The Short and Intermediate Term Effect of Rib Raising on Lung Function on a Child with Asthma: A Comparison Case Study

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ABSTRACT

Background: Asthma is the most common chronic illness effecting children and adolescents in Australia, and is associated with increasing morbidity rates and financial costs to our society.

Objective: The aim of this study was to determine whether the use of a specific manual therapy technique, rib raising, could produce short and intermediate term improvements in the lung function in children with chronic asthma.

Clinical Features: A comparative single case study was carried out between two asthmatic children aged 16-17, both with a long history of mild asthma requiring the use of ventolin up to five times a week.

Intervention: One received the rib raising technique and the other a sham technique. Pre and post treatment FEV_1 and FVC were recorded for both participants over the short and intermediate term.

Outcomes: The rib raising participant showed, in the short term (20 minutes post treatment), up to a 13.81% increase in FVC and up to an 18.37% increase in FEV_1 compared to the sham technique of 3.48% and 8.28%, respectively. In the intermediate term (one week post treatment) the rib raising improved FVC by 10.49% and FEV_1 by 24.90%, while the sham yielded FVC improvements of 0.87% and FEV_1 of 5.73%. Overall FEV_1/FVC increased by 8% in the rib raising compared to only 3% in the sham technique.

Conclusions: These results demonstrate that rib raising produce an increase in the lung function of an asthmatic child in the short and intermediate term.

Further research is required to determine the possible benefits of rib raising on children with chronic stable asthma.

Keywords: Asthma, Osteopathy, Rib-raising, Manual Therapy, Children

INTRODUCTION

Asthma is the most common chronic illness effecting children and adolescents in Australia.[1] Current statistics show that up to two in five primary school aged children and up to one in seven teenagers suffer from the disease,[2,3] with prevalence rising at a rate of 1% per year. It is the most common cause of absenteeism from school and childhood admissions into hospital.[2,3] While the number of deaths that occur from asthma attacks is declining, the increase in treatment and medication cost is constantly rising for the Australian public and has been recently estimated to be $750 million per year.[3,4] This places a large burden on the public health care system which will only increase with the rising prevalence of asthma unless suitable alternative asthma management strategies are developed.

While the pathophysiology of asthma is understood to some degree, the exact causes behind the disease process are not. The airway obstruction common with asthma is often caused by a combination of hyper-responsiveness of the airways, infiltration of inflammatory mediators and bronchospasm.[5,6] It has also been postulated that abnormal neural control of the airways may contribute to the pathophysiology of asthma.[7] The autonomic nerves contribute to regulate functions such as muscle tone, vascular permeability and the release of inflammatory mediators, which may partly explain the pathophysiological changes seen in an asthma patient.[7] The pathophysiological changes manifest

as impaired expiration which leads on to hyperinflation distal to the obstruction, an alteration in the biomechanics of the thoracic cage, which over time leads to the classic barrel chest appearance, and an increase work of breathing.[5] In chronic asthmatics the secondary muscles of respiration are placed under increased load and can become chronically hypertonic and patients have to exert considerable effect to overcome mechanical restrictions to respiration.[8] While the airflow restriction is often reversible, either spontaneously or with medication, this may not be true for of the biomechanical restrictions through the costoverterbral joints and the myofascial components and these are some of the possible areas where manual therapy can play a role in the treatment and relief of asthma.

In the past β-adrenergic drugs have been relied on to control the symptoms of asthma, but it has been shown that these do not address the inflammation responses[5] and as such there has been a shift away from the use of beta-adrenoreceptors towards the use of inhaled corticosteroids.[3] The current medical guide for asthma management is the daily use of inhaled corticosteroids to address the underlying pathophysiology of inflammation, with the use of an inhaled beta-agonists to relieve smooth muscle spasm where required.[9] If the asthma is still not controlled then the dose of inhaled corticosteroid is increased.[7,10] Corticosteroid use can have an adverse systemic effect when used regularly over a long period of time, such as growth retardation and

osteoporosis.[11] It has also been found that they may contribute to a decline in pulmonary function[12] leading to an increase in the morbidity rate[13] and risk of death.[14]

