decompressed L3-4, L4-5, L5-S1 showing Cobb's angle of 33°, reversal of Lumbar Lordosis to 0° and 33° pelvic tilt

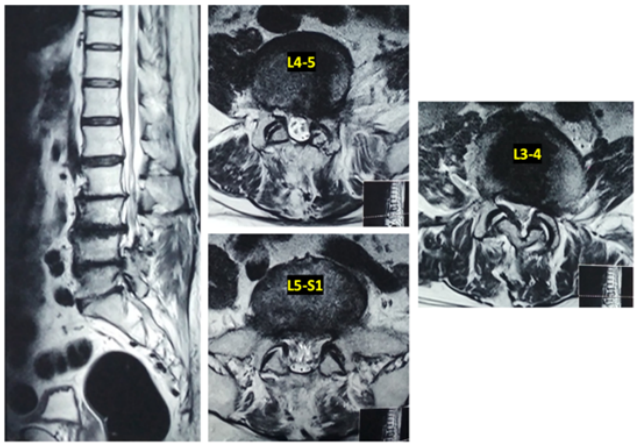


Fig. 8: Case 5: Group B: MRI showing recurrent Lateral recesses stenosis at L3-4, L4-5, L5-D1 with Instability at L3-4, L4-5, L5-S1

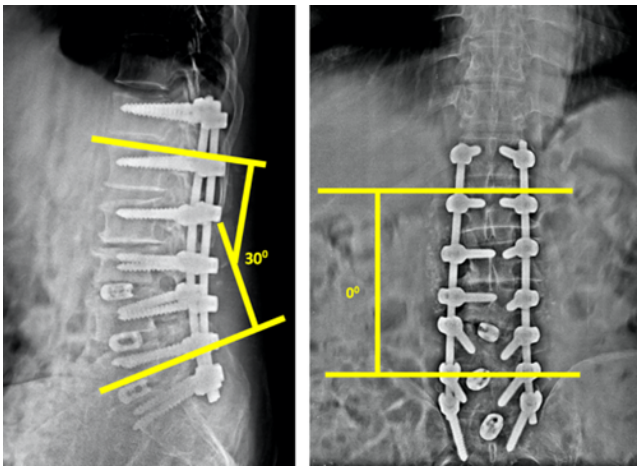
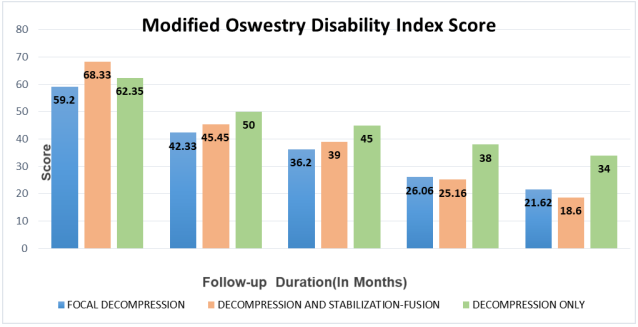


Fig. 9: Case 5: Group B: Post operative X-ray showing L3-S1 revision decompression, posterior instrumented stabilization from D12 to S1, correction of deformity with L3-4, L4-5, L5-S1 fusion

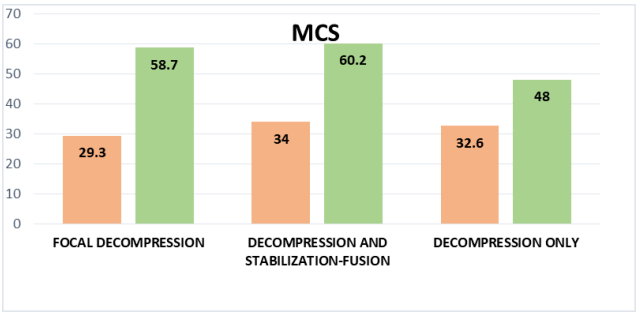
The functional outcomes of the patients in different group were assessed with Modified Oswestry Disability Index (MODI) and SF 36 scores. The pre-operative scores were compared to scores measured at the end of 2 years.

