Adult Scoliosis: Surgical Outcomes

Abstract

Background: Adult scoliosis is a common spine deformity. It is very debilitating to daily activities of the patients. Surgical management requires a clear assessment of the functional impact of scoliosis, the failure of conservative treatments and precise analysis of radiological investigations (full spine views, dynamic X-rays and MRI). The back pain was the main complaint as it was the main presentation. The aim of the work is to assess the outcomes of surgical procedures in patients with adult scoliosis.

Methods: This prospective study was conducted on 30 patients with adult scoliosis with cobb angel more than 10 degrees. Surgical techniques (anterior and posterior approaches, decompression, osteotomies, fusion, and instrumentation) done and tailored to each patient. Decompression alone found usually not enough, fusion needed almost in all cases.

Results: Patient disability using Oswestry disability index assessed before and after intervention. Also a good, accepted change achieved as 15 patients restore about 75% of their abilities ,7 patients restore more than 50% of their usual ability,3 patients restore about 25% of their usual ability. Cobb's angel before intervention was 6 cases > 60 degrees,14 cases between 50 and 60 degrees and 10 cases between 40 and 50 degrees became 14 cases between 10 and 0 degrees, and 10 cases between 10 and 20 degrees. Surgical treatment of adult scoliosis is associated with a better quality of life for patients when good selection of the patient and maneuvers done. Visual analogue scale before and postoperative, and three and six months later detect ,a good result achieved, As VAS before intervention was ; 20 patients from 9 to 10,9 patients from 6 to 8, one patient from 3 to 5. VAS post-operative after sex months became only four patients from 6 to 8, twenty four patients from 3 to 5and only two patients from 0 to 2.

Conclusions: Surgical management of adult scoliosis become more applicable, Spine managed as one unit, Correction of coronal and sagittal malalignment done together, Do not neglect one of them. Using both free hand , c arm and even navigator when needed help in good outcomes and complications avoidance, management strategy differ according many factors, The technique requires proper selection of cases before surgery and meticulous attention during surgery to identify the correct starting point, screw orientation and screw length selection. Surgical outcomes of adult scoliosis clinical, radiological and neurological outcome were satisfied without major complications.

Keywords: Adult Scoliosis, Cobb’s angel, spine deformity

Introduction:

Scoliosis in adults is a lateral curvature of the spine in the frontal plane of the body, which implies that the vertebral column bends to one side.It is not only a lateral deformity; it is a three-dimensional deformity affecting all three planes and is defined as a spinal deformity in a skeletally mature patient with a Cobb angle greater than 10° in the coronal plain.Cobb angle is a technique for determining the degree of scoliosis. To begin, we must determine which vertebrae are the end vertebrae of the curve deformity (the terminal vertebrae) - the vertebra with the most angled endplates. Following that, lines are drawn along the endplates, and the angle formed by the intersection of the two lines is measured. When the curvature is not indicated, the lines will not cross on the film/monitor, allowing for the plotting of two more lines, each at right angles to the preceding lines.

Adult scoliosis is classified into four main categories: Type 1: Primary degenerative scoliosis, caused primarily by disc and/or facet joint arthritis, affecting those structures asymmetrically and characterised by predominantly back pain symptoms, which are frequently accompanied by or without signs of spinal stenosis (central as well as lateral stenosis). These curvature are often referred to as "de novo" scoliosis. Type 2: Adolescent idiopathic thoracic and/or lumbar spine scoliosis that develops into adulthood and is often associated with secondary degeneration and/or imbalance. Secondary adult curves of type 3: In the setting of an oblique pelvis, for example, as a result of leg length discrepancy or hip pathology, or as a secondary curve in idiopathic, neuromuscular, or congenital scoliosis, or asymmetrical abnormalities at the lumbosacral junction. Type 4: When a metabolic bone disease (most often osteoporosis) is present in conjunction with asymmetric arthritic disease and/or vertebral fractures. [1].

Clinical manifestations vary and Scoliosis is an abnormal side-to-side curvature of the spine in the form of a S or C. Adults may develop degenerative scoliosis or have no known aetiology (idiopathic). Adult Idiopathic Scoliosis is the most prevalent form of scoliosis. Adult idiopathic scoliosis occurs when idiopathic scoliosis starts in adolescence and progresses into adulthood with increased symptoms.

