Scholars Journal of Applied Medical Sciences (SJAMS) **ISSN 2320-6691 (Online)**
Sch. J. App. Med. Sci., 2017; 5(8D):3282-3287 **ISSN 2347-954X (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublishers.com DOI: 10.36347/sjams.2017.v05i08.057

Original Research Article

A Prospective Study to Assess Changes in Pulmonary Function Tests in Patients of Spinal Deformity Treated by Halo-Pelvic Traction

Dr Raj Singh[1], Dr Renu Bala[2], Dr Krishna P Mazumdar[3], Dr Sukhbir S Sangwan[4], Dr Zile Singh Kundu[5], Dr. Vinit Verma[6], Dr Sant Lal Beniwal[7], Dr Rajpal Beniwal[8]

[1]Associate Professor, [3,6]Assistant Professor, [4]Ex-Head of Department, [5]Senior Professor, [7,8]Post Graduate Resident, Department of Orthopaedics, Paraplegia & Rehabilitation Pt. BD Sharma PGIMS, Rohtak (Hry) India.

[2]Professor Department of Anaesthesiology and Critical Care. Pt. BD Sharma PGIMS, Rohtak (Hry) India.

***Corresponding author**
Dr Raj Singh
Email: rajpotalia@gmail.com

Abstract: Respiratory function of patients with spinal deformities is likely to be abnormal and treatment is a surgical challenge in the presence of deranged pulmonary function. Halo-pelvic traction is a valuable alternative in these cases for correction of deformity. We studied the effect of halo-pelvic traction on pulmonary function in patients with spinal deformities to seek any improvement in PFT with correction of deformity. Thirty patients with severe scoliosis or kyphoscoliosis undergoing surgical treatment with halo-pelvic traction, anterior release or posterior fusion were prospectively evaluated with pulmonary function tests assessing volume (forced vital capacity) and FEV_1 (forced expiratory volume in 1 second). The PFT were noted pre-operatively as well as post-operatively after removal of halo-pelvic traction along-with demographic and other curve characteristics. The mean pre –operative FVC was 1.56 ± 0.58 L and % of predicted valve was 66.2±26% (12 – 112%) while Pre-op FEV_1 was 60.38±21.3% with range 10-90%. The post operative FVC was1.67± 0.67 L while % of the predicted value was 70.59±26.6% (15-123%). The post operative FEV_1 % of predicted value was improved to 64.35±21.9% with range12-105%. The difference between per-op FVC% and post –op FVC was 4.4±5.58% (range -11 to 20%) and FEV_1 % was 3.97±4.9 % (range -9.5 to 16.8%). There was no major pulmonary complication peri-operatively in any of the patient. PFT in a patient with spinal deformity varies according to cobbs angle and level of apex vertebra. Pre- operative PFT were important predictors of post-operative PFT. Post-operatively there is improvement of pulmonary functions and it also depends upon degree of correction and the approach of surgery.

Keywords: Spinal deformity, pulmonary function test, Halo-pelvic traction, Scoliosis, Kyphosis

INTRODUCTION

Spinal deformities such as scoliosis are quite common in young population [1]. Significant morbidities are associated in such patients. Correction of deformity by surgical interventions is indicated not only to maintain trunk balance but also to improve cardiopulmonary functions thereby reducing long term sequelae related to restrictive lung diseases [2-7]. Surgery has always been a challenging task in such patients. Compromised pulmonary functions further add to difficulties [8]. Preoperative pulmonary function tests (PFT) are indicated since deranged PFT may aggravate postoperative pulmonary complications [2].

Halo-pelvic traction is quite effective means of correcting and maintaining the correction of spinal deformities. Patients tolerate it well and maximum correction can be obtained without much discomfort and interference with daily physical activities [9]. The impact of curve correction on PFT has been studied and the results are contradictory [10]. Moreover, most of the studies are retrospective and bearing of halo-pelvic traction on PFT are lacking. Hence, we planned the present study assuming that there will be improvement in PFT because the chest is not encased in rigid cast and patients are mobile. The purpose of present study was to assess PFT in patients with spinal deformities and its association with cobbs angle and apex vertebra. We

further evaluated the changes in PFT following maximum correction of deformity using halo-pelvic traction.

