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# Retrospective evaluation of 113 children with scoliosis

Duygu ÖLMEZ<sup>1</sup>, Arzu BABAYİĞİT<sup>1</sup>, Mustafa KIR<sup>2</sup>, Demet ALAYGÜT<sup>3</sup>, Nevin ÜZÜNER<sup>1</sup>, Özkan KARAMAN<sup>1</sup>, Nurettin ÜNAL<sup>2</sup>, Gül SAYLAM<sup>2</sup>

<sup>1</sup> Dokuz Eylül Üniversitesi Tıp Fakültesi, Çocuk Allerji Bilim Dalı, İzmir

<sup>2</sup> Dokuz Eylül Üniversitesi Tıp Fakültesi, Çocuk Kardiyoloji Bilim Dalı, İzmir

<sup>3</sup> Dokuz Eylül Üniversitesi Tıp Fakültesi, Çocuk Sağlığı ve Hastalıkları Anabilim Dalı, İzmir.

## ÖZET

### Skolyozlu 113 çocuğun retrospektif değerlendirilmesi

*Bu çalışmanın amacı; skolyozlu 113 çocuğun demografik özelliklerini, preoperatif solunum fonksiyon testlerini ve ekokardiyografik incelemelerini değerlendirmek ve preoperatif incelemeler ile postoperatif komplikasyonlar arasındaki ilişkileri saptamak. 2004-2006 yılları arasında opere olan 113 skolyozlu çocuğun tıbbi kayıtları, preoperatif solunum fonksiyon testleri ve ekokardiyografik incelemeleri retrospektif olarak değerlendirildi. Preoperatif solunum fonksiyon testleri, preoperatif solunum semptomları ve postoperatif solunum komplikasyonları arasındaki ilişkiler araştırıldı. Hastaların 37'si erkek, 76'sı kız çocuğu idi. İlk ve son operasyon sırasında hastaların ortalama yaşları sırasıyla  $11.2 \pm 3.8$  ve  $11.7 \pm 3.6$  yaş idi. Skolyoz nedeniyle yapılan operasyon sayısı ortalama  $1.5 \pm 1.4$  idi. En sık görülen form hastaların %42.5'inde bulunan idiopatik skolyozdu. Hastaların %68.1'inde hiç solunum semptomu yoktu. Preoperatif FVC, FEV<sub>1</sub>, PEF ve MEF<sub>25-75</sub> değerleri sırasıyla hastaların %43.4, %58.4, %53.1 ve %65.5'inde normal saptandı. Ekokardiyografiler hastaların %34.5'inde normal bulundu. En sık görülen kalp kapak anomalisi hastaların %25.7'sinde saptanan mitral kapak prolapsusu idi. Çalışmamızda skolyozlu çocuklarda preoperatif solunum fonksiyon testleri, preoperatif solunum semptomları ve postoperatif solunum komplikasyonları arasında anlamlı bir ilişki saptanmadı.*

**Anahtar Kelimeler:** Skolyoz, çocuklar, preoperatif solunum fonksiyon testleri, preoperatif solunum semptomları, postoperatif solunum komplikasyonları, ekokardiyografi.

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### Yazışma Adresi (Address for Correspondence):

Dr. Duygu ÖLMEZ, Dokuz Eylül Üniversitesi Tıp Fakültesi, Çocuk Sağlığı ve Hastalıkları Anabilim Dalı, Allerji Bilim Dalı, Balçova, İZMİR - TÜRKİYE  
e-mail: duygu74olmez@yahoo.com

## SUMMARY

### *Retrospective evaluation of 113 children with scoliosis*

Duygu ÖLMEZ<sup>1</sup>, Arzu BABAYİĞİT<sup>1</sup>, Mustafa KIR<sup>2</sup>, Demet ALAYGÜT<sup>3</sup>, Nevin UZUNER<sup>1</sup>, Özkan KARAMAN<sup>1</sup>, Nurettin ÜNAL<sup>2</sup>, Gül SAYLAM<sup>2</sup>

<sup>1</sup> Department of Pediatric Allergy, Faculty of Medicine, Dokuz Eylül University, Izmir, Turkey

<sup>2</sup> Department of Pediatric Cardiology, Faculty of Medicine, Dokuz Eylül University, Izmir, Turkey

<sup>3</sup> Department of Pediatrics Health and Diseases, Faculty of Medicine, Dokuz Eylül University, Izmir, Turkey.