While manual therapy and osteopathic treatment does currently play a role in the management of children with asthma,[15] there has not been a great deal of research into which specific techniques benefit asthmatic children or their mechanism of action. The philosophy of osteopathy is a holistic approach based on the principle that structure and function are interrelated and therefore can affect one another.[16] Beal found that altered or impaired function frequently occurs in the somatic system and that these somatic dysfunctions, as observed in the tone of segmentally related myofascial structures, may manifest as pre-symptomatic signs of disease and be an expression of the viscero-somatic reflex.[17]

Beal's[17] findings are supported by D'Alonzo and Krachnam[18] who suggested that viscero-somatic reflexes from the lung parenchyma result in an increase in para-vertebral muscle spasm and Carruthers has claimed manipulation of segmentally related somatic structures, to influence visceral function, has shown promising results.[19] Kuchera and Kuchera state that the influence on visceral structures acts by way of the somatic-visceral reflex.[20] Wheatly, et al,[7] have shown in a past study an increase in pulmonary function in adults with asthma following rib

raising, however there has been little evidence to show that this technique also applies to asthmatic children.

Brockenhauer, et al, also showed promising results when conducting a study examining the effect that osteopathic manipulative therapy (OMT) had on the pulmonary function of chronic adult asthmatics.[21] It was found that thoracic excursion increased following osteopathic manipulative procedures. While this increase was quite small, in some of the participants it represented up to 86% of total thoracic excursion. Guiney, et al, showed that the same treatment principles applied to paediatric asthmatics, and found that OMT increased Peak Expiratory Flow (PEF) in children with chronic asthma.[8]

These studies are limited however by a combination of the use of small sample size, inclusion of asymptomatic individuals and poor choice of measurement techniques. Peak expiratory flow is not as reliable a prediction of a person's lung function when compared to FEV_1,[22] this is due to the fact that PEF is effort dependent, meaning that respiratory muscle strength and patient motivation can affect peak flow, and values tend to be underestimated when compared to FEV_1 readings.[22]

The above studies by Wheatly, et al, and Brockenhauer, et al, show that rib raising and osteopathic manipulation can produce positive outcomes in

improvements of short term pulmonary function in asthmatic and non-asthmatic adults and, while there may be only a limited role that manual therapies could play in the management of acute and severe asthmatics, patients with stable asthma could benefit from incorporating manual therapy as an adjunct to their conventional pharmaceutical management approach.[7]

Manual therapy may have multiple positive effects on children with asthma, such as an improvement of quality of life[2] and a decrease in symptoms and while past studies have suggested that specific techniques can improve pulmonary function it is important to determine if there is any significant improvement in short and intermediate term lung function in properly constructed clinical trials. The aim of this study is to examine the short (at twenty minutes post treatment) and intermediate term effects (at one week post treatment) that rib raising has on the pulmonary function of children diagnosed with chronic asthma.

METHODS

Recruitment

This study initially set out to conduct a pilot clinical trial with ten participants for each of the treatment technique and sham technique groups. A total of twenty participants were required in order to determine effect size and the statistical significance of any outcomes. Participants were sought to be recruited from 17 schools within the St. Albans area through a combination of flyers attached to

newsletters and the use of the electronic notice boards. We were, however, only able to recruit two participants and so the research project was adapted to a case study where the rib raising treatment was compared to a sham technique.

Patient Presentation

The following two patients were recruited into the study via advertisements as local schools and at Victoria University. The two patients were allocated to one of the two groups through the drawing of cards, while this is not a true random design in which each participate would of had equal chance of receiving either group, it was necessary for this study design due to low recruitment forcing this study to become a case comparison, thereby requiring one patient in each group.