MATERIALS & METHODS

The present prospective study was conducted in the Department of Orthopaedics, Paraplegia & Rehabilitation of our institution. Thirty patients of either sex, having severe scoliosis or kyphoscoliosis requiring surgical intervention were enrolled in the study after obtaining consent from patients or parents. A detailed clinical history pertaining to presentation, any associated anomaly or cardiopulmonary symptoms was obtained. General and systemic examination was performed; routine as well as special investigations such as MRI scan, Chest X-ray (Fig1a) were done. Pulmonary function tests (FVC & FEV_1) were done as baseline by spirometry at full voluntary efforts by the patient. Patients were taught respiratory exercises before surgery for post-operative period.

In patients with scoliosis, anterior release and halo-pelvic traction for correction of the curve and then posterior fusion of the curve after obtaining maximum correction was done while in patients with kyphoscoliosis halo-pelvic traction was applied and then curve correction was done with distraction and after maximum possible correction achieved, the arthrodesis was done by posterior fusion. Halo-pelvic traction was removed after radiological consolidation of fusion and pop cast was given after removal and then patients were managed with spinal orthosis in follow up.

Postoperative PFT & Chest X-ray were done after removal of HPT (Fig 1b). The patients were regarded as 'responders' if there was ≥5% improvement in PFT; as 'non-responder' if there was 0-5% improvement in PFT. Decline in PFT in any patient was also noted. The patients were assessed for correction of deformity and anthropometric measurements were repeated.

STATISTICS

The data was analyzed SPSS software version 18 (SPSS Inc, Chicago, IL, USA). The continuous variables were presented in the form of mean ± SD and range while categorical data was presented in the form of number and percentages. Preoperative and postoperative PFT were analyzed using student t test. Pearson correlation was used to determine association between pre-op PFT and cobs angle and apex vertebra; correction of deformity with percentage improvement of PFT. The p value < 0.05 was taken as significant.

RESULTS

A total of 30 patients underwent correction of spinal deformities using HPT. Patients belonged to younger age group (13.6 ± 3.792 years) and female preponderance was observed (16:14). Most common deformity was scoliosis and etiology was idiopathic and congenital. Mean cobbs angle was75.68º ± 17.32º with a range from 50º to 128º and apex vertebra in most of the cases are D-8, 9 and 10 (Table 1). The surgery performed is shown in Table 2. Majority of patients underwent anterior release along with halo-pelvic traction followed by posterior fusion in 19 patients. The mean pre –operative FVC in 30 patients was 1.56 ± 0.58 (n=30). And in FVC% of predicted valve was 66.2 ± 26% (12 – 112%) while Pre-op FEV_1 in %age of predicted value was 60.38±21.3% with range 10-90%.Table 3 shows pre-operative and post-operative PFT as per the deformity and location of the apex vertebra and site of the curve. There was negative correlation between cobs angle and pre op FVC as well as FEV_1 with pearson's correlation coefficient($r = -0.268$, $p = 0.15$, n=30) and on statistical analysis of relationship between halo-pelvic traction and pulmonary function showed that there was strong correlation between pre-operative and post-operative FVC with ($P < 0.001$, $r = 0.97$, $n = 30$) and not on other variables. Table 4 shows distribution of patients as per changes in PFT (FVC %) after deformity correction. There was decrease in PFT in 10 % of the patients while 47% of the patients remained stable as there was ±5% change in FVC%. Rest of the patients were responders >5% in30% of the cases and >10% in 13% of cases. In scoliotic patients mean pre-op FVC1.52±0.65 which had a negative correlation with cobbs angle with pearson's correlation coeff.value ($r = -0.129$) at $n = 20$ and $p = 0.587$ while post op FVC has $r = 0.012$ at n= 20, $p = 0.96$. The post operative FVC %of the predicted value was 70.59±26.6% (15-123%) at n=30. The post operative FEV_1 % of predicted value was improved to 64.35±21.9% with range12-105%. The difference between per-op FVC% and post –op FVC was 4.4±5.58% (range -11 to 20%) and FEV_1 % was 3.97±4.9 % (range -9.5 to 16.8%). There was no major pulmonary complication intra-operatively or post-op in any of the patient.

