THE INFLUENCE OF THE TREATMENT OF SCOLIOSIS WITH MIAMI TLSO ON THE SELECTED PARAMETERS OF PULMONARY FUNCTION

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Selected parameters of pulmonary function in a group of 34 girls with late-onset idiopathic scoliosis (mean age 13,6 and mean thoracic curve of 33.5°), treated with Miami Thoraco-lumbo-sac.ral orthosis (TLSO), were tested. We found vital capacity (VC) to be 3.4 SD 0.7L, forced vital capacity (FVC) 3.2 SD 01.6L and forced expiratory volume in the 1st second (FEVl) 2.8 SD 0.6 L. After correction of thoracic curve, mean 14.08° SD 3.76 (43.3 %), achieved by TLSO, we have noticed statistically significant (p<0.01) diminution of these parameters. VC was 5.0 %, FVC 6.4 % and FEVl for 5.5 % lower in TLSO. The obvious reason for this difference is mechanical limitation to the inspiratory movement. The differences have no impact on activities of everyday life, because they can appear only in the maximal inspiratory position.

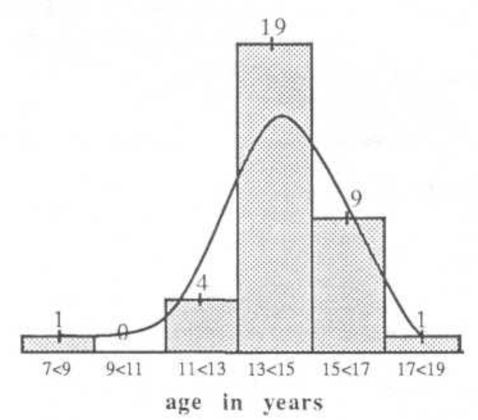
Key Words: Idiopathic scoliosis, pulmonary function, influence of ILSO.

The Scoliosis Research Society has defined scoliosis as lateral spinal curvature of 10° or greater. Brace treatment of idiopathic scoliosis attempts to mechanically control and modify the natural history of spinal curvature. TLSO is used in the treatment of idiopathic scoliosis with apex of the curve below. Th7. Underarm bracing reduces respiratory movements simply by strapping of the thorax. Pulmonary function in the children wearing Miami TLSO was not investigated until now, while similar study exist for Milwaukee and Stagnara braces. The purpose of orthopaedic treatment must take into account the need to mainlin respiratory function as well as to procedure a stable, compensated spine. So we wanted to explore the immediate impact of TLSO on pulmonary function in children with idiopathic scoliosis.

MATERIALS AND METHODS

A group consisted of 34 girls with late-onset idiopathic scoliosis mean age 13.6 years (Standard deviation SSDC, 1.66 years) ranging from 7 to 17 years of age (Fig.l). Girls included in our study were skeletal}' immature (Risscr sign was in the range between 0-2 and vertebral ring apophyses have not been fused with vertebral end plates). All of them had single major thoracic curve (apex varied from Th7 to Thll), mean angulation 33.47° (SD, 5.78°) ranging from 24° to 50° (Fig.2). There were 24 (68 %) right thoracic curves.

Pulmonary function tests (PFT) were performed at rest, in sitting position, with and without TLSO. The following parameters of pulmonary function were measured:



Frequency distribution of ag patients with scoliosis
Fig. 1

1. Static volumes : vital capacity (VC), total lung capacity (TLC), intrathoracic gas volume (ITG V), expiratory reserve volume (ERV) and residual

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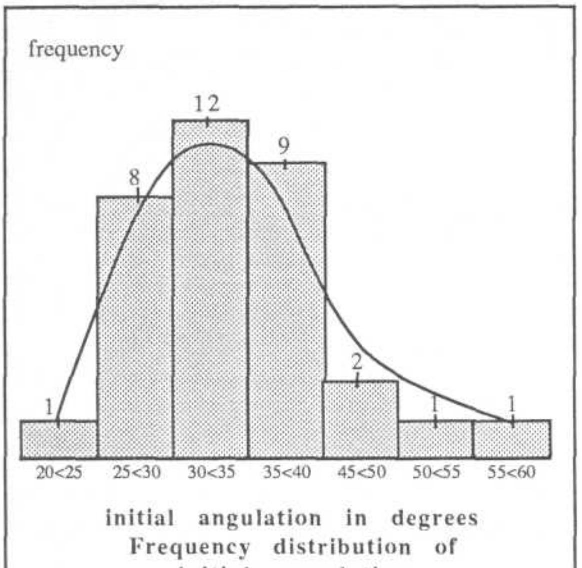
volume (RV) measured by body plethysmography and spirometry.

