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Scoliosis surgery, predictors and outcomes in a tertiary care hospital, Riyadh, KSA

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Abstract
Background: Scoliosis is a back deformity, defined as structural lateral curvature of spine more than 10° (cobb angle) with rotation. Surgical intervention has better radiographic and clinical outcomes for the patients. However, it's not indicated in all cases and it's associated with certain complications.
Methods: This is case series study which tracked subjects with scoliosis surgery. We investigated the data of all scoliosis surgery cases in our institution from 2009 to 2016 with internal board review approval. A data collection form was used to extract the data from the charts which included some demographic data such as age, gender, and date of birth, and indication of the procedure were included. Perioperative data such as operative time, blood loss, and perioperative death were estimated. Also, post-operative complications were included. Length of stay in hospital was calculated. Preoperative and postoperative recorded x-rays were interpreted and recorded. All of the reviewed data were coded and expelled into Excel sheet. Statistical package for social sciences (SPSS) version 22 was used for data analysis. Categorical variables were described by frequencies and percentages. Unpaired t-test was used to compare the pre and post-operative outcomes.
Results: The mean age for the patients' who underwent the surgery is 17.7 (range, 8-56 years). 39% (32) of the sample is male and 61% (50) is female. The mean blood loss was 482.3 mL (range, 200-2900 mL) with the mean days of stay in hospital was 10 days (range, 4-90 days). The mean operative time was 250 minutes (range, 130-360 minutes).
The most common indications for the surgery where neuromuscular scoliosis 36 (43.9%), idiopathic scoliosis 32 (39%). The mean cobb angel was 65° (range, 40°-116°) preoperatively and cobb angel of 16.1° (range, 0-87°) (P<0.001) postoperatively.
Conclusion: Scoliosis surgery are effictive method of correcting different types of scolisos and are associated with minimal complications.

Keywords: Scoliosis, surgery, predictors, outcomes

Introduction
Scoliosis is a back deformity, defined as structural lateral curvature of spine more than 10° (cobb angle) with rotation. Most of scoliosis patients presents with no pain but many patients could develop symptoms related to decreased space of internal organ such as constipation and others could develop neurological symptoms and breathing problems in severe cases [1, 2].
The causes of scoliosis could be divided into idiopathic, congenital, and neuromuscular scoliosis. Idiopathic scoliosis is considered the most prevalent cause of scoliosis when there is no definitive cause of the scoliosis and it accounts for 80% of the causes [2]. Idiopathic scoliosis could be further divided upon the age of the affected patient [3]. Adolescent idiopathic scoliosis (AIS) affects the adolescent above the age of 10 and found to be the most prevalent type of idiopathic scoliosis with 0.47-5.2% of the whole population [4], while children between the ages of 3-10 who develop idiopathic scoliosis are considered to have juvenile idiopathic scoliosis. Infants with idiopathic scoliosis are considered to have infantile idiopathic scoliosis. Another cause of scoliosis is congenital scoliosis which is defined as scoliosis developed due to a vertebral defect which happened during pregnancy. Congenital scoliosis was found to develop more commonly than congenital kyphosis or lordosis [5]. Usually children whom are born with congenital cause develop scoliosis due to the slow progression of one side of the

abnormal vertebrae in comparison to the other side. Finally, neuromuscular scoliosis which has been proven to be one of the most progressive spinal deformities [6], this cause of scoliosis usually occurs with patients with neurological or muscular diseases. Very frequent diseases may cause neuromuscular scoliosis including cerebral palsy (CP), trauma to spinal cord, spinal muscular atrophy, and Duchenne muscular dystrophy (DMD) [7].

Treatments for patients with scoliosis vary from observation, bracing and surgery. Conservative treatment for patients with scoliosis is proven to have a role in prevention for progression of scoliosis. A study in patients with adolescent idiopathic scoliosis (AIS) showed that patients with bracing have less progressive scoliosis when compared to observation group [8]. Another study by Wiemann *et al*. showed the same results [9]. These results have demonstrated the importance of intervention for further prevention of scoliosis progression. A study by Bettany-Saltikov *et al*. compared conservative to surgical treatment of scoliosis and found no proof of preference of one way of treatment above the other one [10]. However, a systematic review by Yadla *et al*. showed that surgical intervention has better radiographic and clinical outcomes for the patients [11]. These results show evidence for the effectiveness of surgical intervention in terms of clinical and radiographic outcome.