Scoliosis idiopathic is a condition that affects either the upper (thoracic) or lower (lumbar) spine. The discs and joints in the spine may deteriorate, resulting in spinal stenosis. Scoliosis may also develop in spinal joint arthritis, resulting in bone spurs.

Scoliosis is often degenerative beyond the age of 40, when the consequences of ageing and a weakening spine combine to produce scoliosis. Additional causes include facet joint arthritis and disc space collapse. Scoliosis degenerative is often associated with osteoporosis, particularly in women, as the alterations accumulate and the spine gradually sags into a curvature. [2].

Pain, neurogenic symptoms, and increasing aesthetic deformity are all indications for therapy. Non-operative treatment options include physical conditioning and exercise, pharmaceutical medications for pain management, orthotics, and invasive techniques such as epidural and facet injections.

Operative therapy should be considered only after a comprehensive and interdisciplinary assessment of the risks and benefits. [3] Decompression, instrumented stabilisation with posterior or anterior fusion, correction of deformity, or a combination of these are possible. Perioperative problems are common and must be addressed while determining the best surgical therapy. The main aim of surgical therapy is to alleviate pain and enhance the patient's quality of life. [4]

The purpose of this study is to evaluate surgical results in individuals with adult scoliosis.

Patients and Methods:

This hospital based prospective study was conducted on 30 patients with adult scoliosis with cobb angel more than 10 degrees. Patients were admitted and operated upon in the Department of Neurosurgery, in Tanta University Hospitals from April 2016 to April 2019. All patients' data were collected, diagnosis of patients and treatment plans outcomes occurred are confidentially kept secret and patients are secured by specific codes. All patients confirmed informed consent and were asked to share us in the study and the ethical committee requirements done.

The inclusion criteria: Patients with a Cobb angle of more than 10 degree in adult >18 years, Patients with progressive curve, patients with neurological deficit or disability, patients with intractable pain and patients refractory to medical treatment for 6 months. The exclusion criteria: Spinal infection, coagulopathy, Spinal malignancy, adolescent idiopathic scoliosis.

Clinical assessment: history, examination, investigation, patient history: Is important to identify type of scoliosis and choose mode of management.

Examination: patient's physical examination to detect the cause, the overall appearance is important, the skin patches as in skin neuron disorders and the neuromuscular power system before the evaluation of the backs of the patients A height measurement is indicator to monitor skeletal growth pattern and the incidence of scoliosis curve progression.

Neurological examination: A detailed neurological examination was done to evaluate balance (coronal and sagittal), for detection of abnormal reflexes and motor power testing in all muscles, and sensory level testing of the lower extremities, back and chest parameter. Rapid assessment of power and balance can be made by observing gait pattern, Weakness of the lower limbs may be caused by a spinal lesions or a central nervous system disease. Sensory changes may clear spinal syrinx causing the scoliosis. Upper and lower limbs deep tendon abnormal reflexes should be included, as the Babinski test done.

Investigations -Routine laboratory work up.

Neuro imaging: Plain x-ray: antero –posterior, lateral, cobb angle measured- Dynamic films detection instability, flexibility. MRI spine for good assessments of spine and detection of abnormalities

Preoperative Preparation: Preparation preoperative assessment was done to ensure that patient was optimized for the procedure. This typically includes evaluation chest condition ,coagulation profile, blood pressure management, diabetes mellitus control, risk stratifications smoking cessation, weight loss plan, etc. The surgeon and anesthesiologist teams oversees the entire perioperative work but relies heavily on these other specialists to minimize anticipated complications and optimize better outcomes.

Ensure Consent was taken from the patient preoperatively, radiographic studies were obtained and evaluate and revise the extension and level of decompression and or fixation measures of pedicles and better site for insertion needed

Other perioperative preparation: Antibiotics are started 2 hours before surgery and continued for 7 days after surgery. In the first 2 days they were given intra venous and then orally. Also, hemoglobin level is tested postoperatively and anemia is corrected if founded.