*To evaluate demographic features, preoperative pulmonary function tests and echocardiographic examinations of 113 children with scoliosis and to determine the associations between preoperative investigations and postoperative complications. Medical records, preoperative pulmonary function tests and echocardiographic examinations of 113 children with scoliosis who were operated between January 2004 and 2006 were evaluated retrospectively. Associations between preoperative pulmonary function tests, preoperative pulmonary symptoms and postoperative pulmonary complications were investigated. There were 37 male and 76 female patients. The mean ages of the patients at the time of the first and last surgery were  $11.2 \pm 3.8$  and  $11.7 \pm 3.6$  years respectively. The mean number of surgery performed for scoliosis was  $1.5 \pm 1.4$ . Idiopathic scoliosis was the most common form constituting 42.5% of the patients. 68.1% of the patients had no preoperative pulmonary symptoms. Normal preoperative FVC, FEV<sub>1</sub>, PEF and MEF<sub>25-75</sub> values were detected in 43.4%, 58.4%, 53.1% and 65.5% of the patients respectively. Echocardiograms were found normal in 34.5% of them. The most common cardiac valve anomaly was mitral valve prolapsus which was detected in 25.7% of the patients. No significant associations were found between preoperative pulmonary function tests, preoperative pulmonary symptoms and postoperative pulmonary complications of children with scoliosis in our study.*

**Key Words:** *Scoliosis, children, preoperative pulmonary function tests, preoperative pulmonary symptoms, postoperative pulmonary complications, echocardiography.*

Scoliosis is caused by the lateral displacement and rotation of the vertebral bodies (1). The purpose of operation is to halt the development of scoliosis and further damage to the cardiopulmonary function (2). Scoliosis increases the risks of pulmonary complications after surgery because it is associated with progressive restrictive lung disease (3). It results a decrease in pulmonary function due to the stiffness of the chest wall and the decrease in the force of the respiratory muscles (4).

The association between spine deformities and major cardiac malformations is well recognized (5). However there are few studies reporting the prevalence of asymptomatic cardiac valve anomalies of the patients with scoliosis (6).

We aimed to evaluate demographic features, preoperative pulmonary function tests (PFTs) and echocardiographic examinations of 113

children with scoliosis retrospectively who were operated in our hospital and to determine the associations between preoperative investigations and postoperative pulmonary complications.

## MATERIALS and METHODS

We evaluated the medical records, preoperative PFTs and echocardiographic examinations of 113 children with scoliosis retrospectively who were consulted with Departments of Pediatric Allergy and Pulmonology and Pediatric Cardiology before surgery between January 2004 and 2006. Age at the time of diagnosis, age at first and last surgery, gender, type of scoliosis, number of surgery due to scoliosis and family history of scoliosis were recorded. Preoperative PFT parameters [forced expiratory volume in 1 second (FEV<sub>1</sub>), forced vital capacity (FVC), peak expiratory flow (PEF), (forced expiratory

flows at 25% to 75% of vital capacity ( $FEF_{25-75}$ ), echocardiographic examinations, type of surgery, preoperative pulmonary symptoms and postoperative pulmonary complications of the last surgery were noted. PFTs were performed by respiratory technicians using a calibrated spirometer in cooperative children over the age of 6 years. Cardiac evaluation included a two dimensional echocardiogram in M mode and a color ultrasound Doppler examination.

The descriptive analysis included the mean, range, and standard deviation of the quantitative variables. The Chisquared test was employed to compare proportions. Statistical significance was set at a p value of less than or equal to 0.05. Data were processed with the SPSS software package, version 15.

## RESULTS

There were 37 (32.7%) male and 76 (67.3%) female patients. The mean ages of the patients at the time of the first and last surgery were  $11.2 \pm 3.8$  (range 1-18) and  $11.7 \pm 3.6$  years (range 1-18) respectively. The mean time between the diagnosis of scoliosis and the first surgery was  $3.8 \pm 3.7$  years (range 0-16). The mean number of surgery performed for scoliosis was  $1.5 \pm 1.4$  (range 1-14).

Thirty eight (33.6%) patients had congenital scoliosis, 48 (42.5%) idiopathic scoliosis, 6 (5.3%) scoliosis due to a neuromuscular disease, 4 (3.5%) scoliosis with syndromes and 17 (15%) kyphoscoliosis. Ten patients (8.8%) had a positive family history of scoliosis. Mean age of the patients with idiopathic scoliosis was  $11.1 \pm 3.4$  years (range 1-17).