In addition, scoliosis surgery has a high rate and variety of complications ranging from superficial wound infection to a much more severe complications like neurological deficit and even death. A systematic review by Hans-Rudolf Weiss *et al*. showed the rate of complications in scoliosis surgery and how it varies depending on the indication and emphasized the importance of establishing a standardized way of reporting the complication which may show a more accurate account of surgical complication [12].

The aim of our study is to assess the effectiveness of surgical intervention of patients with variant types of scoliosis in matter of radio-graphical outcomes, and to determine perioperative and postoperative complications of scoliosis surgery.

Methods

This is case series study which tracked subjects whom underwent scoliosis surgery. We investigated the data of all scoliosis surgery cases in our institution from 2009 to 2016 with Cobb angle of more than 20 and less than 116 with internal board review approval. 82 cases (32 males and 50 females) were followed up; inclusion criteria included any age, male and female gender, patients who underwent scoliosis surgery. We included patients with different scoliosis types in that period of time, including idiopathic, congenital scoliosis, post RTA, CP, radiculopathy, low back pain, VACTERAL, and incomplete paraplegia. Cases of repairing kyphotic curve along with scoliosis were included. A data collection form was used to extract the data from the charts which included some demographic data such as age, gender, and date of birth, and indication of the procedure were included. Perioperative data such as operative time, blood loss, and perioperative death were estimated. Also, post-operative complications such as neurological complications and wound infection were included. Length of stay in hospital was calculated. Preoperative and postoperative recorded x-rays were interpreted and recorded. Spinal deformity of the patients was mainly assessed with X-ray in each visit. The average months of follow-up was 41 months, minimum follow-up of the patients was 24 months and maximum follow-up was 80 months. All of the reviewed data were coded and expelled into Excel sheet. Statistical package for social sciences (SPSS) version 22 was used for data analysis. Categorical variables were described by frequencies and percentages. Unpaired t-test was used to compare the pre-operative and post-operative outcomes.

Results

The mean age for the patients' sample is 17.7 (range, 8-56 years). 39% (32) of the sample is male and 61% (50) is female. The mean blood loss was 482.3 mL (range, 200-2900 mL) with the mean days of stay in hospital was 10 days (range, 4-90 days). The mean operative time was 250 minutes (range, 130-360 minutes). Table (1) summaries the demographic data. Table (2) summaries perioperative and postoperative data.

Many patients had more than one indication for the surgery. The indications for the surgery were due to 43.9% (36) neuromuscular Scoliosis, 39% (32) Idiopathic scoliosis, 2.4% (2) kyphoscoliosis, 7.3% (6) post RTA, 1.2% (1) cerebral palsy, 2.4% (2) low back pain, 1.2% (1) radiculopathy , 1.2% (1) incomplete paraplegia and, 1.2% (1) was due to VACTERAL. Table (3) summaries the indication for the patients who underwent the surgery.

The mean cobb angel decreased from 65° (range, 40°-116°); thoracic cobb angel 59.4° (range, 5-110°), and lumbar cobb angel 64.8° (range, 30-105°) preoperatively to cobb angel 16.1° (range, 0-87°) (P<0.001); thoracic cobb angle 22.6° (range, 3-72°) and lumbar cobb angel 22.3° (range, 1-58°) postoperatively. Table (4) summaries the preoperative and postoperative cobb angel.

Table 1: Demographics data

Variable	Value
Number of patients	82
Age (mean)	8-56 years old (17.7)
Male (%): Female (%)	32 (39%): 50 (61%)

Table 2: Perioperative and postoperative data

Variable	Values
Operative time by minutes (mean)	130-360 minutes (250)
Blood loss by mL (mean)	200-2900 mL (482.3 mL)
Perioperative death	0
Neurological complications (percentage)	1 (1.2%)
Wound infection	1 (1.2%)
Length of stay in hospital (mean)	4-90 days (10)

Table 3: indication for surgery

Variable	Percentage (frequency)
Neuromuscular Scoliosis	43.9% (36)
Idiopathic scoliosis	39% (32)
Kyphoscoliosis	2.4 % (2)
Post RTA	7.3% (6)
Cerebral palsy	1.2% (1)
Low back pain	2.4% (2)
Radiculopathy	1.2% (1)
Incomplete paraplegia	1.2% (1)
VACTERAL	1.2% (1)