Operative Technique:

Anesthesia, patient positioning, and monitoring: After general anesthesia the patient was positioned in the prone position usually radiolucent operating room table. The patient is positioned on chest rolls with the knees slightly bent. Pressure points are padded carefully. Intraoperative fluoroscopy is used. The C-arm is brought into position for intraoperative fluoroscopy. The patient is prepared and draped with betadine, and the C-arm is used to obtain anterior posterior and lateral fluoroscopic images to confirm the location of instrumentation during the procedure

Operative procedure:

The incision is centered over the affected level and a linear midline skin incision. The muscles are dissected from the midline to lateral, subperiosteal dissection for less blood loss, and self-retaining retractors are used to expose bony landmarks well. The level of the exposure can usually be established and confirmed by using C. arm

The good lateral dissection of muscles must be done far laterally for good expose of bones to decorticate for good fusion incidence. The goals of surgery are to decompress stenotic canal to relive the neural elements compression, correct the adult scoliosis malalignment and restore normal alignment.

Selection of maneuver according to the plan decided from decompression when needed and level extension decided any part from performed a Thoracic vertebra number four to sacrum posterior spinal instrumentation and fusion usually needed with pedicle screw instrumentation, iliac fixation to avoid sacro ilac joint late complication and multilevel posterior column osteotomies needed for correction of deformity.Intraoperative CT navigation was used in some cases to place the pedicle screw instrumentation when it was difficult using C arm as some cases of dysplastic pedicles.

Figure 1: Figure from navigator intraoperative CT screen

Image from the intraoperative CT are used for good and accurate insertion of screws and to avoid the harm to nearby structures.

For mobilizing the apex of the curve osteotomies are done among the apex of the curve. Decompression, Compression of convex side, distraction of concave side and cantilever forces were done for better correction of the curvature and restoration of normal alignment, and titanium rods inserted are used to keep the improved new position. Local bone graft for fusion, allograft and bone from decompression and from osteotomies were used for the good fusion.

The operation time is estimated and hemoglobin level is assessed intraoperative and post-operative.

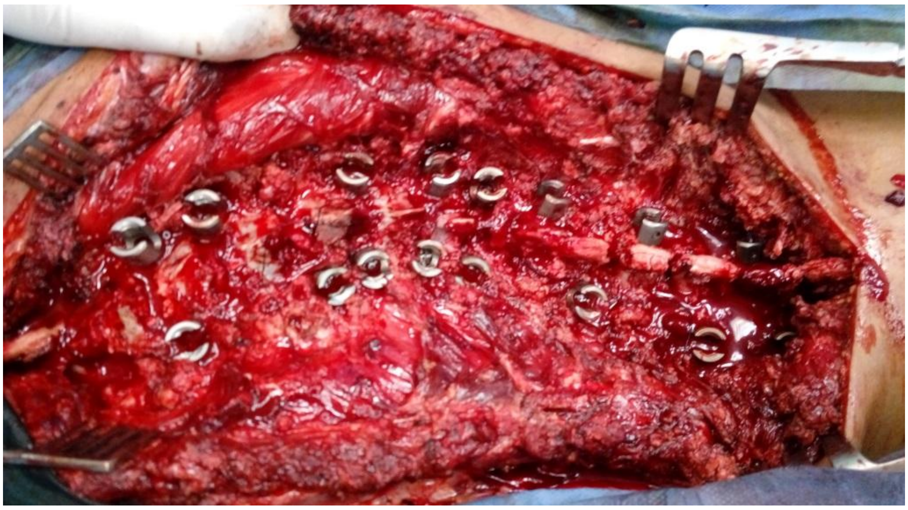

Figure 2: After screws insertion

Figure 3: Rod insertion

Principles of Deformity management: Curve stiffness diagnosed by bending x. ray films, The stiffness of a curve will influence surgical strategy because a stiff curve resists correction by: Posterior articular facetectomy ,Anterior release ,Costal facet releases, Rib osteotomy Anterior release ,Remove ALL/PLL ,Incise disc ,Remove disc, Structural Interbody graft or cage.

