A retrospective study of anesthesia management in patients operated for neuromuscular scoliosis

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Abstract

Aim: Scoliosis frequently develops as a complication of neuromuscular diseases, often progressing and necessitating surgical intervention. Although complications can arise in spinal fusion surgery for all types of scoliosis, they are more frequent during and after the procedure in cases of neuromuscular scoliosis.

Methods: After receiving approval from the ethics committee of our hospital, this study conducted a retrospective review of patient files from individuals who underwent surgery for neuromuscular scoliosis at Ankara Training and Research Hospital between 2008 and 2012. A total of 26 patient files were analyzed. Patient parameters including age (years), gender (female (F), male (M)), weight (kg), presence of neuromuscular disease, concomitant cardiovascular and respiratory conditions, as well as other systemic anomalies and diseases, spirometry findings (FEV1, FVC, FEV1/FVC), nutritional status (total protein, albumin), pre-operative hemoglobin (Hg) and hematocrit (Htc) levels, Cobb angle index, angle direction, type of surgical approach (anterior or posterior), muscle relaxants utilized, additional dosage requirements, operation duration, intraoperative bleeding volume (ml), transfusion volume (ml), and intraoperative complications were documented.

Results: As the Cobb angle increased, several factors were affected: the duration of the operation was extended ($p < 0.05$), there was an increase in blood loss ($p = 0.012$), and more blood transfusions were required ($p = 0.32$). Furthermore, there was a correlation between increasing age and the amount of blood transfused ($p = 0.035$).

Conclusions: It has been concluded that a comprehensive preoperative assessment is crucial, as it can offer valuable insights into anesthesia management both before and after surgery for scoliosis. Therefore, conducting a detailed preoperative evaluation is essential for patients undergoing these procedures

Keywords: *Scoliosis, anesthesia, spinal fusion*

1. Introduction

Scoliosis is characterized by a sideways curvature of the spine exceeding 10 degrees, as determined by the Cobb method on standing vertebral X-rays.[1,2] It is classified into five main types: idiopathic, congenital, syndromic, compensatory, and neuromuscular.[3]

Neuromuscular diseases encompass a variety of conditions affecting either the motor neuron or the peripheral nervous system.[4] Central nervous system (CNS) involvement is not observed in neuromuscular diseases. Scoliosis frequently develops as a complication of neuromuscular diseases, often progressing and necessitating surgical intervention.[1]

Surgical intervention for scoliosis not only halts the progression of cardiopulmonary and neurological decline but also enhances cosmetic appearance. Effective perioperative care involves thorough preoperative preparation, meticulous intraoperative anesthesia management, and vigilant postoperative monitoring. Assessing postoperative medical complications and mortality rates is crucial for evaluating surgical outcomes. With complication rates ranging from 14% to 44%, understanding potential risk factors before surgery and implementing preventive measures are essential.[5,6]

Although complications can arise in spinal fusion surgery for all types of scoliosis, they are more frequent during and after the procedure in cases of neuromuscular scoliosis.[7,8]

Pulmonary and cardiovascular complications are prevalent among individuals with neuromuscular diseases, including unclassifiable lung conditions, pulmonary collapse, insufficiency, chronic respiratory failure, and the need for ventilator support. Cardiovascular issues such as cardiomyopathy, hypotension, and tachycardia are also common. Given these underlying health conditions and associated comorbidities, patients with neuromuscular scoliosis are deemed to be at a heightened risk for postoperative complications.[9,10]

Due to these characteristics, patients with neuromuscular scoliosis represent a unique population requiring special considerations for anesthesia.

This retrospective study aims to explore the preoperative charac-

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teristics, anesthesia protocols, as well as intra- and postoperative complications and associated conditions in patients who underwent surgery for neuromuscular scoliosis at our hospital.

2. Materials And Methods

All patients who underwent surgery with a diagnosis of congenital neuroscoliosis and whose file information was accessible were included in the study, thus a power analysis was not performed.

Inclusion criteria for the study were having undergone surgery for congenital neuroscoliosis. Exclusion criteria included having a psychiatric diagnosis and the inability to access post-operative follow-up records.

After receiving approval from the ethics committee of our hospital, this study conducted a retrospective review of patient files from individuals who underwent surgery for neuromuscular scoliosis at Adana city Hospital between 2017 and 2022. A total of 26 patient files were analyzed.