Patient #1: A 17 year old full time student with a long history of mild asthma that requires the use of ventolin 3-5 times a week. The patient was 181cm in height and had a mass of 79kg, on the initial examination he was found to have an increased kyphosis, a restriction to right trunk rotation and an elevated first rib on the right. The patient currently does not use any preventer medication, only his prescribed ventolin to treat his asthma and had not received manual therapy as a treatment for his asthma in the past. This patient received the rib raising technique.

Patient #2: A 16 year old full time student with a long history of mild asthma that requires the use of ventolin 1-2 times a week. The patient was 194cm in height and weighed 85kg, on the initial examination he was found to have a slight left convex scoliosis in the mid thoracic spine and a restriction to lateral expansion of the lower ribs with breathing. The patient currently does not use any preventer medication, only his prescribed ventolin to treat his asthma and had not received manual therapy as a treatment for his asthma in the past. This patient received the sham technique.

Ethics approval was gained from the Victoria University Human Research Ethics Committee and all volunteers and their guardians gave informed consent prior to inclusion in the study. Neither of the patients had received osteopathic treatment for their asthma in the past. Participants completed a questionnaire developed by the National Asthma Council to determine eligibility and to categorize their asthma as mild (N=2), moderate or severe.

Procedure

Base Line Examination

Pulmonary function tests were carried out in the same treatment room, in the afternoon, by the same researcher, who was blinded to which of the two groups that participants were in, and were measured using a Vitalograph Spirometer with the subject seated and their nose occluded. All treatments and

examinations were carried out in the same treatment room by a fully registered and qualified osteopathic practitioner, the same practitioner was used throughout the study. Participants wore gowns that allowed unrestricted access to the upper 7 thoracic vertebrae and attended Victoria University Osteopathic Medicine Clinic at St. Albans on the same day for four consecutive weeks.

Forced vital capacity (FVC) and forced expiratory volume in one minute (FEV_1) readings were recorded according to the guidelines set out be the American Thoracic Society.[23] These measurements were chosen as they give the most reliable results when of predicting lung function. Other measurements such as peak expiratory flow were not included as it is effort dependent, meaning that respiratory muscle strength and patient motivation can affect peak flow, and values tend to be underestimated when compared to FEV_1 readings.[22] All measurements were carried out on a Vitalograph Spirometer with an error margin of 2%.[24] The participants were given a familiarisation trial in the first week, where they were given a demonstration and standardised instructions on how to use the spirometer and a chance to practice the procedure. The parents/guardians were permitted in the treatment room. A minimum of three acceptable readings of FEV_1 and FVC were required from the participants, and a maximum of eight was allowed to accommodate variability between expiratory breaths. The two maximum values of FEV_1 had to be within 0.2L of one another, as per guidelines from the American Thoracic Society.[23]

In the second and third week pulmonary measurements were recorded pre-treatment after the participant had sat quietly for 10 minutes to be used as the baseline reference for both the treatment course and for comparison for in between each treatment.

Intervention

Patient #1 then, in week two and three received the rib raising treatment technique and patient #2 the sham technique.

Rib raising technique

Rib angles one to six were identified by the examiner using palpation as set out by Field by the registered osteopath,[7] the rib raising technique was then be applied bilaterally on ribs one through to six, with the subject in the supine position. The treatment technique was adapted from Kuchera and Kuchera[20] and used in a previous study by Wheatley, et al.[7]

Sham technique

The patient was told that they would receive 'laser therapy', they were instructed to lie prone while a laser pointer was directed at rib angles one through to six for approximately the same length of time taken to perform the rib-raising technique.

FEV_1 and FVC were then recorded immediately following the treatment (0 minutes post-treatment) and then again at 10 and 20 minutes post-treatment, as reported in table 1 and table 2. Participants were instructed to sit quietly in between each time interval. Participants returned in the forth week for FEV_1 and FVC to be recorded, after having sat quietly for 10 minutes. The technician recording the measurements was blinded as to who received which technique.