Osteotomies: osteotomy mean to Cut and Remove parts of Bone. Osteotomies are done in the anterior or posterior of the spine. In scoliosis curves management , an osteotomy is important method used for good correction of the spinal deviation. Adults degenerative scoliotic curves especially with rigid curves idiopathic with large curves large cobb's angel causing deformity, correction of flatback, and in reconstructions of normal spinal alignment restoration is needed after a definitive spinal fusion. Surgical methods as Thoracoplasty on other words Rib Resection for management of rib hump as Patients with idiopathic adult scoliosis usually have a rib hump. One of the aims of surgical scoliosis management intervention is to remove the rib hump. Thus, thoracoplasty is a surgical method that used to reduce rib hump degree. The procedure includes partially removing of ribs may reach as many as five ribs. This procedure is usually performed as part of the idiopathic scoliosis cases surgery, but it may be performed with the help of cardiothoracic surgeon at same time. Also a chest tube drain is inserted for a day or two after thoraco- plasty is done. Thoracoplasty need to be done decline nowadays due to improve derotation instruments tools. Principles of correction pioneered by Harrington the most important two are to, distract concave side and compress convex side.

Three different Techniques used for pedicle screw insertion: As the vertebrae images of fluoroscopy will not be very clear. In reality, we used three general techniques ,free hand ,fluoroscopy assistant and intraoperative CT navigator guided , they are currently used by operators for placement of accurate pediclular screws. Techniques can be classified as either free-hand (*i.e*., without the aid of any imaging) used before correction depending on normal anatomy and images of the patients or assisted with either fluoroscopy using intraoperative C.arm or intraoperative neuro-navigator guidance technology according to difficulty of every case.

Rod application: A rod will be prepared suitable length, curve and contour needed for the patient so that it will easily attached through the heads of all screws which are polyaxial. After insertion, it will be tightened to the heads of the screws using antitorck tools.

Follow up: All patients were evaluated clinically on regular periods ,First day, after three months and ,after six menthes. Clinically; pain was assessed with pain scale, visual analog scale, and the quality of life, which was assessed by using the Oswestry Disability Index.

Radiologically ; The Cobb's angel method

The explanation of visual analog scale used. It is horizontal line pain degree from 0 to 10 according patient feels on which, VAS= 0 means no pain a tall, VAS= 10 means that the patient's **pain** intensity is the maximum.

Oswestry Disability Index (ODI) is standard tool for spine surgery assessment of results, thus we used for pre-operative evaluation and post-operative evaluation of disability of adult scoliosis patients assessed in all cases. The frequency of analgesic medications used before and after intervention was compared. Return to usual work was evaluated as a percent of working capacity of the patient before (at the latest follow-up evaluation) of the pre morbid occupation as estimated by the patient (100%- 75%- 50%- 25%- 0%).

Radiological follow up: Approximately within 48 hours postoperative, anterior-posterior and lateral plain radiographs were done to detect the degree of correction and exclusion of any complications.

Statistical analysis:

Statistical analysis was done by SPSS v26 (IBM Inc., Chicago, IL, USA). Quantitative variables were presented as mean and standard deviation (SD). Qualitative variables were presented as frequency and percentage (%).

Results:

Age and sex incidence are shown in Table 1.

Table 1: Age and sex incidence

Age	**No. of patients**	**%**
18-30	10	33.3
> 30 ≤ 40	2	6.7
>40 ≤ 50	3	10
>50	15	50
Mean ±SD	43.52±8.35	
Sex	**No. of patients**	**%**
Male	10	33.3
Female	20	66.7

Regarding Type of scoliosis, idiopathic type was more common in young and degenerative type was more common in old cases. Table 2

Table 2: type of scoliosis, incidence of associated back instability, duration of symptoms prior to intervention, clinical presentation type and main presentation.

Consanguinity	**No. of patients**	**%**
Idiopathic	16	53
Degenerative	14	47
Incidence of associated back instability		
stable	16	53
unstable	14	47
Duration of symptoms prior to intervention		
< 12m.	5	16.7
12-18m.	7	23.3
>18m.	18	60
Mean ±SD	11.36±2.41	
Clinical presentation type		
Spinal canal stenosis	10	33.3

malalignment	20	66.7
main presentation		
Progressive curve	6	20
Back pain	14	47
Claudication pain	10	33

