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International Journal of Physical Medicine and Rehabilitation

Case Report

Effect of Orthotic Treatment on Curve Correction and Cardio Respiratory Functions in Congenital Scoliosis with Single-Level Hemi Vertebrae

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ABSTRACT

Background: The natural world of congenital scoliosis with hemi vertebrae is changeable, especially when it is combined with a unilateral unsegmental bar. Orthotic treatment's primary aim is to stop further curve progression. The aim of this study is to find the effect in treating congenital scoliosis with single-level hemi vertebrae using orthotic interventions on curve correction and its cardio respiratory functions.

Case description and method: A 14 years old with single-level hemi-vertebrae related congenital scoliosis tookunder non-operative treatment at his body with an average supplement period of 2 years. Spinal orthosis (moulded-TLSO, high Profile Boston Brace) was fitted on the patient according to SRS guidelines. Breathe cardio-respiratory data analysis and the metabolic data analysis are done through the COSMED-Srl-Italy,K4B2 respectively.

Finding: The cardio-respiratory table and graph established a significantly better result in congenital scoliosis with spinal orthosis. Orthotic treatment gives good result over only physiotherapy treatment in term of curve progression and correction.

Outcomes and conclusion: The case study shows that high profile Boston brace can stop curve progression in the case of congenital scoliosis without any adverse effect on cardio-respiratory parameters in hemi vertebrae patient.

Keywords: Cardio respiratory; Congenital scoliosis; Hemi vertebrae; Orthotic treatment; Curve correction

BACKGROUND

Congenital scoliosis is involved in spinal global axis due to progressive abnormality and its incidence is approximately 1/1000 births [1-3]. Ecological and genetic factors are responsible etiology for the congenital scoliosis and also affects the human spine development during 6 week of development [4]. The growth of the divisions in the spine takes 3 to 6 weeks from birth of a child [5]. Genetic factors are responsible for forming congenital scoliosis. Cardiac, renal and other anomalies may be present with congenital scoliosis [6,7]. Radiological study suggest that spinal asymmetrical vertebral growth is a significant cause for creating segmented or unsegmented hemi vertebra accompanied with curvature [8]. The abnormalities for the congenital scoliosis are caused by hemi vertebra, wedge vertebra or block vertebra [9].Most of the curve progression a well as spinal development are observed during the first years of a child including its adolescent period [10]. Many statistical analysis reports suggest that 25% of curves are non-progressive, 25% mildly progressive and 50% highly progressive and will needs non-operative or operative treatments [11-14].

Treatment for Congenital scoliosis is to keep the patient under observation or bracing or lastly surgery. Observation and bracing is mostly applied with non-progressive curves and those patients having adequate balance capacity. Bracing are particularly not indicated for the correction but it is effective to stop curve progression, prevention to develop compensatory curve, build up balance or maintain alignment after surgery [15]. Surgical treatment is quit unsafe for neurological damage more in congenital over idiopathic scoliosis [16].Surgical treatment is indicated for those patient having positive curve progression factors, gross imbalance of spine and having greater curve [17,18]. Timely detection and timely start of non-operative

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Received date: February 20, 2020; **Accepted date:** March 10, 2020; **Published date:** March 17, 2020

Citation: Raihan HMA, Poly Ghosh (2020) Effect of Orthotic Treatment on Curve Correction and Cardio Respiratory Functions in Congenital Scoliosis with Single-Level Hemi Vertebrae. Int J Phys Med Rehabil 8:539. DOI: 10.35248/2329-9096.20.08.539

treatment helps to minimize the surgical options and its gives a good result for prevention of curve progression as well as development of compensatory curves [19-21].

According to literature review it's concluded that orthotic treatment is more effective in case of idiopathic scoliosis compared to congenital scoliosis.

The aim of this case study was to find the effect in treating congenital scoliosis with single-level hemi vertebrae using orthotic interventions in terms of on curve correction and cardio respiratory functions.