2. Dynamic volumes : forced vital capacity (FVC), forced expiratory volume in the 1st second (FEVI) measured by flowmeter.

3 . Air flow at certain lung volumes: forced expiratory flow at 50 % of vital capacity (FEF50), forced expiratory flow at 25 % (FEF25), peak expiratory flow (PEF) and peak inspiratory flow (PIF) measured by flow-volume curve.

4. Airway resistance: inspiratory (RAWIN), expiratory (RAWEX), peak (RPEAK), total (RAW), measured by body plethysmography.

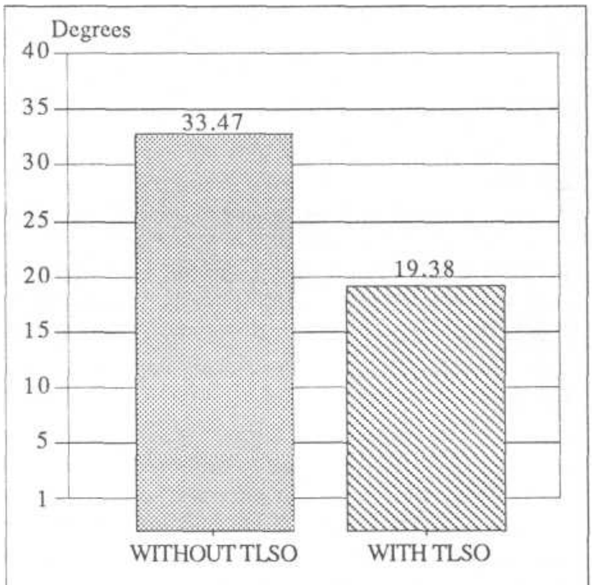
All patients have been diagnosed and threaded in the Department of Spinal Surgery, Special Hospital of Orthopaedic Surgery "Banjica" and PFT measurements carried out in the Laboratory of Pulmonary Function, Institue of Pulmonary Diseases and TBC. All patients had established progressive idiopathic scoliosis demanding TLSO treatment. The degree of the spinal curve was measured from plain anteroposterior (AP) radiography in standing position, using Cobb's method. Each patient was tested without TLSO and immediately after bracing. The sequence of testing with or without brace was randomized. The obligate condition for this study was good cooperation in the PFT performance. PFT measurements were performed on Jaeger Pncumoscreen and Jaeger Bodyplctismograph.



Frequency distribution of initial angulation
Fig. 2

RESULTS

The average initial angulation before application of TLSO was 33.47° SD 1.66, and after bracing was corrected to 19.38° SD 7.37. Initial average correction in brace was 14.08° SD 3.76 (Fig. 3). The mean percent of correction was 43.33 %. The difference between initial and brace angulation was statistically significant.



Mean curve angulation in patients with scoliosis
Fig. 3

The results of PFT measurements with and without TLSO, their differences and the satistical significance arc presented in the Table 1.

Comparing parameters of PFT with and without TLSO we can notice following changes:

Static volumes: VC and TLC arc capacities limited by maximal expansion of thorax, so in brace they are diminished (5.0 % and 5.5 %) statistically significantly. ITGV and ERV arc even more diminished (14.3 % and 15.5 %). The change of RV is not statistically significant (Fig. 4).

Dynamic volumes (FVC and FEVI) are decreased for 6.4 % and 5.5 % which is also statisTically significant (Fig. 5).

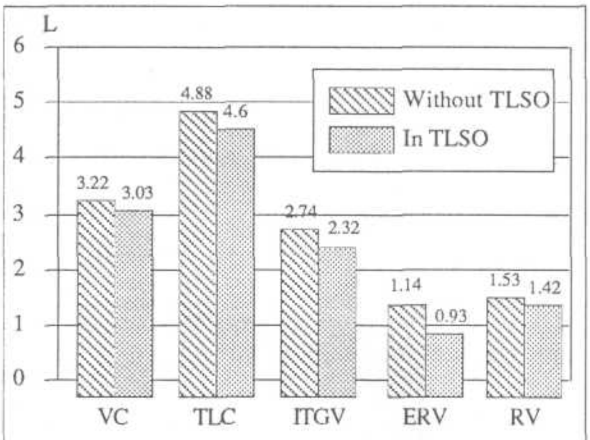
Airflow is decreased only at greater lung volumes (FEF50 5.2 % and PEF 6.3 %), while there is not any change at lesser lung volumes (FEF25 0.5 %). PIF is also significantly decreased (4.1 %) (Fig. 6)

Airway resistance demonstrates decrease of RAWIN (14.9%), RAW (7.9%), RAWEX and RPEAK are not signicantly changed (Fig. 7)