Level of scoliosis, pre-operative cobb's angel and duration of surgery. Table 3

Table 3: level of scoliosis, pre-operative cobb's angel and duration of surgery

level of scoliosis	No. of patients	%
Dorsal	7	23.3
Lumbar	12	40
Dorso-lumbar	11	36.7
pre-operative cobb's angel		
40-50	6	20
50-60	14	46.7
>60	10	33.3
duration of surgery		
<1.5	8	26.7
1.5 -2.5	16	53.3
>2.5	6	20

Table 4: Estimated blood loss and both cobb's angel and type of scoliosis

blood loss	No of patients	%	*cobb's angel*	Degenerative cases 16	Idiopathic cases 14
<500 cc	8	26.7	***40-50***	***5***	***3***
500-1000 cc	16	53.3	***>60***	***10***	***6***
>1000 cc	6	20	***50-60***	***4***	***2***

Late complication: One case only developed adjacent segment decompensation after 1 year as late complication still under observation as no related symptoms. Table 5

Table 5: Mild transient complication occurred

Complications	No. of patients	%
pneumothorax	1	3.3
Failure of enough level insertion	1	3.3
Pain Exacerbation	2	6.6

External brace dependence shown in figure 8.

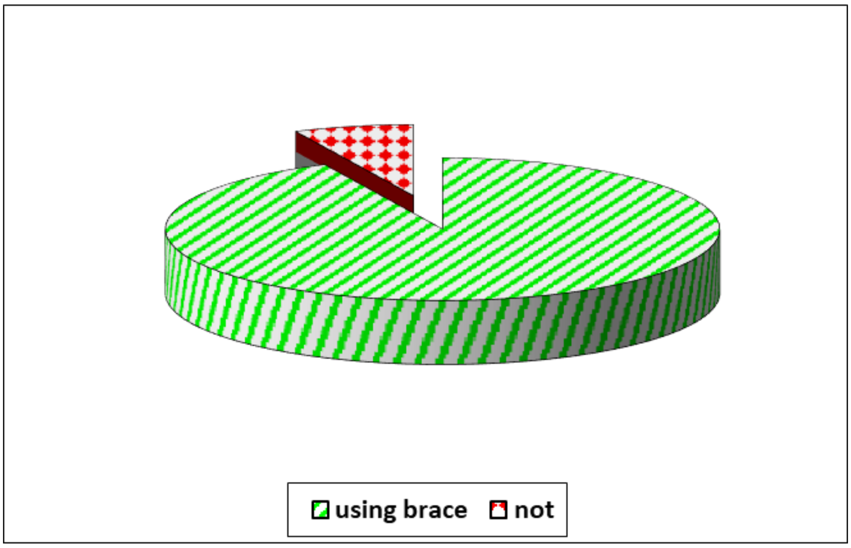

Figure 4: Effect of surgery on external brace support

Outcomes according to Oswestry disability index of patients. Table 6

Table 6: Outcomes according to Oswestry disability index of patients:

Result	No. of patients	%
100%	5	18
75%	15	50
50%	7	22
25%	3	10
0%	0	0.000

Frequency of analgesic used before and after surgery and Relation between fusion segment lengths and outcome. Table 7

Pain was evaluated using a 11-point Visual Analog Scale for Pain (VAS Pain) Scale from 0 (no pain) to 10 (worst *experienced pain)* before and after the procedure. Table 7

Table 7: Frequency of analgesic used, relation between fusion segment lengths and outcome and pain scale before and after surgery

Frequency of analgesic	Before	After		
More than twice	22	1		
Twice	5	5		
Once	3	6		
None	0	18		
Fusion segments	Pain on vas before	After		
<5	8	4		
5	6	4		
6-7	5	2		
8-9	7	3		
>9	8	1		
Pain scale	Before	Immediate after	3 months after	6 months after
9 to 10	20	0	0	0
6 to 8	9	3	3	4
3 to 5	1	23	24	24
0 to 2	0	24	3	2

Cobb's angel before and soon after surgery and 3 and 6 menthes later. Table 8

Table 8: Cobb's angel before and soon after surgery and 3 and 6 menthes later

Cobb's angel	**before**	**Immediate after**	**After 3 months**	**After 6 menths**
>60	6	0	0	0
50 to 60	14	1	1	1
40 to 50	10	2	2	2
30 to 40	-	3	3	3
20 to 30	-	10	10	10
10 to 20	-	14	14	14

Discussion

Adult scoliosis is a common spine deformity. It is very debilitating to daily activities of the patients. Surgical management requires a clear assessment of the functional impact of scoliosis, the failure of conservative treatments and precise analysis of radiological investigations (full spine views, dynamic X-rays and MRI). The back pain was the main complaint as it was the main presentation in 14 cases, then claudication pain in 10 cases.

