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Perioperative Management in Reconstructive Scoliosis Surgery: A Retrospective Clinical Research

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Abstract

Aim: The anesthetic management of scoliosis surgery is important due to concomitant diseases such as cardiovascular and respiratory function failure, the surgery of which is specific and complex. The aim of this retrospective study is to evaluate data from anesthetic practices in scoliosis surgery.

Material and Methods: We have examined the medical records of the anesthetic applications of 33 patients who have undergone scoliosis surgery. Patients' age, gender, weight, concomitant disease, Cobb angles, instrumentation levels, duration of anesthesia and surgery, preoperative and postoperative hemoglobin levels, the amount of intraoperative blood loss and blood transfusion, duration of intensive care unit, and hospital stay were evaluated.

Results: The mean age of patients was 15.46±4.73 years. The mean cobb angles were 56.4±20:27 degrees, levels of instrumentation 11.87±3.39, duration of anesthesia and duration of surgery was 424.93±108.63 mins, and 385.46±105.71 mins, respectively. Cobb angles of patients were significantly related to duration of anesthesia and surgery, length of stay in the intensive care unit and the hospital. There was also a significant relation between the length of hospital stay and the duration of anesthesia and surgery. The amount of blood loss was similarly related to duration of anesthesia, duration of surgery, blood transfusion, and age.

Conclusion: When the Cobb angle increases, the duration of anesthesia and surgery increases in likewise manner, which in turn also increases the amount of bleeding. The anesthesiologists are advised to take comorbidities and required monitoring into consideration. It has been found out the degree of Cobb angle is especially important.

Key Words: Scoliosis; Anesthesia; Spinal Fusion.

Rekonstrüktif Skolyoz Cerrahisinde Peri-operatif Yönetim: Retrospektif Klinik Araştırma

Özet

Amaç: Skolyoz cerrahisinin anestezi yönetimi; skolyoza eşlik eden hastalıklar, skolyozun kalp ve solunum sisteminde yaptığı değişiklikler ile uygulanan cerrahinin özellikli ve karmaşık olması nedeniyle önemlidir. Bu retrospektif araştırmanın amacı, skolyoz cerrahisindeki anestezi uygulamalarımızda elde ettiğimiz verileri değerlendirmektir.

Gereç ve Yöntemler: Skolyoz nedeni ile posterior enstrümantasyon operasyonu yapılan 33 hastanın anestezi yönetimi geriye dönük olarak incelendi. Hastaların yaşı, cinsiyeti, vücut ağırlığı, eşlik eden hastalıkları, cobb açıları, enstrümantasyon seviyeleri, anestezi ve operasyon süreleri, preoperatif ve postoperatif hemoglobin seviyeleri, kanama miktarları ve kan transfüzyonu miktarları, yoğun bakımda ve hastanede kalış süreleri değerlendirildi.

Bulgular: Hastaların ortalama yaşı 15.46±4.73 yıl. Ortalama cobb açıları 56.4±20.27 derece, enstrümantasyon seviyeleri 11.87±3.39, anestezi süresi 424.93±108.63 dk ve cerrahi süre ise 385.46±105.71 dk olarak bulundu. Hastaların cobb açıları ile anestezi ve cerrahi süreleri, hastanede ve yoğun bakım ünitesinde kalış süreleri arasında anlamlı ilişki olduğu görüldü. Hastanede kalış süresi ile anestezi ve cerrahi süre arasında anlamlı ilişki vardı. Kanama miktarı ile anestezi süresi, cerrahi süre, kan transfüzyonu ve yaş arasında anlamlı ilişki vardı.

Sonuç: Cobb açısı arttıkça anestezi ve cerrahi süre artmakta, bu da kanama miktarını artırmaktadır. Skolyoz cerrahisinde anestezi yönetiminde eşlik eden hastalıkların göz önüne alınması ve cerrahi için gerekli olan monitorizasyonun sağlanmasının yanında Cobb açısına özellikle dikkat edilmelidir.

Anahtar Kelimeler: Skolyoz; Anestezi; Spinal Füzyon.