CASE DESCRIPTION AND METHOD

Post-test experimental case study was performed at National Institute for the Locomotor Disabilities, Kolkata, India.

Independent variable was cobb'sangle, cardio respiratory functions and dependent variables were Moulded-TLSO-high profile Boston brace. Cardioresporiity data collection instrument COSMED K4b2 system was used.

The Case: Patients name Laddu Kumar, age 14 years old with single-level hemi-vertebrae related congenital scoliosis undertook non-operative treatment on his body with an average supplement period of 2 years.

Chief complaint: Lateral curvature of spine and problem in posture.

Trunk, Flexor-4+, Extensor-4+. Trunk range of motions is with in normal range.

Hip (Flexor, Extensor, Abductor, Adductor, Internal rotator, External rotator), (Flexor, Extensor) and Ankle (Plantanflexor, Dorsiflexor) with normal grade i.e. Grade 5. Hip, knee, ankle all passive and active range of motions are normal.

All the shoulder (Flexor, Extensor, Abductor, Adductor, Internal rotator, External rotator) elbow (Flexor, Extensor), wrist (Flexor, Extensor) of upper limb were in normal grade. i.e. Grade 5 and range of motion is also normal.

Pain is not present.

Tenderness absent.

Spasm absent.

LLD present right side half inch shortening.

Sensation intact.

Cobb' s angle-29 degree (thoracic curvature)

Apex of vertebra-T6

Lumbar curve-20 degree

Apex of vertebra-L3.

Vertebra rotation is present in thoracic region-grade-2 according to Nash-Moe method

Speech-NAD

Hearing-NAD

Vision-NAD

Memory-NAD

Coordination-NAD

Writing-independent, reading-independent and playing.

Running and jumping-independent.

Prolonged sitting-independent.

Prolonged standing-independent, squatting-independent.

Scoliosis of the upper dorsal spine is noted with concavity to the left side.

Hemi-vertebra is noted at D6 level. L2 and L3 vertebra are fused.

Rest of the vertebral bodies and appears normal. No cervical rib is notated.

Both Sacroiliac and hip joints appears normal.

No abnormal paravertebral soft tissue shadow is noted.

Bony maturity is not completed (Risser's sign-II).

Progression factor active (according to rib-vertebral angle differences).

Shoulder asymmetry, pelvic obliquity and waist asymmetry was prominent.

No organ is missing.

Adam test positive.

Balance is nearly normal (Checked through Force plate).

Without orthotic intervention physiotherapy was continued for 1 year. After that we apply on him spinal orthosis. First orthotic recommendation was Milwaukee brace but was rejected by the patient. Then we applied on him moulded-TLSO-high profile Boston brace according to a sub classification of the SRS definition of curve type. After application of moulded TLSO follow up was done after 6 months. For the limb length discrepancy we provide shoe compensation. Institute ethical permission has been taken for this study (Letter Number-Review letter No: IEC/1610/RandD/08/2015).

Breathe cardio-respiratory data analysis and the metabolic data analysis is done through the gold standard COSMED-Srl-Italy, K4B2. We measure the O2 consumption level PaO2, PaCO2, Tidal volume, Heart rate, Energy cost, VO2, VCO_2 and O2 expenditure. Post experimental data was taken without brace and with the brace. The patient was quite psychologically normal. Patients had no stress, anxiety or fear. Basic input data was height and weight. Adaptability period was five minute. Data were taken at normal room-temperature while in the sitting position and after 30 meter self-selected walking test. At first, parts of the Cosmed K4B2 analyzer were attached to the patient's body (Figure 1). Heart belt was fixed to the patient's box thorax and the K4b2 unit was attached to the front of the harness. Battery was fixed at the heart belt on the subject's back. Then the battery cable was connected to the 6V plug of the K4b2 control panel. Precaution was taken so that the red plug, that repairs the plug from water or sweat drops, was on the Portable Unit side. Then the antenna cable was connected to the antenna plug of Portable Unit control panel. The heart frequency receiver and temperature probe cable was inserted in the HR-Temp plug placed on the control panel and the male connector of the turbine was inserted in the Turbine plug on the control panel. After that the power supply cables, antenna and turbine on the right side of the jacket was fixed with the Velcro stripes provided in the equipment and the heart frequency probe was fixed on the left side. Every data was taken three times and mean value was used for the result.