Statistical Analysis

Percentage change was used to compare the treatment to the control group for both the pre- and post-treatment testing, in terms of FEV_1 and FVC values. Results are presented in relation to short-term effects (0, 10 and 20 minute post-treatment) and medium-term effects (1 and 2 weeks post-treatment). Results are reported as mean for all directly recorded values. The ratio of FEV_1/FVC was also compared from the start of the trial to one and two weeks post treatment (immediate term effect) and can be seen in table 3.

RESULTS

Short term improvements were seen in the rib raising participant, as shown in Table 1, with up to a 13.81% improvement in FVC at twenty minutes post treatment compared to only up to a 3.48% improvement in the sham participant. FEV_1 also increased to a larger degree in the short term in the rib raising

participant who showed an 18.37%, twice that, in terms of percent, of the improvement seen in the sham technique of 8.28%.

While the degree of percentage increase of FVC and FEV_1 was less in week 2 compared to week 1, this could be as a result of the improvement in FVC and FEV_1 (intermediate term effects) carried over from week 1. (Refer to Table 1)

Insert Table 1 here.

Intermediate term improvements of FVC and FEV_1 were also greater for the rib raising participant, shown in Table 2, with a percentage increase of 10.49% and 24.90%, respectively. This was, in terms of percentage change, 12 times the FVC and 4 times the FEV_1 of the sham technique participant who yielded an increase of 0.87% and 5.73%, respectively.

Insert Table 2 here.

The ratio of FEV_1/FVC, shown in Table 3, increased by an overall 7.9% in the rib raising participant compared to only a 2.9% increase in that of the sham technique, indicating more positive results in the rib raising group.

Insert Table 3 here.

DISCUSSION

The application of rib raising increased lung function in this current case study versus sham technique and therefore supports the further investigation of manual therapy techniques, particularly rib raising, to treat patients with chronic asthma. This current study showed an increase in the short and intermediate term lung function in the treatment participant with chronic asthma following the use of a rib-raising as a treatment technique when compared to a sham application. The results in this current study are consistent with the findings of Wheatly, et al,[7] who found short term improvements in lung function in chronic adult asthmatics following the use of rib raising techniques and Guiney, et al, whose findings indicated that osteopathic manipulative therapy improved the lung function of children with asthma.[8]

The small improvement seen in the sham technique individual could possibly be attributed to a placebo effect and, as suggested by Masarsky and Weber, the participants desire to please the researcher which encourages them to try harder or by becoming more relaxed in the testing environment leading to easier breathing.[26] In our current study attempts were made to control for these conditions as all participants were given familiarisation trials, a standard script[23] and had to produce a minimal of three exhalations. The examiner was also blinded as to which patients had received the treatment or the sham to eliminate examiner bias. Each of the participants were also long term of mild asthmatics

and as a result it is likely that they would have had prior experience with spirometric and peak flow testing procedures. Even if these conditions had not been effectively nullified they would not account for the vast difference in improvements seen between the treatment modularity and that of the sham technique.

The mechanism of action that produces the improvements seen in the lung function following the rib raising is not well understood. Guiney, et al, proposed that lung function deficits may be the result of the respiratory systems dependence on the musculoskeletal system.[8] Guiney, et al, suggested that a fully effective respiratory cycle can be achieved by increasing the mobility of the thoracic cage and spine to allow for full excursion of the ventilatory mechanism[8]. Therefore by treating the structure of the thoracic cage and spine, through OMT and specific techniques such as rib raising, this is effectively improving the function of the respiratory system. Brockenhauer, et al, shares this view in their study where they examined the effectiveness of the application of OMT in order to restore maximal compliance to the rib cage of asthmatic participants.[21] While the final increase in thoracic excursion was small, in some cases it represented up to an 86% increase of baseline measurements. However, the methodology of measuring thoracic excursion used in the Brockenhauer, et al, study requires further validation before the findings can be used as evidence of treatment results. The findings of Guiney, et al, and Brockenhauer, et al, that the use of