Table−1 Demographic Profile of the patients

Age (Yrs)	13.6 ± 3.792
Gender (M:F)	14(47%) : 16(53%)
Type of deformity Scoliosis Kyphoscoliosis	 20 10
Curves Left / right (Scoliotic Only) Thoracic / Thoracolumbar (All)	 11 / 9 14 / 16
Cobb's angle (Mean ±SD)	75.68 º ±17.32º

Table-2 Surgical Procedures

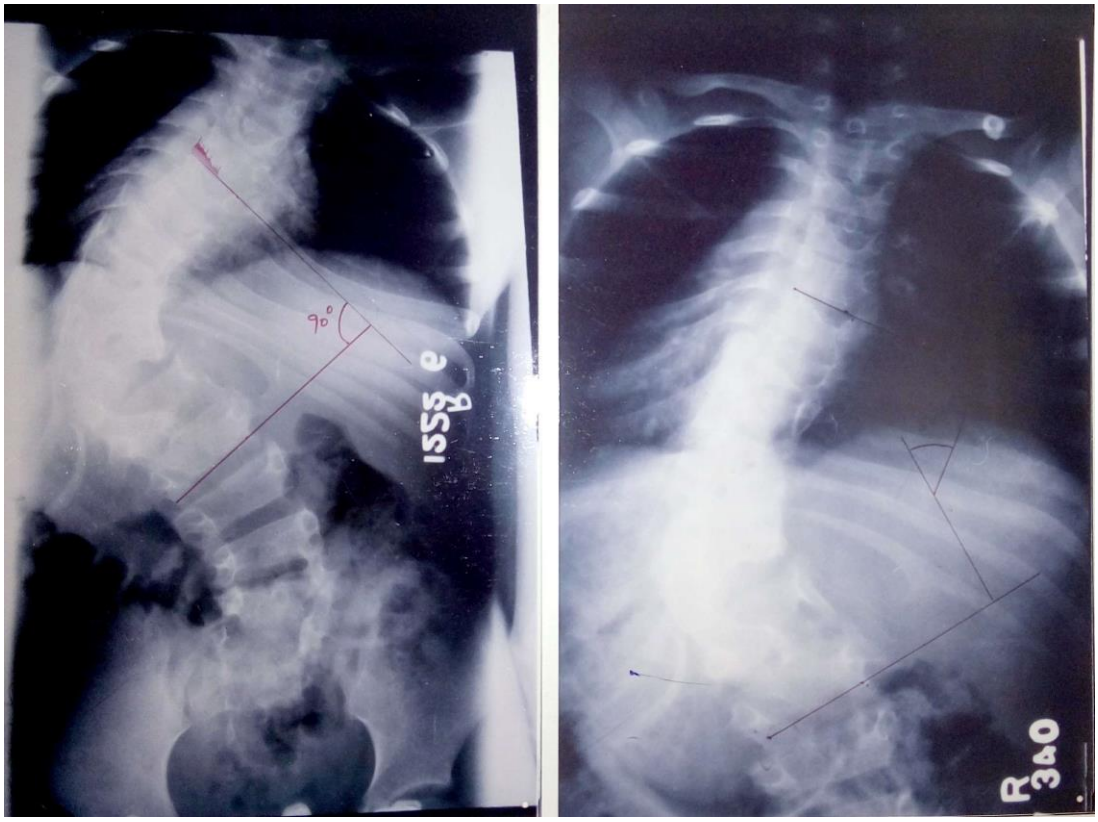
Type of surgery	No. of patients
HPT only	4
HPT with post fusion	7
Anterior release with HPT and post Fusion	19

Table-3: Changes in pulmonary function tests (absolute values) as per the curve characteristics

Type of deformity	Pre- operative			Post –operative	
	FEV1 (L)	FVC (L)	Ratio	FEV1(L)	FVC(L)
Scoliosis (n=20)	1.22 ±0.53	1.53±0.63	.76	1.29±0.56	1.62 ±0.65
Kyphoscoliosis (n=10)	1.31±0.36	1.63±0.44	.80	1.42±0.38	1.77±0.47
Site of deformity					
Thoracic (n=14)	1.22±0.56	1.52±0.66	.80	1.28±0.59	1.59±0.69
Thoracolumbar (n=16)	1.28±0.41	1.6±0.59	.79	1.39±0.42	1.74±0.51
Curves with apex vertebra					
D-10 and above(n=12)	1.35±0.27	1.71±0.33	.79	1.47±0.23	1.86±0.29
Upto D-9 (n=18)	1.19±0.58	1.47±0.68	.76	1.25±0.61	1.54±0.72
Overall (n=30)	1.25±0.51	1.56±0.58	.77	1.34±0.51	1.67±0.60