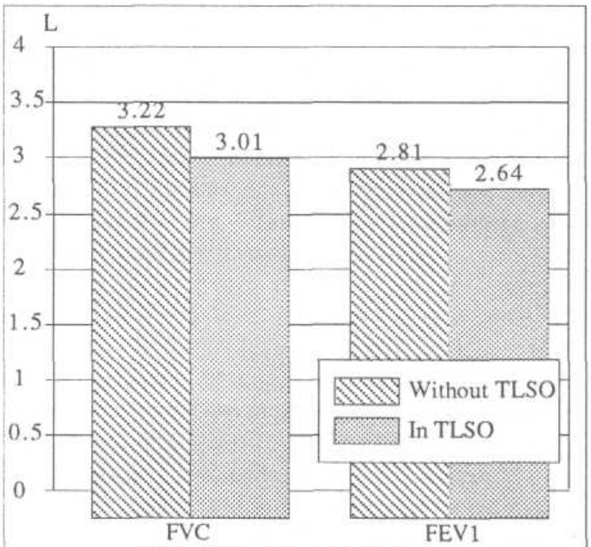
PFT	WITHOUT BRACE MEAN	SD	WITH BRACE MEAN	SD	DIFFERENCE VALUE	%	t-TEST P	signif.
Static volumes (L) :								
VC	3.22	0.68	3.03	0.59	0.19	5.0	<0.01	v.s.
TLC	4.88	0.93	4.60	0.89	0.28	5.5	<0.01	v.s.
IGV	2.74	0.58	2.32	0.52	0.41	14.3	<0.01	v.s.
ERV	1.14	0.40	0.93	0.34	0.20	15.5	<0.01	v.s.
RV	1.53	0.34	1.42	0.37	0.11	5.2	<0.05	n.s.
Dynamic volumes (L) :								
FVC	3.22	0.65	3.01	0.60	0.21	6.4	<0.01	v.s.
FEVI	2.81	0.58	2.64	0.53	0.16	5.5	<0.01	v.s.
Airflow (L/S) :								
FEF50	3.84	0.94	3.63	1.00	0.20	5.2	<0.05	s.
FEF25	1.90	0.68	1.83	0.63	0.70	0.5	>0.05	n.s.
PEF	6.62	1.25	6.19	1.18	0.43	6.3	<0.01	v.s.
PIF	4.31	0.95	4.11	0.87	0.19	4.1	<0.05	s.
Airway resistance (kPa/(L/sec)) :								
RAWIN	0.38	0.18	0.30	0.18	0.78	14.9	<0.05	s.
RAWEX	0.54	0.28	0.61	0.73	-0.06	29.8	>0.05	n.s.
RPEAK	0.35	0.12	0.31	0.15	0.31	2.4	>0.05	n.s.
RAW	0.23	0.08	0.20	0.09	0.02	7.2	<0.01	v.s.

Table 1. Results of PFT and their statistic significance.

The initial correction in TLSO has no corrclation- with any difference of PFT parameters with and without TLSO.



Static lung volumes in patient with scoliosis
Fig. 4

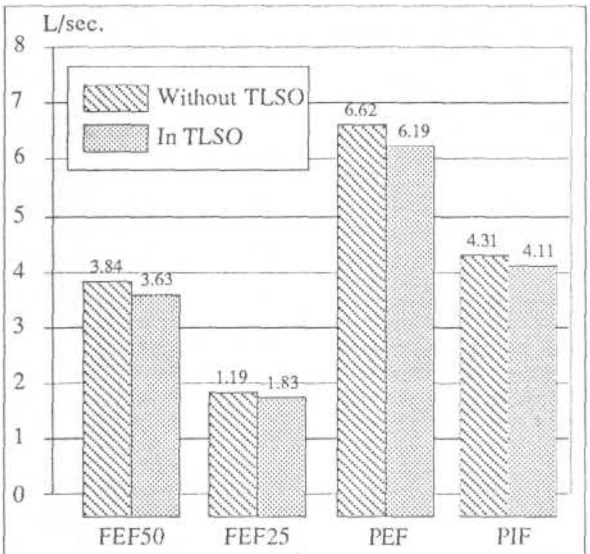


Dynamic lung volumes in patients with scoliosis
Fig. 5

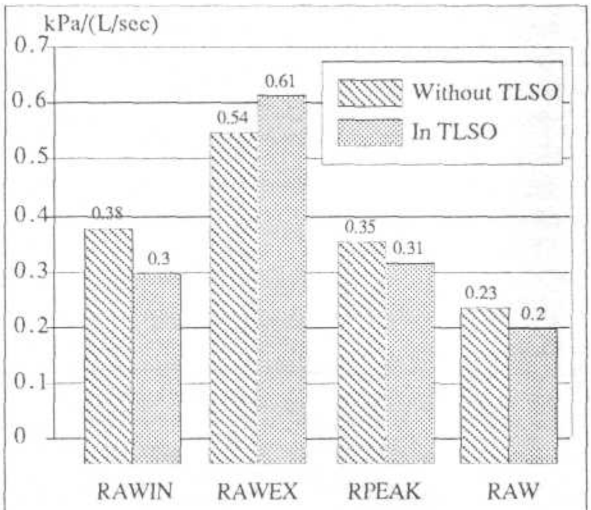
DISCUSSION

Evaluating the effects of TLSO of PFT in scoliosis children we found that strapping of thorax by TLSO bracing limited inspiratory expansion of chest wall.