There was statistically significant (p <.001) improvement in average MODI scores in both group A and group B at the end of 2 years. Average pre-operative score of 59.2 reduced to 21.62 in group A at the end of 2 year whereas group B improved from 68.3 to 18.6. Improvement was seen in average MODI scores of patients in group 3 too, but it was not statistically significant. (Graph 1)

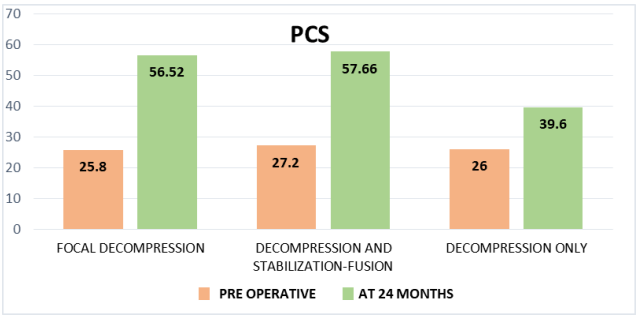
Both Components of SF-36 score showed statistically significant improvement in Group A and group B at the end of 2 year (p <.001). Patients from group 3 also showed improvement in average MCS and PCS scores, but that was not significant statistically. (Graphs 2 and 3)



Graph 1: Periodic evaluation of average MODI scores of patients in all 3 groups



Graph 2: Periodic evaluation of average MCS components of SF-36 score of patients in all 3 groups

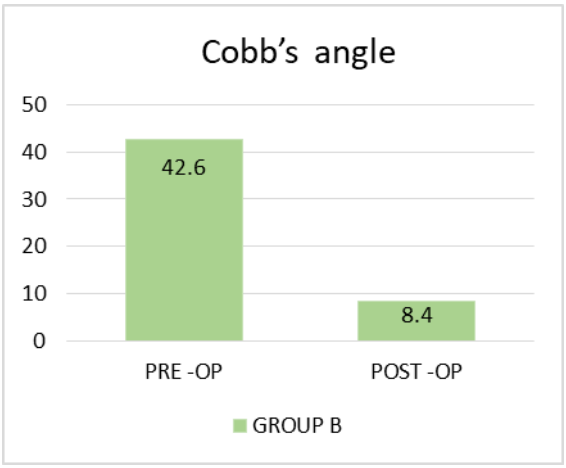


Graph 3: Periodic evaluation of average PCS components of SF-36 score of patients in all 3 groups

There was drastic correction in the Cobb's angle in group B. Average pre-operative Cobb's angle in patients in group B was 42.6° which was corrected to 8.4° post operatively. (Graph 4)

4. Discussion

De Novo scoliosis is a jamboree if complex spinal pathologies. The primary goal of surgery is to relieve back pain, improve radiating pain and claudication and to the correct deformity.[5,6] Both surgical options may be carried out to achieve these goals, including decompression only or decompression, correction of deformity & fusion,



Graph 4: Assessment of pre and post-operative Cobb's angle in group B

which varies with every patient. If patient selection is done carefully according to the algorithm, focal decompression can give excellent results. Kyu-Jung Cho et al stated that focal decompression gives good outcome in carefully selected patients.[7] In our study too, patients who had small curves (<30°), had no lateral subluxation or stenosis at the apical vertebra, had no sagittal imbalance and had predominantly radicular symptoms were treated with focal decompression. In a large study of patients with symptomatic lumbar canal stenosis and degenerative scoliosis, it was seen that in those with scoliotic curves measuring <20 degrees who underwent decompression alone, needed no revision surgery and had excellent symptomatic relief after 4 years of follow-up.[8] Vaccaro et al suggested 3 important intraoperative precautions, not damaging the facet joints, not decompressing at the apex and not decompressing the whole curve.[9] We strictly adhered to all these surgical principles which were paramount in not aggregating the rapid progression of the curve. 11 patients who were operated with focal decompression showed statistically significant improvement of both MODI and SF 36 scores.