Surgical techniques (anterior and posterior approaches, decompression, osteotomies, fusion, and instrumentation) done and tailored to each patient. Decompression alone found usually not enough, fusion needed almost in all cases. The main goals of surgery are treatment of symptoms, correction of deformity in coronal and sagittal plane and achievement of a solid fusion. We used short fusion segment only in 8 cases and long fusion segment in the rest of cases, as we found it is better outcome, less incidence of revision surgery or extension needed.

Adult scoliosis was categorised by Aebi 2005 [5] into three main categories depending on the aetiology of the deformity. Type I scoliosis is a basic degenerative form produced by degenerative alterations in the asymmetry of the vertebral discs and the posterior articulation. Type II idiopathic scoliosis is characterised by the progression of idiopathic scoliosis that began before maturity. Secondary adult scoliosis is classified as type III. Extravertebral factors such as static scoliosis or pelvic inclination contribute to type IIIa. Kind IIIb is a type of bone metabolic illness that is related to osteoporosis and scoliosis and is characterised by spinal bone weakening.

The Aebi 2005 [5] classification categorises scoliosis types according to their aetiology, which aids in treatment planning and prediction of natural progression. However, this technique does not assist in determining the, since it does not take into account the unique characteristics and magnitude of the deformity.

Schwab et al[6] .'s categorization system is based on the connection between radiographic results and clinical assessment, and it classifies the apex of the curve, lumbar lordosis, and vertebral body subluxation based on radiographic data. The lower apex of the curve, coupled with the loss of lordosis, is shown to result in a negative health-related quality of life (HRQOL). Surgery is more often used to treat individuals with decreased lumbar lordosis and increased vertebral curvature. Thus our study classification into three groups is better as it helps in choosing appropriate operating method.

According to the Schwab et al., 2012[7] research, 63 percent of adults with scoliosis reported experiencing discomfort, almost double the rate reported by those without scoliosis ("The pain drawing in AIS." 2001.).Patients with scoliosis have continuous pain at a rate double that of non-scoliosis patients, and 73% of patients with scoliosis report having back pain in the last year, compared to just 28% of non-scoliosis patients. 23 percent of those with scoliosis described their pain as terrible, painful, or upsetting, compared to only 1.4 percent of individuals without scoliosis. In our study we agree with **Schwab,** as we found the same clinical presentation except our patients comes usually later on due to lack of health awareness. Low back discomfort is almost twice as common in individuals with scoliosis as in those without.

Adult degenerative scoliosis patients have three surgical options: decompression alone; decompression plus restricted short fusion; and decompression combined with long fusion and deformity correction.

Masuda K, Higashi T, et al., 2018 [8] demonstrate the surgical result of decompression alone vs decompression with restricted fusion for adults with scoliosis in their research. The decompression and fusion groups increased their JOA scores from 5.9 1.6 to 10.0 2.8 and from 7.2 2.0 to 11.3 2.8, respectively, with no significant difference between the groups. At the final follow-up, the Cobb angle in the decompression group increased from 14° 2.9° to 14.3° 6.4° and remained stable, while in the fusion group, the Cobb angle dropped from 14.8° 4.0° to 10.0° 8.5° after surgery. Thus, we found decompression alone is not enough so we do not agree with **Masuda K** et al., 2018 [8] as, when the apex of the adult scoliosis curve decompressed alone, progression of the curve usually occurs. On other words decompression lead to more destabilization of already weakly balanced spine. Surgery is used to alleviate back discomfort, ease radiating pain and claudication, and to rectify deformities. To accomplish these objectives, a variety of surgical procedures may be used, including decompression, fusion, and/or correction of deformity. Long level fusion with correction of deformity may result in excessive blood loss and prolonged surgery time, both of which contribute to increased postoperative complications. If such problems are expected, restricted surgery may be chosen based on the patient's age and overall health. However, when restricted surgery is chosen, pain often returns and degenerative change may develop in the non-fused region, ultimately resulting in neighbouring segment illness. [9]

According to Shapiro et al., 2003 [10], patients with a modest Cobb's angle and normal sagittal imbalance may benefit from decompression and restricted short fusionThose with a significant Cobb's angle and a positive sagittal imbalance will need a lengthy fusion with rectification of deformity.