OMT can improve pulmonary function support this current study, in that the application of a manual technique is capable of causing improvements to the respiratory function of asthmatics by increasing the motility of the thoracic cage and spine and addressing any strains or injuries of the respiratory joints and muscles.[21]

Kuchera and Kuchera suggested a different mechanism of action and proposed that the positive results shown from rib raising are maybe related to a somatic-visceral reflex due to the close proximity of the sympathetic chain ganglia, located just anterior to the capsule of the costo-vertebral joints bilaterally.[20] Rib raising, Kuchera and Kuchera suggested, exerts an inhibitory effect on the sympathetic nervous system and can lead to enhanced venous and lymphatic drainage from the bronchial tissues, decrease in bronchial spasm and ease the patient's respiratory effects by loosening mucus plugs, and therefore improves breathing.[20] While these possible physiological changes, as a result of the viscero-somatic reflex, may improve pulmonary function in asthmatics they are more long term effects and are not likely explanations of the short term improvements which were observed in this current study. They may be beneficial in maintaining and accentuating improvements that people with asthma achieved in the short and intermediate term, but would require further investigations.

Carruthers suggested that somatic dysfunction of the upper 7 thoracic vertebrae and their associated ribs may act to maintain asthma by way of mechanical dysfunction and through their close relationship to the sympathetic nervous system which provides innervation to the lungs and their bronchi.[19] Carruthers claimed manipulation of somatic structures, to influence visceral function, had shown promising results.[19] Manipulation of these structures may take the form of several manual therapy techniques including rib raising and while this current study was able to demonstrate that rib raising can result in improvements in lung function in the short and intermediate term, it is beyond the scope of this study to determine the exact mechanism responsible for these positive results and may be due to a combination of the neural and biomechanical elements.

Manual therapy techniques, such as rib raising, which are aimed at increasing rib and thoracic spine motion, in addition to increasing arterial supply and lymphatic return, could be beneficial to patients with asthma[27] and assist the body's innate ability to heal during times of exacerbations.[28] It had been shown in previous studies a decrease of 14% in length of hospital stay in asthmatic adults, when osteopathic treatment was added to their management plan.[29] This suggests that the application of manual therapy aimed at improving pulmonary function may assist in decreasing the morbidity rate of asthma and the rising burden that it has to the public health system.

The results of the current study could have positive implications for the incorporation of manual therapy, particularly rib raising following more research, into the treatment régime of children with chronic asthma. The findings demonstrate that the improvements seen in the rib raising technique were greater then in the sham technique, for both short and intermediate term effects. The rib raising technique yielded a 13.81% increase in FVC and an 18.37% increase in FEV_1, twenty minutes post treatment, compared to the sham technique of 3.48% and 8.28% respectively. Intermediate term effects were also promising, with rib raising increasing FVC 10.49% and FEV_1 24.90% when compared to the sham technique of 0.87% for FVC and 5.73% for FEV_1, from the original pre-treatment values. The ratio of FEV_1/FVC also showed greater improvement with rib raising, producing a 7.9% increase compared to a sham technique increase of 2.9%. These results are consistent and supportive of findings of other studies by Wheatly, et al,[7] Brockenhauer, et al,[21] Guiney, et al,[8] and Field, et al,[30] who each found that manual therapy applications, whether rib raising, OMT or massage, produced greater improvements in asthmatics when compared to a control group. However as this current study was a two case comparison there is a need for further investigations with larger clinical trials before we can say that the findings apply to the population at large.