Photo: 1- With-out Brace

Photo: 1- With-out Brace

Figure 1: Attachement of Cosmed K4B2 analyzer to patient's body.

Instrument Validation-COSMED K4b2: The K4b2 (The gold standard with high accuracy) is the first COSMED portable system for intrapulmonary gas exchange analysis on true breath by breath basis. COSMED is the only manufacturer having more than 20 years of experience in mobile metabolic testing be it in the field or in laboratory in any discipline like Sport Medicine, Research, Human Performance, Gait Lab, Occupational health, Cardiology, Cardiac Rehabilitation, Clinical Nutrition and any application that requires the measurement of the cardio-respiratory response either in the field or in the lab. The fast O2 and CO2 analysers are maintained at a constant temperature. Sampling flow and pressure are continuously monitored. A barometer along with a temperature and pressure sensor allows instantaneous correction for any change in the environmental conditions. The K4b² is provided with all necessary hardware for testing in the field.

RESULTS

The cardio-respiratory table and graph established a significantly better result in congenital scoliosis with spinal orthosis (Table 1) (Figure 2). Orthotic treatment gives good result over only physiotherapy treatment in terms of curve progression and correction. As per current X-ray report, upper curve magnitude is unchanged and lower curve is corrected. Data Analysis was performed through SPSS 20.01 version and M.S excel and paired t-test statistical tool was used for finding significance.

Table 1: Mean differences of the Cardio-respiratory and metabolic parameters.

	Condition	Mean	SD	Significance
PaO2(mmHg)	Without brace	139.5254	2.4094	<0.0001
	With brace	142.3729	1.5525	
VO2(mL/min)	Without brace	480.6994	121.04	<0.0001
	With brace	621.8895	109.8558	
VT(liter)	Without brace	0.316	0.0563	0.0001
	With brace	0.3504	0.0369	
Energy Exp (Kcl/min)	Without brace	0.0687	0.5124	<0.0001
	With brace	0.5386	0.4357	
O2 Exp(mL)	Without brace	38.5202	5.6595	0.0003
	With brace	42.1416	4.745	
O2 Cost mL/min/Kg	Without brace	0.9498	2.2795	<0.0001
	With brace	0.0869	1.5324	
Heart rate(bpm)	Without brace	88.2034	8.8294	<0.0001
	With brace	98.1186	8.6085	
VCO2(mL/min)	Without brace	134.7535	46.8989	0.9336
	With brace	135.5611	22.1332	

PaO2(2.85 mmHg), VO2(141.19 mL/min), VT(0.03 liter), Energy Exp (0.47 Kcl/min), O2 Exp (3.62 mL), Heart Rate (9.91

bpm) and VCO2 (0.81 mL/min) parameters are increased. Only O2 Cost (0.86 mL/min/Kg) is decreased.

OUTCOME

The aim of this case study is to find the effect in treating congenital scoliosis with single-level hemi vertebrae using orthotic interventions on curve correction and its cardio respiratory functions.

High profile Boston brace gives good results in terms of stopping upper curve progression and lower curve correction within 6 months of follow up on this particular case. Its gives a positive sign for delaying surgery or quit this option altogether spinal Orthotic treatment is less effective in congenital scoliosis and its application is infrequently observed [15].There have been very few studies available for the nonoperative treatment in case of congenital scoliosis. Blount first declared the millukee bracing being used for the congenital scoliosis [22]. Robert et al. expressed that orthotic treatment (Millukee brace) has a useful purpose in congenital scoliosis and it has postponed of the surgery. It was also concluded that the brace application is more effective in case of idiopathic scoliosis compared to congenital scoliosis [23].