Scoliosis being a three-dimensional deformity, coronal and sagittal imbalance often exist together in ADS. It is important to correct these for good functional outcome. Schwab et al and Glassman et al stressed that even more than coronal imbalance, correction of sagittal imbalance is more important to give satisfactory long-term outcomes.[10,11] In our study too, sagittal balance was categorically corrected during instrumentation and fusion. No case with sagittal imbalance was treated with decompression alone except the ones on high risk group (3 patients). According to the algorithm, ones with loss of sagittal balance, ones who had Predominant back symptoms with radicular symptoms with Large curves (>30°) and with Lateral subluxation of apical vertebra were treated with Decompression and long instrumented fusion with correction of deformity. Patients in whom instrumented fusion was done with good correction of sagittal imbalance, had excellent betterment at the end of 2 years in both MODI and SF 36 scores. Transfeldt EE et al compared decompression alone with full curve correction in patients with larger curves.[11] They found that Patient satisfaction was highest in the full curve correction group and lowest in those receiving decompression only. This goes to support our algorithm for selection proper patient for specific treatment modality.Birknes et al stated that not only the stenosis, but the narrowing for the foramens of concave side of the deformity also leads to compression of roots and radicular symptoms.[1] Correction of deformity and indirect decompression of the foramens during the instrumented fusion could also be a confounding factor in good functional outcome in group B. Coronal deformity in form of Cobb's angle was also was corrected significantly in group B. Average Cobb's angle was 42.6° pre-operatively which was corrected to 8.4° post operatively. Aebi M and Gupta MC put forth following operative considerations for good surgical outcome.[2,12]

1. The lateral subluxation should be included in the fusion.
2. Instrumentation should never be stopped at the apex of the curve.
3. The upper instrumented vertebra should better be horizontal than tilted.
4. The spondylolisthesis and retrolisthesis if any, should be included in the fusion.

We strictly adhered to all these surgical principles for all cases of instrumented fusion for optimal surgical and functional outcome. The level of uppermost instrumented vertebra has also been a debate in past. It is said that D10 is more stable than D11 and D12 due to true rib attachment on D10 and it reduces chances of adjacent segment degeneration.[13] Cho et al. reported that since it's a degenerative process, even stabilizing D10 won't completely stop adjacent segment degeneration. So, fusion till D11 or D12 is acceptable as long as the upper instrumented vertebra is above the upper end vertebra.[14] We followed similar principle and stabilised in all cases till D11/D12 depending upon the upper end vertebra.

In the age group where ADS establishes, co-morbidities also play a significant role in decision making of a surgeon. Decompression, correction of sagittal and coronal balance with instrumented stabilization of 6-7 vertebral levels can be a lengthy procedure with large volume of blood loss.[15] This can prove to be fatal in patients with significant co-morbidities and with higher risk for anesthesia. Kyu-Jung Cho et al suggested that quick focal decompression can be considered in these patients, irrespective of the type of the deformity.[7] We too opted for similar approach in patients who were disabled enough so that surgery was warranted,

but not fit to undergo a lengthy procedure like deformity correction and fusion. 3 of the 4 patients in group C had larger curves (> 30°) with loss of sagittal balance. None of that was corrected, so even though the functional outcome was better at the end of 2 years, it was not statistically significant and they didn't fare as well compared to group A and B. Unfortunately 2 years is a short period of follow up to assess whether the patient will require a revision surgery in the foreseeable future.