INTRODUCTION

Manifesting itself around chest and waist regions of the vertebrae, scoliosis is a complex, three-dimensional deformity that involves the shifting movement of the vertebrae either to the right or to the left and the rotation of the vertebrae around their axes (1). If the anteroposterior and lateral radiographs of the spine of an upright person show the Cobb angle, the angle between the beginning and the end of the curve, to be over 40-45 degrees, the patient is considered for surgical operation (2). According to its etiology, scoliosis is divided into two basic groups: idiopathic and neuromuscular. Idiopathic scoliosis is the most common type and it may develop in 1 to 3% of adolescents between the ages of 10-16 (3). In untreated scoliosis patients, fatal cardiopulmonary complications such as hypoxemia, hypercapnia, or cor pulmonale may develop. Through surgical treatment of scoliosis, cardiopulmonary and neurological deterioration is prevented and cosmetic improvement is achieved (4).

The presence of concomitant diseases, cardiac and respiratory changes caused by scoliosis, and the complex nature of the surgery make scoliosis surgery a complicated application for anaesthesiologists. A detailed preoperative assessment is required for patients undergoing scoliosis surgery because of the possible cardiopulmonary problems and neuromuscular diseases patients may have. The choice of premedication and anesthetic techniques to be applied are decided according to the type of surgery, patient's respiratory and cardiac status, and presence of associated anatomical abnormalities and neuromuscular diseases (5). Due to long surgical procedures, serious bleeding problems and possible neurological damage, many variables should be monitored closely such as invasive arterial blood pressure, central venous pressure, depth of anesthesia, and neurological assessment [somatosensory evoked potentials (SSEP) and motor evoked potential (MEP)].

In this retrospective study, we intend to present our clinical experiences with anesthetic management of patients with scoliosis.

MATERIAL AND METHODS

After obtaining the approval of the ethical board, we have retrospectively analysed the anesthesia records of patients who received scoliosis surgery between January 2012 and October 2012. 40 patients were evaluated at first though, at first, three and then four more of these patients were excluded from the study due to different surgical procedures they had undergone and insufficient data, respectively.

Throughout the study, we recorded the data related to age, gender, weight, height, concomitant diseases, cobb angles, levels of instrumentation, anesthesia and operation time, preoperative and postoperative hemoglobin levels, blood loss, amounts of the crystalloid, colloid and blood transfusions applied, and the durations spent in intensive care unit and hospital stay.

Preoperative preparations have been made by consulting with relevant departments for concomitant diseases (cardiology, neurology, pulmonology and anesthesia). When applicable (if the disease was cooperated), we also applied pulmonary function test.

For all patients undergoing the operation, we have administered the same anesthetic protocol explained below. Patients were taken to the operating room without sedation administration. After the routine monitoring (electrocardiogram, pulse oximetry and noninvasive blood pressure), we performed induction by applying propofol (2-2.5 mg / kg), fentanyl (1 microg / kg) and, to facilitate the intubation, a single dose of vecuronium (0.6 mg / kg). Following the intubation, we placed the radial artery cannula, central venous catheter, and urinary catheter. We monitored the body temperature by heat probe, and the depth of anesthesia by bispectral index (BIS) monitor. Keeping the end-tidal at CO_2 35-40 mmHg, we administered mechanical ventilation, and conducted neuromonitoring by SSEP and MEP.

Once the patients were in the prone position, we continued the procedure with total intravenous anesthesia (TIVA). The depth of anesthesia was acquired through propofol infusion (80-100 microg/kg/min), maintaining BIS value between 40 and 60. In line with the hemodynamic data, we applied remifentanil infusion at 0.2-0.4 mcg/kg/min. Postoperative analgesia was administered by morphine through the epidural catheter which was placed in the epidural space openly visible to the surgeon. To this end, a 0.05 mg/kg of morphine was administered epidurally at the end of surgery, and the same dose was repeated after an hour when needed. IV paracetamol (15mg/kg) was used as supportive analgesic in 6-hour intervals.

All of the patients were operated by the same surgeon with posterior approach and spinal instrumentation techniques. Regardless of whether patients had any problems, they were removed to Anesthesiology and Reanimation intensive care units.

For the analysis of the data, we used IBM SPSS statistics 21.0 for Windows. The compliance of the data with the normal distribution was performed with the Shapiro Wilk test. Quantitative variables were expressed with mean ± standard deviation (SD) while qualitative variables were indicated by numbers and percentages. The relationships between the variables were calculated by using Spearman's rho correlation coefficient. The $p<0.05$ value was considered statistically significant.