Table-4 Showing PFT Changes along with no of cases

PFT Change (FVC%)	No. of Cases
Decrease	3 (10%)
0% to 5%	14 (47%)
>5 %	9(30%)
>10%	4(13%)



Fig−1: (a&b) Chest X-ray pre-operative (a) and after removal of Halo-pelvic Traction. (b)

DISCUSSION

The thoracic spine is an important structure consisting of the thoracic cage in which major organs, such as the heart and lungs lie. Structural changes of spine as seen in scoliosis can influence functioning of these vital organs [11]. There is decrease in chest wall compliance directly and lung compliance indirectly due to progressive atelectasis and air trapping. This leads to significant increase in work of breathing which may result into respiratory failure [5]. The pulmonary functions of these are known to be abnormal. Preoperative evaluation of respiratory functions is very important because they help in predicting and avoiding postoperative pulmonary complications by selecting the appropriate surgical approach. Surgical correction of deformity successfully improves cosmetic appearance but pulmonary impairment is not overcome with.

In our study we enrolled patients with severe spine deformity and found deranged PFT in them. There was more decrease in FVC while FEV_1 was slightly reduced and their ratio was almost unchanged. Scoliosis results in restrictive lung disease, which could result in decreased lung volume as manifested by a decrement of total lung capacity. There was negative correlation between cobbs angle and FVC which means that more severe the spine deformity, greater is the impact on respiratory functions. Our results are similar to those by Huh *et al*. in terms of decrease in FVC but the authors found decrease in FEV_1 too which was absent in our study but the ratio was with-in normal. The mean cobb's angle in Huh *et al*. was 53.8º while in our study it was75.68º with range from 50º - 128º [12]. Zang *et al*. had found significant correlation between abnormal pre-op PFT and pre-op symptoms, the average cobs angle was 73.26º (range 45º-141º) and shown that pre operative symptoms predicted abnormal PFT but no correlation with post-op respiratory complications. They have shown that pulmonary complications are more with anterior trans-thoracic approach. [2] Both of these studies were retrospective, while our study was prospective. Patients with apex vertebra above diaphragm had more derangement of PFT similar to previous study because of the obvious reason that involvement of thoracic spine has more impact on respiratory profile.

Dickson RA and winter RB *et al.* observed that correction of thoracic lordosis improves pulmonary functions of the patients. Although costoplasty alone cause a significant fall in PFT of the patient in post-op period but procedure done to improve thoracic lordosis as well as spinal fusion cause much lesser fall in PFT [13].

Koller H *et al.* observed stabilization of pre-op PFT level values without any significant increase in PFT values after correction of deformity [8]. Some of the authors described significant improvement in PFT of 2%-11% [10, 14-16]. Newton *et al*. shown pre-operative FVC% was highly predictive of post-op FVC% [17]. The results of present study also confirm the results of the other studies regarding the important role of pre-op PFT as predictor of post-op PFT. The role of traction for curve correction on PFT was shown by Rizzi *et al*. in which they used HGT (halo-gravity traction) and find it beneficial for improvement of FVC. In his study he reported in 19 patients pre-op FVC% was 27% and HGT FVC% was 34% representing an improvement of 7% [5].

O'brian *et al.* observed an improvement in respiratory functions of 22% in case of paralytic scoliosis treated with halo-pelvic traction [18]. Yau ACMC *et al*. had observed an overall 16% average (17-42%) increase in vital capacity after correction in tubercular kyphosis treated by halo-pelvic traction [19]. In our study the improvement of 4.4±5.58% (range -11% to 20%) in FVC% of predicted value was observed as we have both scoliotic and kyphotic patients. In addition to the above intensive pre-op respiratory exercises by the trainer as preformed in our patients can improve PFT. The exact cause of deterioration of PFT in correction of spinal deformities is not known but it appears to be changes in chest cage, scarring of respiratory muscles and post –op pleural adhesions however for improvement in vital capacity might be correction of lordo-scoliosis and fusion of spine in the corrected position.

The study had few limitations. The sample size was small. Second, the long term follow-up of patients was lacking. We took a single reading of PFT after removal of HPT. There could be alteration in PFT after that too. Third, we measured FVC and FEV_1 other parameters could have been measured.

CONCLUSION

PFT in a patient with spinal deformity varies according to Cobbs angle and level of apex vertebra. Pre- operative PFT were important predictors of post-operative PFT. Post-operatively there is improvement of pulmonary functions when HPT is used as a part of interventional management and it also depends upon degree of correction and the approach of surgery. Further studies comprising of more number of patients are indicated to confirm our results.