Graph of Cardio-respiratory and metabolic parameters.

Statistical analysis of observed data: Statistical analysis shows that the averages observed for normal and moulded TLSO in all cardiorespiratory parameters are statistically significant. Except VCO2.

R.Q (Respiratory coefficient, VCO2/VO2)=1. (Respiratory Exchange Ratio) RER: is defined as the ratio of CO2 Production to O2 consumption under exercise condition. An RER>0.90 is indicative of anaerobic activity, and an RER>1.00 is indicative of severe exertion. Without brace the value of R.Q=0.2 and with brace is 1.23.

There is strong correlation between the severity of spinal curvature and reduction in vital capacity in patients with idiopathic scoliosis [24-26]. Paralytic scoliosis causes a greater decrease in lung volumes than is the case when similar curves are accompanying with normal muscle function [26-27].

According to Owange-Iraka et al. the mean loss in VC for the congenital scoliosis was 53% (SD ± 15%) and in idiopathic scoliosis the mean percentage loss in VC was 36% (SD+20%). For a particular angulation of the spine the loss in VC was approximately 15% greater in congenital scoliosis than in idiopathic scoliosis. And concluded that for a given degree of scoliosis, the congenital type was associated with a significantly greater shortfall in vital capacity (VC) than the idiopathic type [28].

CONCLUSION

Congenital scoliosis might impose an additional restriction on lung function. Therefore we have investigated the differences in vital capacity (VC) and other cardio respiratory functions particularly during the period of this case study. It is observed that the patient was comfortable with the Brace even there is significant differences in cardiorespiratory and metabolic parameters for that patient.

This case report expresses supporting evidence for the orthotic treatment in congenital scoliosis. This treatment plan for congenital scoliosis is having a positive effect to reduce surgical interventions or further delay the process of going for surgery. Orthotic treatment provides a positive effect for the patients with hemi vertebrae and patient is benefited for compensatory curve correction and unchanged magnitude of major curve inside the nearby normal cardio-respiratory functions.

ACKNOWLEDGEMENTS

Authors would like to thanks Dr.S.P.Das, Director, National Institute for Locomotor Disabilities (Divyangjan), Kolkata and MoSJE, Govt. of India for giving permission to present this work.

FUNDING ACKNOWLEDGEMENT

We do not receive any funding for this study.

CONFLICT OF INTEREST

There is no conflict of interest in this work.

REFERENCES

1. Giampetto PF, Blank RD, Raggio CL, Merchant S, Jacobsen FS, Faciszewski T, et al. Congenital Scoliosis and idiopathic scoliosis: Clinical and genetic aspects. Clin Med Res. 2003;1:125-136.
2. Slabaugh PB, Winter RB, Lonstein JE, Moe JH. Lumbosacral hemivertebrae: A review in twenty-four patients, with excision in eight. Spine 1980;5(3): 234-244.
3. Winter RB, Moe, JH Eilers VE. Congenital scoliosis a study of 234 patients treated and untreated Part I: Natural history. J Bone Joint Surg. 1968;50(1):1-15.
4. Arlet V, Odent T, Aebi M. Congenital scoliosis. Eur Spine J. 2003;12(5):456-463.
5. Ganey TM, Ogden JA. Development and maturation of the axial skeleton in the Pediatric Spine. 2001;3-54.
6. Maisenbacher MK, Han JS, O'Brien ML, Tracy MR, Erol B, Schaffer AA, et al. Molecular analysis of congenital scoliosis: A candidate gene approach. Hum Genet. 2005;116:416-419.
7. Campbell RM Jr, Smith MD, Mayes TC, John AM, Donna BWC, et al. The characteristics of thoracic insufficiency syndrome associated with fused ribs and congenital scoliosis. J Bone Joint Surg. 2003;85(3):399-408.
8. McMaster MJ, David CV. Hemivertebra as a cause of scoliosis: A study 104 patients. J Bone Joint Surg. 1986;68:588-595.
9. McMaster MJ, Ohtsuka K. The natural history of congenital scoliosis. A study of two hundred and fifty-one patients. J Bone Joint Surg. 1982;64:1128-1147.
10. Dimeglio A, Alain, Federico C, Philippe YC. Growth and adolescent idiopathic scoliosis: When and how much?J Pediatr Orthop. 2001;31:28-36.
11. Holte DC, Winter RB, Lonstein JE, Denis F. Excision of hemivertebrae and wedge resection in the treatment of congenital scoliosis. J bone and Joint Surg. 1995;77(2):159-171.
12. Winter RB, Moe JH. The results of spinal arthrodesis for congenital spine deformity in patients younger than 5 years old. J Bone Joint Surg. 1982;64:419-432.