RESULTS

Throughout our retrospective study conducted on 40 cases, we had to eleminate three of our patients due to different surgical techniques applied and four due to inaccessibility to detailed information related to their medical history. Patients' demographic and operative data are indicated in Table 1. The mean age of the patients was 15:46 ± 4.73 years; 14 (41%) of them were males and 19 (59%) were females; the mean Cobb angle was 56.4 ± 20.27 degrees and their instrumentation levels were 11.87 ± 3:39. The anesthesia time was 424.93 ± 108.63 mins; the operation time was 385.46 ± 105.71 mins.

Preoperative findings showed the following additional diseases in 10 of our patients: Dandy-Walker syndrome and cerebellar vermis agenesis (in 1 patient), asthma (in 1 patient), cerebral palsy (in 3 patients), type 1 chiari malformation (in 1 patient), meningeal cyst excision (in 1 patient), ductal ectasia (in 1 patient), epilepsy (in 2 patients), blindness (in 1 patient), strabismus (in 1 patient), paraplegia (in 3 patients), Duchenne muscular dystrophy (in 1 patient), neurofibromatosis (in 1 patient), and the left hand thumb anomalies (in 1 patient).

Table 1. Patients' demographic and operative data; n (%), mean ± SS, median (minimum-maximum)

	Mean ± SS (%)	Median(minimum-maximum)
Age (years)	15.46±4.73	16 (11-25)
Sex		
Males	14 (41)	
Females	19 (59)	
Weight (kg)	44.4±10.82	45.5 (20-65)
Height (cm)	147.18±10.82	151 (103-177)
Anesthesia Time (mins)	424.93±108.63	420 (180-690)
Surgery Time (mins)	385.46±105.71	385 (150-660)
Cobb Angle(degrees)	56.4±20.27	52.5 (36-112)
Instrumentation level	11.87±3.39	13 (3-13)
Intraoperative blood loss (mL)	1278±494	1000 (400-7000)
Preoperative Hb(g/dL)	13.18±1.52	13.3 (9.8-15.9)
Postoperative Hb (g/dL)	10.56±1.56	10.3 (7.8-12.9)

Hb; hemoglobin

The median preoperative hemoglobin (Hb) was 13.18 ± 1.52 g/dl while the mean postoperative hemoglobin level was 10.56 ± 1.56 g/dl. The average amount of intraoperative bleeding was 1278.12 ± 494.02 ml, while the average intraoperative crystalloid amount was 3012.9 ± 1316.68 mL and the average colloid amount was 727.27 ± 254.82 ml. We did not apply blood transfusion to four patients who lost 10 to 20% or less of their total blood volume during surgery; the mean intraoperative blood transfusion and fresh frozen plasma amounts used during the operation were 1.75 ± 2.64 units and 0.95 ± 2 units, respectively. None of our patients showed any intraoperative anesthesia-related complications.

We did not encounter any need for mechanical ventilation or hemodynamic disturbances in any of the patients in the postoperative period. 7 patients had nausea and vomiting complaints. One of the patients had wound infection, another neurological deficits. The mean length of stay in the intensive care unit for patients was 1.78 ± 1.47 days, while the average length of hospital stay was 6.93 ± 2.67 days.

There were statistically significant relationships between the cobb angles and duration of anesthesia (p=0.000) based on Spearman's rho correlation coefficient, the total duration of surgery (p = 0.001), and hospitalization (p = 0.028) and intensive care unit stay (p = 0.010). Similarly, there was a significant relationship between anesthesia, hospital stay (p = 0.038), and duration of surgery (p = 0.033). Again, there were notable relationships between the amount of bleeding and duration of anesthesia (p=0.039), duration of surgery (p=0.040), blood transfusion (p=0.000), and age (p=0.001) as indicated in Table 2.

Table 2. Relationships between the variables

	AT	ST	ICUS	HS	Blood transfusion	Age
Cobb angle	r=0.587, p=0.000	r=0.561, p=0.001	r=0.449, p=0.010	r=0.388, p=0.028	r=0.294, p=0.129	r=0.189, p=0.299
Blood loss	r=0.367, p=0.039	r=0.366, p=0.040	r=-0.192, p=292	r=-0.111, p=0.544	r=0.839, p=0.000	r=0.551, p=0.001
HS	r=0.369, p=0.038	r=0.378, p=0.033	r=0.352, p=0.048		r=-0.254, p=0.192	r=-0.057, p=0.757
IL	r=0.186, p=0.309	r=0.227, p=0.212	r=0.138, p=0.452	r=0.82, p=0.657	r=-0.159, p=0.418	r=-0.119, p=0.517

AT= anesthesia time, ST= surgery time, ICUS=intensive care unit stay, HS= hospital stay, IL= instrumentation level.