Patient parameters including age (years), gender (female (F), male (M)), weight (kg), presence of neuromuscular disease, concomitant cardiovascular and respiratory conditions, as well as other systemic anomalies and diseases, spirometry findings (FEV1, FVC, FEV1/FVC), nutritional status (total protein, albumin), pre-operative hemoglobin (Hg) and hematocrit (Htc) levels, Cobb angle index, angle direction, type of surgical approach (anterior or posterior), muscle relaxants utilized, additional dosage requirements, operation duration, intraoperative bleeding volume (ml), transfusion volume (ml), and intraoperative complications were documented. Additionally post-operatively, we recorded hemoglobin (Hg) and hematocrit (Htc) levels, admission to the intensive care unit (extubated or intubated), length of stay in the intensive care unit (in days, greater or less than 72 hours), and any other postoperative complications were recorded.

We investigated whether there was any link between these data collected from patients.

2.1. Statistical analyses

We conducted data analysis using the SPSS for Windows 11.5 software package. The Shapiro-Wilk test determined the distribution of continuous variables' proximity to normality. Descriptive statistics were presented as mean ± standard deviation or median (minimum - maximum). We assessed differences between groups using Student's t-test for means and the Mann-Whitney U test for median values. Nominal variables were analyzed using Fisher's Chi-Square test with Fisher's exact test. Spearman's correlation test determined significant correlations between continuous variables. Results were deemed statistically significant for $p<0.05$

Table 1

Demographic and operative data

Frequency	n	Mean	Std. Deviation	Median	Minimum	Maximum
Age	26	14,62	6,42	13,00	9,00	40,00
Weight	26	39,38	9,86	36,50	26,00	56,00
FEV1	22	66,00	13,86	61,50	47,00	90,00
FVC	22	71,68	16,23	66,00	49,00	101,00
FEV1/FVC	22	92,18	4,70	92,00	78,00	103,00
TPR	26	6,05	1,12	6,01	3,60	8,40
ALB	26	3,71	0,79	4,00	2,20	4,80
PRE Hg	26	12,80	1,20	12,60	10,60	15,00
POST Hg	26	9,60	0,99	9,50	7,50	12,00
PRE Htc	26	37,58	3,85	37,30	32,00	43,00
POST Htc	26	28,88	3,13	29,00	21,00	35,00
Lymphocyte Count	26	2,03	0,91	1,70	1,10	5,00
Curvature Level	26	12,92	2,42	13,00	8,00	18,00
COBB	26	73,73	26,37	72,50	19,00	120,00
Blood Loss	26	1526,92	1691,64	1150,00	450,00	9500,00
Transfusion Volume	26	886,54	390,01	725,00	300,00	1800,00
Operation Duration	26	234,81	51,04	212,50	170,00	330,00
Intensive Care Admission	26	0,80	0,91	0,00	0,00	2,00
Duration of Stay in Intensive Care	26	1,19	1,55	0,00	0,00	5,00
Duration of Hospitalization	26	11,31	3,44	5,00	5,00	20,00

3. Results

Demographic and operative data of the patients are shown in Table 1. In this table, 9 of the patients were male and 17 were female.

Table 2

Patients' history and perioperative data

		Frequency
NM diseases	• 0	1
	• CP	8
	• Duchenne Muscular Dystrophy	1
	• Fa	1
	• Amk	1
	• Nf Type-1	8
	• Nf Type-2	1
	• Neurogenic Bladder	1
	• Polio	3
	• SMS Type-2	1
	• Total	26
Other		
	• 0	14
	• Asthma	1
	• DM Type-1	1
	• Epilepsy	1
	• Kyphosis	3
	• Cystic Fib	1
	• Lymphamgioma	1
	• Meningomyelocele	2
	• Pev	2
	• Total	26
Area	Ctl	3
	Tl	23
	Total	26
Direction	L	19
	R	7
	Total	26
Approach	A	1
	P	25
	Total	26
Intraoperative Comp.	Absent	25
	Present	1
	Total	26
Postoperative Comp.	Absent	25
	Present	1
	Total	26
Intensive Care Unit stay > 72 hours	Absent	22
	Present	4
	Total	26

When examining the correlation between preoperative and intraoperative factors and admission to the intensive care unit (ICU), length of ICU stay, and overall hospitalization duration, we found that the likelihood of ICU admission rose with increased curvature levels (p=0.034). Additionally, both the likelihood of ICU admission (p=0.045) and the duration of ICU stay (p=0.019) increased with higher amounts of transfused blood. No significant correlation was observed between other variables and ICU admissions, ICU length of stay, or overall hospitalization duration (p>0.05). (Table 3)