According to Berjano et al., 2014[11], when long fusion is used, a careful choice of the distal fusion level (L5 or S1) and the proximal fusion level (T10 or the thoracolumbar junction) should be made. For fusions extending to the sacrum, it is prudent to consider restoring sagittal balance and firm fixation with extra iliac screws. Any surgical treatment for adult degenerative scoliosis is known to have a somewhat high rate of complications; thus, the risks and benefits of each operation should be carefully evaluated before proceeding.

We utilised three commonly used surgical methods for pedicle screw implantation. Techniques may be categorised as free-hand (i.e., without the use of imaging) or as aided by fluoroscopy or intraoperative CT with navigation technology. This results in reduced complexity and more safety measures. We concur with Sehrloglu et al2012 .'s [12] research, which demonstrates that combining methods results in a lower incidence of problems.

According to Aebi's study [13], doing maximal corrective surgery on patients over the age of 65 and those with significant morbidities is considered hazardous.For adult scoliosis patients who are unable to adjust to corrective surgery, it is essential to speak with the patient to ensure that he or she is happy with the surgical outcomes, which merely address the symptomatic spinal stenosis while leaving the unbalanced symptom unaddressed.

We concur with Ploumis et al., 2012 [14], who showed that although lengthy fusions for adult scoliosis decreased sagittal malalignment, the prevalence of coronal malalignment did not alter from preoperative to early postoperative follow-up. Additionally, 18% of patients with normal postoperative coronal balance acquired new coronal balance during follow-up. Koller et al., 2016[15] also discovered this: The research of adult spinal deformity patients matched into two cohorts showed a statistically significant improvement in sagittal balance, as well as a marginally significant increase in sagittal correction, preferring the sacrum over the L5 group. Individual studies' risk of bias was determined using criteria established by JBJS [16], which were updated to include criteria for methodological quality and risk of bias, as recommended by the Agency for Healthcare Research and Quality (AHRQ).The total strength of evidence across studies was determined using principles established by the Grades of Recommendation Assessment, Development, and Evaluation Working Group15 and AHRQ guidelines.

Two categorization schemes were suggested in 2014. The first is by Berjano et al., 2014[17], which aims to offer advice on the selection of fusion extension methods and lengths in adult patients with degenerative or idiopathic abnormalities. The second article, by Lamartina et al., 2014 [18], included a thorough anatomical categorization of sagittal and coronal abnormalities, as well as precise suggestions for treatment location. We agree with both of them as both help in selection of the treatment plan.

As Chen's article [19] did, we classified symptoms into two categories: those related with spinal stenosis and those associated with spinal deformity. The neurological claudication is a stenosis symptom, whereas the axial mechanica pain is a deformity symptom. Then they limited surgical approach to this two-category classification procedure. Decompression surgery is used to treat instances of neurological claudication pain caused by primary lumbar stenosis, whereas corrective surgery is used to treat cases of mechanical discomfort produced by deformity.

Lenke and Silva et al., 2010 [20] develop surgical strategies based on the primary symptom and overall health of the patient. The most important location is the source of the pain.Purely axial discomfort is most often associated with sagittal imbalance. Spinal canal stenosis causes the radical agony. Additionally, they noted that forward posture does not alleviate sagittal imbalance-related discomfort unless the patient sits or stands with the trunk supported by the arms. Ploumis et al., 2012 [14] emphasised the need of differentiating neurological claudication from ischemic vascular claudication. While forward posture (such as biking) may alleviate the discomfort of neurological claudication, standing still and resting alleviates the pain of vascular claudication.