DISCUSSION

In this study, we have observed revealing correlations between patients' Cobb angles and anesthesia and surgery durations, along with the length of hospital and intensive care unit stays. In particular, there were consequential relationship between the length of hospital stay and the duration of anesthesia and surgery. In likewise manner, there was also significant relationship between the amount of bleeding and duration of anesthesia, duration of surgery, and between blood transfusion and ages of the patients.

Scoliosis is divided into two basic groups: idiopathic scoliosis and neuromuscular scoliosis. The most common type is idiopathic scoliosis (70%) and the male/female ratio of the disease is ¼. The second most common type of scoliosis is neuromuscular scoliosis which is accompanied by cerebral palsy, syringomyelia, muscular dystrophy, and Friedreich's ataxia (6). According to the concomitant diseases and their etiologies, we have observed neuromuscular scoliosis in 5 of our patients (15%). Three of the patients had a history of cerebral palsy, while one had neurofibromatosis, and another had muscular dystrophy. 25 of our patients (75%) had adolescence idiopathic scoliosis.

In three of our patients, we noticed the development of the vertebrael disorder (hemivertebrae). These rates were similar to those in previous studies (5,7). Anderson et al. have listed the possible factors that would increase postoperative pulmonary complications in patients undergoing scoliosis surgery as follows: non-idiopathic scoliosis, obstructive pulmonary disease, arterial hypoxemia, mental retardation, being over 20 yeras of age, and anterior fusion (8). Correspondingly, Seo et al. have found out that poor preoperative pulmonary functions in adult patients increase postoperative complications (9).

The integrity of the spinal cord is potentially at risk during scoliosis surgery. It is agreed that intraoperative monitoring of the spinal cord function has been proven to reduce the risk of motor deficit or paraplegia, and thus, it is considered to be requisite during surgical procedures (7,10). Hermanns et al. have stated that, during the spine surgery of both idiopathic and neuromuscular scoliosis patients under propofol-remifentanil anaesthesia, patients' cortical somatosensory evoked potential (SSEP) was effective and reliable (11). SSEP and MEP monitoring, both of which have been considered useful or determining sensory and motor disorders during intraoperative periods, were performed in all our patients.

To ensure a healthy neuro-monitorisation, certain anaesthetic techniques are required (12). It has been reported that propofol and remifentanil applied TIVA is suitable for neuro-monitorisation (9). In conrast to sevoflurane, isoflurane and nitrous oxide, propofol is routinely preferred during operations since it has minimal effective on SSEP records (11). Our patients were continually supported by TIVA technique with propofol-remifentanil during the operations. Serious blood loss and blood transfusion in large amounts are two major problems of anaesthetic management in scoliosis surgery (13). The estimated average blood loss during scoliosis surgery have been reported to be 1000 ml for anterior approach and 2000 to 3000 ml for posterior approach (14). In our study, the posterior approach was performed, and the average amount of intraoperative bleeding was found to be 1278.12 ± 494.02 ml. It has previously been stated that blood loss is closely associated with surgical time and increased amount of blood transfusion (7). In our study, too, there was a relation between the amount of bleeding and duration of anaesthesia, duration of surgery, and blood transfusion.

In a study associated with complications related to spinal surgery in children (scoliosis, kyphoscoliosis, spondylolisthesis, trauma and other complications), it has been observed that mortality rates are very low and that complications are closely associated with the type of operation. At the same time, in patients who underwent more aggressive surgery for their deformities, complications and new neurological deficits are noted to be developing more. The study reports infection to be the most important cause of morbidity with a rate of 2.7% (15). Coe et al., in their idiopathic scoliosis surgery series with 6719 patients, have reported the complication rate to be 5.7% (16). In our study, similar to that of Coe et al., the complication rate was 6.1%. In one of our patients, we have observed superficial infection immediately after the operation followed by deep wound infection in the late stages. In another patient, we detected neurological deficits in the postoperative period though the patient did not show any pathologies in neuro-monitorisation during the operation.

As a result, we can conclude that as Cobb angle increases, duration of anaesthesia and surgery also increase which in turn, increases the amount of bleeding. Therefore, in scoliosis surgery, surgeons should consider the concomitant diseases and apply the required monitoring during the operation while also they should pay particular attention to Cobb angle.

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