The most significant difference seen in our patients is a substantial reduction of ERV (15.5 %). Origin of this diminution is reduction of inspiratory movements of thorax by TLSO which can not be completely compensated by increased diaphragmal excursions, especially at sitting position in which measurements of



Airflow
in patient with scoliosis
Fig. 6



Airway resistance
in patients with scoliosis
Fig. 7

PFT were carried out. Inspiratory capacity (1C) is the volume of air that is inhaled into lungs during a maximal inspiratory effort that begins at the end of a normal tidal expiration (ERV) and can be calculated by subtraction of ERV from VC. There is no difference in 1C between measurements with or without TLSO and, of course, there is no significant change of RV, demonstrating that the compensation for limited chest inspiratory movements is on account of ERV. Reduction of other static (VC, TLC) and dynamic (FEV1, FVC) volumes arc consequence of reduction of ERV (Fig. 8)

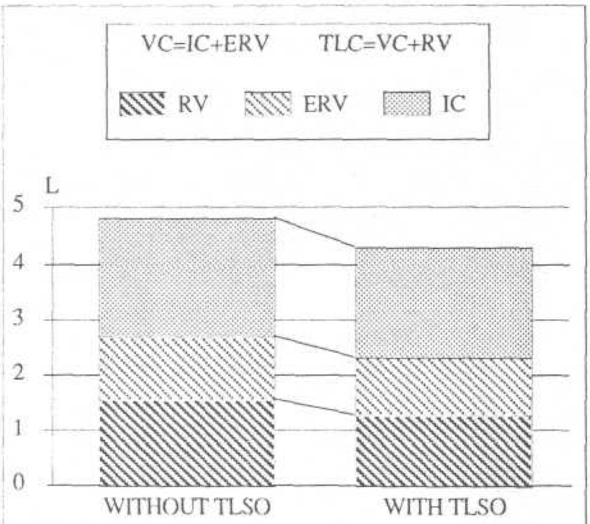
Airflow is decreased at greater, but not at lower lung volumes. A possible explanation for this can be incomplete stretching of expiratory muscles and chest wall in TLSO causing diminution of expiratory forces generated by elastic recoil of chest wall and contraction of expiratory muscles (FEF50). This factor docs not influence airflow at lower lung volumes (FEF25), so it does not change in TLSO.

Peak inspiratory How (PIF) in TLSO is also decreased because of limitation of forced inspiratory movement.

Airways resistance is calculated from the pressure gradients (between alveolar and atmospheric pressure) during a breath:

RAW = (Palv-Patm) / Airflow

Alveolar pressure (Palv) is generated by clastic recoil of king tissue and chest wall. Deeper inspiration will cause greater alveolar pressure at expiration. Thorax in TLSO can not achieve maximal inspiratory position, so the alveolar pressure in expiration is lower. Expiratory airflow in TLSO is also reduced (FEF50, PIF). Consequence is that expiratory airway resistance (RAWEX) and peak airway resistance (RPEAK) arc not significantly changed in TLSO, and RAW is even significantly reduced.



Lung volumes and capacities
in patients with scoliosis
Fig. 8

Inspiratory airway resistance (RAWIN) is significantly decreased. The reason for this is similar; Palv in inspirium is determined by distension of alveoli achieved by expansion of thorax and this expansion is limited by TLSO. Inspiratory airflow (demonstrated by PIF) is less decreased than the expiratory (4.1 % versus 6.3 %), so we have the situation that RAWIN is lower in TLSO.

We also found that there is no correlation (r = -0.049) between the most significantly changed PFT parameter (ERV) and initial curve correction in TLSO.

CONCLUSION

Reduction of static and dynamic lung volumes in TLSO exists and it is statistically significant, but is of no clinical importance. Reduction of airflow at lower lung volumes docs not exist and airway resistance is reduced, so it is clear that even obstruction of small airways (as in asthmatic child in quiet phase of the disease) can not be aggravated by TLSO bracing. TLSO is a reliable device for treatment of scoliotic curves below Th7 and do not seriously compromit respiratory function.

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