Wang R and Huang Y et al., 2013 [21] examined the relative importance of factors influencing blood loss during and after surgery. Data were collected and analysed prospectively from 50 people with scoliosis. Intraoperative bleeding was 1971 +/- 831 ml (mean +/- SD) (61.5 +/- 27 percent of estimated blood volume (EBV)) and was significantly associated with the number of fused vertebrae ($r = 0.66$, $P = 0.0001$) and operation time ($r = 0.46$, $P = 0.0105$). There was no correlation between intraoperative bleeding and the Cobb curve angle (43 to 86 degrees), the mean arterial blood pressure (MAP) (63 to 86 mmHg), the central venous pressure (CVP), the amount of epinephrine infiltrated, muscle relaxants, or opioids used, nor was there any correlation between intraoperative bleeding and the type of opioids used, the minimal body temperature, or whether stored or autologous blood was used. Postoperative bleeding was 1383 +/- 369 ml (43.1 +/- 11.7 percent of EBV) and was positively associated with the duration of the Hemovac drain placement ($r = 0.40$, $P = 0.0285$) and MAP placement ($r = 0.40$, $P = 0.0285$). There was no connection between postoperative and intraoperative bleeding, nor was there any correlation between the number of fused vertebrae and the number of fused vertebrae. Six individuals had significantly more postoperative haemorrhage than intraoperative bleeding. Total bleeding (intra- and postoperative) was 3347 +/- 920 ml (104.2 +/- 30.6 of EBV) and was significantly associated with the number of fused vertebrae (r = 0.63, P = 0.0001) and operation time (r = 0.42, P = 0.0208).

In 207 patients, Asher et al., 2010 [22] conducted a retrospective analysis to evaluate implant/fusion survivorship without reoperation and the risk variables associated with such survival. Of the 207 patients followed, 19 (9.2 percent) needed reoperation, with 16 of them for posterior spine instrumentation-related reasons. At five years, 96 percent of implants/fusions were viable without reoperation for spine instrumentation-related reasons, 91.6 percent at ten years, 87.1 percent at fifteen years, and 73.7 percent at sixteen years. Two implant factors had a substantial effect on the requirement for reoperation: the transverse connection design and the lower instrumented vertebra anchors utilised.

Luhman et al., 2009 [23] conducted a retrospective analysis of 1058 spinal fusions for scoliosis to determine the incidence of and reasons for reoperations.41 (3.9 percent) of the 1058 fusions needed revision: 11 anterior, 25 posterior, and five circumferential. Additionally, 47 additional procedures were required: Twenty revision spinal fusions (for pseudodarthroses, uninstrumented curve progression, or junctional kyphosis); sixteen infections (five acute, eleven chronic); seven implant removals for pain and/or prominence (four complete, three partial); two (4%) revisions for loosened implants; and two elective thoracoplasties.

Yaszay et al., 2009 [24] examined the effects of various surgical methods on pulmonary function in 61 individuals with mostly idiopathic adult scoliosis over a three-year period. They measured vital capacity (VC) and peak flow (PF) in patients before to and after surgery at 1, 3, 6, 12, and 24 months. They discovered that scoliosis methods that pierced the chest wall led with a substantial loss of pulmonary function postoperatively. Return of pulmonary function took three months after posterior thoracoplasty, three months following open anterior fusion, and one year following video-assisted thoracoscopic surgery. According to our findings, we concur with Yaszay et al., 2009, that pulmonary function did not improve immediately and rather worsened, although this was temporary.

Our findings are consistent with the majority of the literature, as Wang et al., 2013 [21] discovered that clinical outcomes were assessed retrospectively using the VAS (visual analogue scale) and ODI (Oswestry Disability Index). Adult scoliosis patients were treated with posterior lumbar decompressive laminectomy, pedicle screw internal fixation, and posterolateral bone graft fusion. Cobb angle at the scoliotic section was 15.4° preoperatively, but reduced to 10.2° immediately after surgery (P 0.05). By the final follow-up, the AIA had risen substantially (4.4 3.4) as compared to pre- and postoperative values (2.5 2.8 and 2.2 2.4, respectively; P 0.05).

Conclusions:

Diffusion tensor imaging is very helpful tool in providing insights on epileptic seizures, prognosis as well as the correct preoperative planning. Diffusion tensor imaging with 3D tractographic reconstruction of white matter tracts are the only methods that allow the calculation as well as visualization of fiber tracts.

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