13. Winter RB, Moe JH, Lonstein JE. A review of family histories in patients with congenital spine deformities. Orthop Trans. 1983;7:32.
14. Winter RB, Lonstein JE, Denis F. Sta-Ana de la Rosa H. Convex growth arrest for progressive congenital scoliosis due to hemivertebrae. J Pediatr Orthop. 1988;8(6):633-638.
15. Alert V, Odent Th, Aebi M. Congenital Scoliosis. Eur Spine J. 2003;12(5):456-463.
16. MacEwen GD, Bunnell WP, Sriram K. Acute neurological complications in the treatment of scoliosis. A report of the Scoliosis Research Society. J Bone Joint Surg Am. 1975;57(3): 404-408.
17. Batra S, Ahuja S. Congenital Scoliosis: Management and future directions. Acta Orthop. Belg. 2008;74:147-160.
18. Hedequist D. Surgical treatment of congenital scoliosis. Orthop Clin N Am. 2007;38(4):497-509.
19. Cheung KM, Zhang JG, Lu DS, K Luk KD, Y Leong JC. Ten-year follow-up study of lower thoracic hemivertebrae treated by convex fusion and concave distraction. Spine. 2002;27(7):748-753.
20. Garrido E, Tome-Bermejo F, Tucker SK, Noordeen HN, Morley TR. Short anterior instrumented fusion and posterior convex non-instrumented fusion of hemivertebra for congenital scoliosis in very young children. Eur Spine J. 2008;17(11):1507-1514.
21. McMaster MJ, Singh H. Natural history of congenital kyphosis and kyphoscoliosis. A study of one hundred and twelve patients. J Bone Joint Surg Am. 1999;81(10):1367-1383.
22. Blount WP. Congenital scoliosis. Proceeding of the Scciete Internationale de Chirurgic Orthopedique et de Chirugie Orthopedique etde Traumalogie, Auitieine Congress. New York. 1960.
23. Robert BW, John HM, Dean GM, Hector PV. The Milwaukee brace in nonoperative treatment of congenital scoliosis, Spine. 1976;1(2):85-96.
24. Bergofasky EH, Turino GM, Fishman AP. Cardio-respiratory failure in kyphoscoliosis. Medicine. 1959;38:263-317.
25. Bjure J, Grimby G, Kasalický J, Lindh M, Nachemson A. Respiratory impairment and airway closure in patients with untreated idiopathic scoliosis. Thorax. 1970;25(4):451-456.
26. Kafer ER. Idiopathic scoliosis. Mechanical properties of the respiratory system and ventilatory response to carbon dioxide. J Clin Invest. 1974;55:1153-1163.
27. Flagstad AE, Kollman S. Vital capacity and muscle study in one hundred cages of scoliosis. J Bone Joint Surg. 1928;10:724-734.
28. Owange-Iraka JW, Harrison A, Warner JO. Lung function in congenital and idiopathic scoliosis. Eur J Pediatr. 1984;142:198-200.