REFERENCES

1. Carter OD, Haynes SG: Prevalence rates for scoliosis in U S adults: Results from first National Health and Nutrition Examination Survey. Int J Epidemiol 1987; 16:537-44.
2. Zhang JG, Wang W, Qiu GX, Wang YP, WengXS, Xu HG. The role of preoperative pulmonary function tests in the surgical treatment of scoliosis. Spine. 2005 Jan 15;30(2):218–21.
3. Weinstein SL. Natural history. Spine. 1999 Dec 15;24(24):2592–600.
4. Pehrsson K, Danielsson A, Nachemson A. Pulmonary function in adolescent idiopathic scoliosis: a 25 year follow up after surgery or start of brace treatment. Thorax. 2001 May;56(5):388–93.
5. Vitale MG, Matsumoto H, Bye MR, Gomez JA, Booker WA, Hyman JE, Roye Jr DP. A retrospective cohort study of pulmonary function, radiographic measures, and quality of life in children with congenital scoliosis: an evaluation of patient outcomes after early spinal fusion. Spine. 2008 May 15;33(11):1242–9.
6. Rizzi PE, Winter RB, Lonstein JE, Denis F, PerraJH. Adult spinal deformity and respiratory failure. Surgical results in 35 patients. Spine. 1997 Nov 1;22(21):2517–2530.
7. Jackson RP, Simmons EH, Stripinis D. Coronal and sagittal plane spinal deformities correlating with back pain and pulmonary function in adult idiopathic scoliosis. Spine. 1989 Dec;14(12):1391–7.
8. Koller H, Zenner J, Gajic V, Meier O, Ferraris L, Hitzl W. The impact of halo gravity traction on the curve rigidity and pulmonary functions in the treatment of severe and rigid scoliosis and kyphoscoliosis: a clinical study and narrative review of literature. Eur Spine J.2012 Mar; 21 (3): 514-29.
9. Raj Singh, Sangwan SS, Renu Bala, Vinit Verma, Kundu ZS, Krishna PM, Kuldeep Singh. Evaluation of Halopelvic traction for curve correction in spinal deformities. IOSR-JMDS 2017 June;16 (6) ,Ver 9: 50-56.

10. Vedantam R, Lenke LG, Bridwell KH, Hass J, Linville DA. A prospective evaluation of pulmonary functions in patients with adolescent idiopathic scoliosis relative to the surgical approach used for spinal arthrodesis. Spine 2000 Jan; 25 (1): 82-90.
11. Huh S, Eun LY, Kim NK, Jung JW, Choi JY, Kim HS. Cardiopulmonary function and scoliosis severity in idiopathic scoliosis children. Korean J Paediatr 2015; 58(6): 218-23.
12. TsiligiannisT, Grivas T. Pulmonary function in children with idiopathic scoliosis. Scoliosis 2012; 7:7.
13. Winter RB. Excessive thoracic lordosis and loss of pulmonary functions in patients with idiopathic scoliosis. J Bone Joint Surg1975; 57 A: 972-77.
14. YaszayB, Jazayeri R, Lonner B. The effect of surgical approaches on pulmonary function in adult idiopathic scoliosis. J Spinal Disord 2009; 22: 278-83.
15. Izatt MT, Harvey JR, Adam CJ, Fender D, Labrom RD, Askin GN. Recovery of pulmonary function following endoscopic anterior scoliosis correction: evaluation at 3, 6, 12 and 24 months after surgery. Spine2006; 31:2469-77.
16. Koller H, Zenner J, Hitzl W, Meier O, Farraris L, Acosta F, Hempfing A. The morbidity of open transthoracic approach for anterior scoliosis correction. Spine 2010; 35: 1586-92.
17. Newton PO, Perry A, Bastrom TP, Lenke LG, Betz RR, Clements D, D'Andrea L. Predictors of post-operative pulmonary functions in adolescent scoliosis. Spine 2007;32: 1875-82.
18. O'brian JP, Yau ACMC, Hodgson AR. Halo-pelvic traction – A technique for severe spinal deformities. Clin Orthop 1973; 93: 179-190.
19. Yau ACMA, Hso LCS, O'brien JP, Hodgson AR. Tubercular Kyphosis – Correction with spinal osteotomy, halo-pelvic distraction and posterior fusion. J Bone Joint Surg 1974;56 A(7): 1419-34.