Table 3

Patient characteristics and laboratory findings

		Sperman's rho		
		Intensive Care Admission	Duration of Stay in Intensive Care	Duration of stay in hospital
AGE	r	,181	,187	,030
	p	,375	,359	,885
	n	26	26	26
FEV1	r	,157	,280	,197
	p	,485	,207	,380
	n	22	22	22
FVC	r	,132	,232	,291
	p	,558	,299	,190
	n	22	22	22
FEV1/FVC	r	,145	,221	-,353
	p	,519	,323	,107
	n	22	22	22
PRE Hg	r	-,265	-,208	-,98
	p	,190	,309	,633
	n	26	26	26
PRE Htc	r	-,161	-,093	-,013
	p	,432	,650	,948
	n	26	26	26
Lymphocyte Count	r	,049	,033	-,105
	p	,812	,874	,608
	n	26	26	26
Curvature Level	r	,418	,338	,078
	p	,034	,092	,706
	n	26	26	26
COBB	r	,306	,356	,221
	p	,129	,104	,277
	n	26	26	26
POST Hg	r	-,351	-,319	-,275
	p	,078	,112	173
	n	26	26	26
POST Htc	r	-,101	-,135	-,250
	p	,624	,511	,218
	n	26	26	26
Blood Loss	r	,230	,290	,273
	p	,257	,151	,178
	n	26	26	26
Transfusion Volume	r	,396	,457	,142
	p	,045	,019	,489
	n	26	26	26
Operation Duration	r	,139	,234	,312
	p	,497	,251	,121
	n	26	26	26

When examining variables in relation to postoperative complications, it was found that the levels of FEV1 (p=0.13) and FVC (p=0.003) were higher in the group experiencing complications compared to those without complications. Additionally, when comparing patients who spent more than 72 hours in the intensive care unit (ICU) with those who did not, it was noted that the postoperative hematocrit (htc) level was lower in the former group (p=0.014).

When analyzing variables potentially affecting the length of stay in the intensive care unit (ICU) and overall hospital stay, it was discovered that the presence of comorbidities ($p > 0.05$) and a Cobb angle greater than 90 degrees were not statistically significant ($p > 0.05$).

As the Cobb angle increased, several factors were affected: the duration of the operation was extended ($p < 0.05$), there was an increase in blood loss ($p = 0.012$), and more blood transfusions were required ($p = 0.32$). Furthermore, there was a correlation between increasing age and the amount of blood transfused ($p = 0.035$).

4. Discussion

In our cohort of 26 patients with neuromuscular disease (NMD), we observed a correlation between increased curvature levels and higher rates of ICU admission. Additionally, as the amount of blood transfusion increased, both the likelihood of ICU admission and the length of ICU stay also increased.

Scoliosis associated with neuromuscular diseases is often progressive.[1] Surgical treatment of scoliosis prevents progression of both cardiopulmonary and neurologic findings.[5] Because of these features, scoliosis requires surgical treatment. However, considering the underlying disease and comorbidities, patients with neuromuscular scoliosis are a special patient group in terms of anesthesia and various complications may develop.

In patients undergoing surgery for idiopathic scoliosis, the major complication rate is 8.6%, with a mortality rate of 0.03% and a pseudoarthrosis rate of 5%.[6] When comparing pediatric and adult patients with idiopathic scoliosis, pediatric patients have lower rates of total complications (14.9%-25.1%) and mortality (0.17%-0.40%) than adult patients.[9]

The mean age of patients undergoing scoliosis surgery ranged from 16 to 47 years, with an average Cobb angle of 40°. Intraoperative bleeding averaged 1038 cc, while the preoperative FEV1/FVC ratio was 89.5. Patients stayed in the hospital for an average of 19 days, with a mean duration of 0.86 days in the intensive care unit. Intraoperative mortality was 1%, with postoperative mortality at 0.05%, and postoperative complications were observed in 7% of cases.[8]

Studies have indicated that in patients with NMD undergoing scoliosis surgery, the mean Cobb angle ranges from 44° to 79.3°. Intraoperative bleeding averages between 1641 and 3221 cc, with patients typically staying in the hospital for 9.2 to 19 days and spending 2 to 3 days in the ICU on average. The mortality rate is around 6.5%, and the incidence of postoperative complications is approximately 15%.[3,5,7]

Among patients with NMD, pulmonary complications stand out as the most frequent preoperative issue, followed by cardiac complications. Pneumothorax emerges as the leading major pulmonary complication.[7] However, in our study, we observed no instances of either pulmonary or cardiac complications. Only one patient experienced bladder perforation.