Seventy seven (68.1%) patients with scoliosis had no preoperative pulmonary symptoms while 9 (8%) patients had cough, 2 (1.8%) wheezing, 3 (2.7%) dyspnea and 22 (19.5%) effort intolerance. No preoperative pulmonary disease was detected from the medical records in 101 (89.4%) of the patients while 4 (3.5%) patients had recurrent pneumonia, 3 (2.7%) asthma and 5 (4.4%) recurrent bronchiolitis. In 104 (92%) of the patients, preoperative chest radiograms were normal. Bronchiectasis was detected in 1

(0.9%), hyperaeration in 6 (5.3%) and pneumonic infiltration in 2 (1.8%) of the patients.

PFTs were performed in 99 (87.6%) of the patients before the last operation. The mean FVC of the patients was  $78 \pm 18.9\%$  (range 32-125%),  $FEV_1$   $83.7 \pm 19.9\%$  (range 28-125%), PEF  $84.8 \pm 22\%$  (range 26-135%), and  $MEF_{25-75}$   $88.6 \pm 31.2\%$  (range 15-179%). Preoperative FVC values were < 60% of predicted in 16 (14.2%), 60-80% in 17 (15%) and > 80% in 66 (58.4%) of the patients. Preoperative  $FEV_1$  values were < 60% of predicted in 16 (14.2%), 60-80% in 17 (15%) and > 80% in 66 (58.4%) of them. Preoperative PEF values were < 60% of predicted in 10 (8.8%), 60-80% in 30 (26.5%) and > 80% in 59 (52.2%) of them. Preoperative  $MEF_{25-75}$  values were < 45% of predicted in 7 (6.2%), 45-65% in 17 (15.1%) and > 65% in 75 (66.4%) of the patients.

There were no significant correlations between preoperative PFTs (FVC,  $FEV_1$ , PEF and  $MEF_{25-75}$ ) and preoperative pulmonary symptoms. Correlation between preoperative FVC and preoperative pulmonary symptoms were given in Table 1. No significant correlation was found between preoperative pulmonary symptoms and postoperative pulmonary complications (Table 2). There were no significant correlations between preoperative PFTs (FVC,  $FEV_1$ , PEF and  $MEF_{25-75}$ ) and postoperative pulmonary complications. Correlation between preoperative FVC and postoperative complications was given in Table 3.

Preoperative echocardiograms were performed in 80 cases (70.8%). Echocardiograms were fo-

**Table 1. Correlation between preoperative FVC and pulmonary symptoms.**

Preoperative pulmonary symptoms	Preoperative FVC		
	Normal	Abnormal	Total
Yes	13	17	30
No	38	31	69
Total	51	48	99

$\chi^2 = 1.154$ ,  $p = 0.283$ .

und normal in 39 cases (34.5%). Mitral valve prolapsus (MVP) was detected in 29 (25.7%), atrial septal defect in 5 (4.4%), mitral valve deficiency in 2 (1.8%), patent ductus arteriosus in 1 (0.9%), aortic arch anomalies in 1 (0.9%), left persistent superior vena cava in 1 (0.9%) and aortic valve deficiency in 2 (1.8%) patients. Thirty seven out of 103 patients without positive family history of scoliosis had valvular anomalies, whereas 7 out of 10 patients with positive family history of scoliosis showed pathological echocardiographic results. There was no correlation between family history of scoliosis and presence of cardiac anomalies ( $\chi^2= 0.14$ ,  $p= 0.71$ ). There were no complications during or after surgery related to the cardiac valve anomalies.

Operation procedures revealed posterior spinal fusion in 89 (78.8%), anterior spinal fusion in 6 (5.3%) and sectioning of the filum terminale for tethered cord in 2 (1.8%) of the patients.

The mean time spent in intensive care in the postoperative period was  $1.6 \pm 1.2$  days (range 1-5). The mean day the patients were entubated

was  $1.2 \pm 0.71$  days (range 1-5). Seventeen (15%) patients needed postoperative ventilation support more than one day. One patient (0.9%) had pneumonia, 3 (2.7%) pneumothorax, 2 (1.8%) pleural effusion and 2 (1.8%) atelectasis after surgery.