5. Conclusion

Adult degenerative Scoliosis is a jamboree if complex spinal pathologies. Strict adherence to indications and contraindications and careful selection of patients according to the algorithm for suited type of operative management gives excellent results in ADS. Not every case needs long stabilization and fusion, focal decompression only also gives satisfactory outcome in properly selected patients and properly followed operative principles. In patients operated by Instrumented fusion, Correction of Sagittal balance also plays a crucial role in satisfactory functional outcome. Cobb's angle is best corrected by stabilization and fusion.

6. Source of Funding

None.

7. Conflict of Interest

None.

References

1. Birknes JK, White AP, Albert TJ, Shaffrey CI, Harrop JS. Adult degenerative scoliosis: a review. *Neurosurgery*. 2008;63(3 Suppl):94–103.
2. Aebi M. The adult scoliosis. *Eur Spine J*. 2005;14(10):925–48.
3. Graham RB, Sugrue PA, Koski TR. Adult Degenerative Scoliosis. *Clin Spine Surg*. 2016;29(3):95–107.
4. Schwab F, Ungar B, Blondel B. Scoliosis Research Society-Schwab adult spinal deformity classification: a validation study. *Spine*. 1976;37:1077–82.
5. Bradford DS, Tay BK, Hu SS. Adult scoliosis: surgical indications, operative management, complications, and outcomes. *Spine*. 1999;24(24):2617–29.
6. Marchesi DG, Aebi M. Pedicle fixation devices in the treatment of adult lumbar scoliosis. *Spine (Phila Pa 1976)*. 1976;17(8 Suppl):304–9.
7. Cho KJ, Kim YT, Shin SH, Suk SI. Surgical treatment of adult degenerative scoliosis. *Asian Spine J*. 2014;8(3):371–81.
8. Hansraj KK, Cammisa FP, O'leary PF, Crockett HC, Fras CI, Cohen MS, et al. Decompressive surgery for typical lumbar spinal stenosis. *Clin Orthop Relat Res*. 2001;384:10–7.
9. Vaccaro AR, Ball ST. Indications for instrumentation in degenerative lumbar spinal disorders. *Orthopedics*. 2000;23(3):260–71.
10. Glassman SD, Berven S, Bridwell K, Horton W, Dimar JR. Correlation of radiographic parameters and clinical symptoms in adult scoliosis. *Spine (Phila Pa 1976)*. 1976;30(6):682–8.
11. Transfeldt EE, Topp R, Mehbod AA, Winter RB. Surgical outcomes of decompression, decompression with limited fusion,and decompression with full curve fusion for degenerative scoliosiswith radiculopathy. *Spine (Phila Pa 1976)*. 2010;35(20):1872–5.
12. Gupta MC. Degenerative scoliosis. Options for surgical management. *Orthop Clin North Am*. 2003;34(2):269–79.
13. Shufflebarger H, Suk SI, Mardjetko S. Debate: determining the upper instrumented vertebra in the management of adult degenerative scoliosis: stopping at T10 versus L1. *Spine (Phila Pa 1976)*. 2006;31(19 Suppl):185–94.
14. Cho KJ, Suk SI, Park SR, Kim JH, Jung JH. Selection of proximal fusion level for adult degenerative lumbar scoliosis. *Eur Spine J*. 2013;22(2):394–401.
15. Silva FE, Lenke LG. Adult degenerative scoliosis: evaluation and management. *Neurosurg Focus*. 2010;28(3):E1.

Author biography

Ketan S Khurjekar, Chief Spine Surgeon

Himanshu G Kulkarni, Fellow, Spine Surgeon

Siddarth Kothari, Resident, Orthopaedics

Shailesh R Hadgaonkar, Spine Surgeon

Ajay R Kothari, Spine Surgeon

Parag K Sancheti, Director

Cite this article: Khurjekar KS, Kulkarni HG, Kothari S, Hadgaonkar SR, Kothari AR, Sancheti PK. Overview of operative modalities and their functional outcomes for adult degenerative scoliosis: How to chose wisely!. *Indian J Orthop Surg* 2022;8(1):32-38.