The primary postoperative complications predominantly revolve around pulmonary issues. These complications entail prolonged atelectasis, intubation exceeding 48 hours, pneumonia, and pneumothorax.[5] Following closely, the second most frequent complication is wound infection, predominantly superficial. Neurological complications rank third in frequency. Additionally, cardiovascular complications such as rod fracture, loosening, pseudoarthrosis, and screw loosening are also observed.[5]

Comparing patients with NMD to those with idiopathic conditions, studies indicate higher total hospital costs, increased comorbidity rates, longer hospital stays, elevated rates of wound site infection, major complications, mortality, pseudoarthrosis, and respiratory failure among patients with NMD.[6]

In a study comprising 194 cases, Weis et al. found no significant correlation between postoperative complications and various factors, including age, gender, Cobb angle, intraoperative and postoperative bleeding, perioperative and postoperative hemoglobin levels, instrumentation level, blood transfusion volume, and preoperative RFT (Respiratory Function Tests) values.[6]

Mohammed et al. further noted in their study of 175 patients with NMD that the group experiencing postoperative complications had longer operation times (419 min vs. 373 min) and higher blood loss (1930 ml vs. 1047 ml) compared to those without complications. Additionally, they found no correlation between postoperative complications and factors such as the surgical approach direction (anterior or posterior), platelet count, white blood cell count, and gender.[5]

In our study, we found that the FEV1/FVC ratio was significantly higher in the group experiencing postoperative complications compared to those without complications. Furthermore, there was a notable increase in the number of intensive care unit admissions and the duration of stay in the intensive care unit as the level of instrumentation and the volume of blood transfused increased.

There was no statistically significant difference observed between anterior and posterior approaches concerning postoperative complications and the duration of intensive care unit stays. In a study involving 126 cases, Hod-Feins et al. noted a lower complication rate with the posterior approach compared to the anterior approach, along with a shorter duration of stay in the intensive care unit. However, they found no association between the Cobb angle, level of instrumentation, and postoperative complications.[8]

When comparing patients who remained in the intensive care unit for more than 72 hours with those who stayed for less than 72 hours, it was found that the former group had significantly lower postoperative hematocrit (HTC) values. Udink et al. noted in their study of 46 NMD patients that 15% required mechanical ventilation for over 72 hours. Interestingly, age and gender showed no association with prolonged mechanical ventilation. However, patients with less than 72 hours of ventilation exhibited lower FEV1 and VC.[3]

While there was a notable correlation between the Cobb angle and factors such as operation time, blood loss, and blood volume, no significant difference in complications was observed between patients with a Cobb angle above and below 90°. We attribute this to the experience of our surgical team. Working with a seasoned team, we believe that preoperative and postoperative complications are not necessarily tied to the Cobb angle. In a study by MODI et al. involving 50 NMD patients, it was found that those with a Cobb angle above 90° exhibited a higher complication rate, longer operation times, and 68% of them experienced at least one major or minor complication. Additionally, they reported two fatalities: one due to hypovolemic shock and the other due to cardiac arrest.[10]

No statistically significant difference was found between the groups with and without comorbidities. In a study conducted by Patil et al., it was observed that the risk of complications was 1.53 times higher in patients with preoperative comorbidities compared to those without. Similarly, Sarıcaoğlu et al. reported that patients who experienced complications had at least one comorbidity.[4]

5. Conclusion

Anesthesia protocols for surgical procedures related to scoliosis involve considerations that impact various bodily systems, particularly the pulmonary and cardiovascular systems.

It has been concluded that a comprehensive preoperative assessment is crucial, as it can offer valuable insights into anesthesia management both before and after surgery for scoliosis. Therefore, conducting a detailed preoperative evaluation is essential for patients undergoing these procedures.

Statement of ethics

Ethical permission was obtained from the Adana City Training and Research Hospital Clinical / Human Research Ethics Committee for this study date on 25.07, 2024, and decision number 81 and Helsinki Declaration rules were followed to conduct this study.

Source of Finance

The authors declare that they have received no financial support for this study

Conflict of interest statement

The authors declare that they have no conflict of interest.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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