## DISCUSSION

Pediatric spinal deformity results from multiple conditions including congenital anomalies, neuromuscular disorders, skeletal dysplasia and developmental disorders (idiopathic) (7). Scoliosis is the most common abnormality of the spine and tends to become clinically evident during periods of rapid somatic growth. The majority of cases are idiopathic and idiopathic scoliosis occurring around puberty is the most common type (1). In our study idiopathic scoliosis was the most common form constituting 42.5% of the patients and the mean age of the patients with idiopathic scoliosis was  $11.1 \pm 3.4$  years similar with the literature.

The prevalence of scoliosis is much higher among girls, with a female to male ratio of approximately 3:1 (1,8). In our study 67.3% of the patients were female compatible with the literature.

A hereditary factor has been suggested on the basis of well described familial patterns of scoliosis, as well as on the much higher risk of developing scoliosis in children whose parents have scoliosis (9). In our study 8.8% of the patients had a positive family history of scoliosis.

Scoliosis has generally been associated with the development of restrictive lung defect. Exercise capacity is usually decreased, and dyspnea on exertion may be one of the first clinical manifestations of scoliosis (1). In our study 31.9% of the patients had pulmonary symptoms such as cough, wheezing, dyspnea and effort intolerance.

Thoracic surgery decreases lung volumes, expiratory flow rates and oxygenation after surgery (10,11). This can lead to pulmonary complications such as pneumonia, bronchospasm and atelectasis (11). The most serious pulmonary complication is the development of postoperative respiratory failure which may delay weaning

**Table 2. Correlation between preoperative pulmonary symptoms and postoperative pulmonary complications.**

Postoperative pulmonary complications	Preoperative pulmonary symptoms		
	Normal	Abnormal	Total
Yes	10	11	21
No	65	25	90
Total	75	36	111

$\chi^2= 3.105$ ,  $p= 0.078$ .

**Table 3. Correlation between preoperative FVC and postoperative pulmonary complications.**

Postoperative pulmonary complications	Preoperative FVC		
	Normal	Abnormal	Total
Yes	6	10	16
No	44	38	82
Total	50	48	98

$\chi^2= 1.399$   $p= 0.237$ .

of mechanical ventilation (1). In our study 15% of the patients needed postoperative ventilation support more than one day.

Preoperative PFTs can be used to predict incidence of postoperative pulmonary complications but there is no direct correlation between the preoperative pulmonary functions and the incidence and severity of postoperative complications (1). Yuan et al, concluded that neither preoperative polysomnography nor infant PFT can predict the need for prolonged postoperative mechanical ventilation following scoliosis surgery in children (12). Padman et al, reported a significant correlation between abnormal preoperative PFTs and postoperative pulmonary complications in patients with scoliosis. In our study no correlation was found between preoperative PFTs and postoperative pulmonary complications (13). Zhang et al, found no significant correlation between preoperative pulmonary symptoms and postoperative pulmonary complications (2). We also did not find any correlation between preoperative pulmonary symptoms and postoperative pulmonary complications compatible with that study.

Distortion of the thoracic cavity by scoliosis affect the functions of the lungs, the large airways, the heart and the big vessels by altering their position and their relation to each other (1). Several authors have postulated that the association between cardiac valve anomalies and skeletal deformities is due to problems in the fetal growth pattern (14). Primiano et al, suggested that cardiopulmonary and thoracic changes in idiopathic scoliosis may be expressions of a common collagen defect (15). Colomina et al, found the prevalence of valvular anomalies in idiopathic scoliosis 24% (6). The most frequently found valvular anomaly was MVP representing almost 75% of the total. Dhuper et al, reported a 13% prevalence of MVP in a series of 139 patients with idiopathic scoliosis (16). Basu et al, detected cardiac defects in 26% of the patients with congenital spinal deformity (17). Although echocardiograms could be performed only in 70.8% of our patients, the most frequently found valvular anomaly was MVP which was detected in 25.7% of the children.

We analyzed the medical records of 113 children with scoliosis retrospectively who were operated in our hospital. Although no correlation was not found between the preoperative PFTs and the incidence of postoperative complications in our study compatible with the literature, data in the literature is not sufficient to determine that PFTs are not needed in patients with scoliosis preoperatively. We also want to point out the high frequency of cardiac valve anomalies especially MVP in patients with scoliosis.

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