Table 4: Preoperative and postoperative cobb angel

Variable	Value (mean)
Preoperative cobb angel	40°-116° (65°)
○ Thoracic cobb angel	5-110° (59.4°)
○ Lumbar cobb angel	30-105° (64.8°)
Postoperative cobb angel	0-87° (16.1°) (*P*<0.001)
○ Thoracic cobb angel	3-72° (22.6°)
○ Lumbar cobb angel	1-58° (22.3°)

Discussion

Our study aims to evaluate radio graphical outcomes preoperatively and postoperatively for patients who underwent scoliosis surgery. Which will help in assessing the effectiveness of surgical intervention objectively. Looking through the literature, the majority of the data published regarding scoliosis surgery outcomes is limited to a certain procedure or a single type of scoliosis. Our study is one of the few -especially in the middle east- to evaluate different surgical outcomes and to include multiple indications from neuromuscular scoliosis to post RTA cases.

When comparing between preoperative and postoperative x-rays for patients who underwent scoliosis surgery, we have found significant decrease in mean cobb's angle, from 65° to 16.1° with a *P*<0.001 (thoracic and lumbar mean cobbs angle difference from 59.4° to 22.6° and 64.8° to 22.3° respectively). A study was done by Ali RM *et al*. which showed similar results when comparing between preoperative and postoperative angle reduction from 65° to 24° [13]. In addition, a systemic review was done by Sanjay Yadla *et al*. to assess adult scoliosis surgery outcomes. The study included 49 articles and showed major curve reduction of 26.6° or 40.7% correction of original curve. Both studies showed similar result to ours and presented significant improvement with surgical interventions from a radiographic point of view [11].

In addition, in our 82 cases the perioperative and postoperative data showed a mean operative time of 250 minutes, mean blood loss of 482.3 ml and a mean length of stay of 10 days. A study was done by Kwan MK *et al*. to compare surgery outcomes between a single versus a dual attending surgeon strategy. Their result showed that those who were operated by two surgeons had shorter operating time 164 min (257.3 min with a single surgeon), less blood loss 893.7 ml (1254.7 ml with a single surgeon) and shorter length of stay 3.4 days [14]. Compared to our data, the blood loss in our study is minimal with a very comparable single surgeon operative time.

Our study analyzed the incidence of multiple perioperative and postoperative complications which mainly included death, neurological complications and wound infection. There weren't any reported cases of death, however there was 1 incident of neurological complication (1.2%) and 1 case of wound infection (1.2%). A cohort study was done on 50 patients post long fusion to the sacrum by Weistroffer JK *et al*. showed an incidence of six nerve root complications, four of which fully recovered and no incidence of deaths [15]. Another study was done by Buchowski JM *et al*. evaluated the neurological complications of pedicle subtraction osteotomy in 108 patients in which neurological complications were seen in 12 patients and were permanent in only 3 patients (11.1%). However, pseudarthrosis which is considered to be one of the most common complications in spine surgery with an incidence ranging between 0-41% was not reported in any of our cases. Based on these results, we find neurological complications to be more common, however they are less likely to be permanent [16].

As far as surgery indications, our study included around 13 indications. Some of the most common indications being neuromuscular scoliosis 36 (43.9%), idiopathic scoliosis 32 (39%). In comparison, a study done by S Swank *et al*. included 222 patients who underwent scoliosis surgery the most common diagnoses ware idiopathic scoliosis (72%), paralytic scoliosis (20%) and congenital scoliosis (5%) [17].

One way to expand the study is to compare our results to a more conservative approach. Also, comparing radiographic outcomes and complication rate between different surgery techniques, age groups and surgery indications could help in determining the ideal and safest approach. In addition, due to lack of proper follow-up, we were not able to assess quality of life, disease progression and long term complication.

Conclusion

Based on our data surgical intervention showed significant improvement from radiological stand point and an acceptable complication rate. However, further data regarding quality of life and disease progression need to be acquired in order to fully evaluate surgery effectiveness.

Competing Interests

The authors declare that they have no competing interests.

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