In addition to measurable pulmonary improvements it is also important to consider the quality of life improvements in that may be seen when using manual

therapy to treat children with asthma. Manual therapies, such as massage, while having shown to have an improvement on pulmonary function in asthmatics have also shown to have improvements in the asthmatics' quality of life.[21,30] Field, et al, found younger children who received massage to have lower levels of salivary cortisol (a stress indicator), and a decrease in their reported anxiety in addition to improved pulmonary functions to a statistically significant level.[30] The older children receiving massage therapy also reported a lowered anxiety level.[30,31] Lower stress levels are important in people with asthma as stress is linked as a possible trigger to an asthmatic attack.[30]

Balon, et al, and Brontfort, et al, found an improvement in the reported quality of life, in addition to small pulmonary improvements, in children following chiropractic manipulation as adjunctive treatment for asthma.[2,32] Improvements in quality of life, while it may not statistically significant, may prove to be clinically significant to an asthmatic child as a decrease in symptoms and an improvement in the quality of life may allow them to partake in more activities and reduce the number of days absent from school. Quality of life can be one of the aspects of patient care that can be overlooked in asthma management when focusing on conventional treatment only. It has been reported that one in five asthmatic students don't ride a bike, play at school or with animals and up to one in three don't participate in organized sport.[4] These factors can affect a child's confidence and cause them to develop poor self-esteem.

While the results of this study are promising for children with chronic asthma, the limitation of the study is that it was based on a two comparison case study. This study had originally been planned as a small pilot study of ten participants in each of the treatment and the sham technique groups. Low participant response to recruitment meant that study had to be altered to a two case comparison. Larger clinical trials are necessary to determine the statistical significance of the treatment modularity and its effect size, this study highlights that improvements in lung function can be achieved and further controlled research trials should be carried out to further investigate this current studies findings.

CONCLUSION

This study demonstrated that rib raising improved the lung function, in the short and intermediate term, of the treatment participant with chronic asthma. While the exact mechanism of action is unknown, and beyond the scope of this study, the results give support to further research into the use of manual therapy techniques and the possible positive outcomes they may have in children with asthma. It is not advocated that manual therapy should replace conventional medical approaches, but rather be incorporated into their régime as a further tool to decrease the severity of this disease. Further clinical trials with large numbers of participants are necessary to determine the statistical significance of

the treatment, and may help to identify sub-groups of asthmatics, and age of children, most responsive to manual therapy techniques.

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Table 1: Short term effects of FVC and FVC1 in Rib raising and Sham technique participants.

	Rib-raising Technique				**Sham Technique**			
	FEV_1 (L)	**% Change**	**FVC (L)**	**% Change**	**FEV_1 (L)**	**% Change**	**FVC (L)**	**% Change**
Pre Treatment	2.45	----	4.06	----	3.14	---	4.60	---
0 min Post Treatment	2.84	15.91	4.68	15.29	3.36	7.00	4.82	4.67
10 min Post Treatment	2.92	19.18	4.64	14.30	3.32	5.73	4.81	4.45
20 min Post Treatment	2.90	18.37	4.62	13.81	3.40	8.28	4.76	3.48
Pre Treatment (week 2)	2.80	---	4.30	---	3.20	---	4.62	---
O Min Post Treatment (week 2)	3.14	12.14	4.70	9.30	3.59	12.03	4.77	3.25
10 Min Post Treatment (Week 2)	3.28	17.14	4.62	7.44	3.41	6.56	4.66	0.87

20 min Post Treatment (week 2)	3.26	16.43	4.55	5.81	3.34	4.38	4.64	0.43

Table 2: Intermediate term effects of FVC and FVC1 in Rib raising and Sham technique participants

	Rib-raising Technique				**Sham Technique**			
	FEV_1 (L)	**% Change**	**FVC (L)**	**% Change**	**FEV_1 (L)**	**% Change**	**FVC (L)**	**% Change**
Pre Treatment	2.45	---	4.06	---	3.14	---	4.60	---
1 week Post Treatment	2.80	14.29	4.30	6.04	3.20	1.91	4.62	0.43
2 Weeks Post Treatment	3.06	24.90	4.48	10.49	3.32	5.73	4.66	0.87

Table 3*:* Effects on the ratio of FEV_1/FVC in the rib raising and sham techniques.

	Rib-raising Technique	**Sham Technique**
	Ratio of FEV_1/FVC	
Pre Treatment	60.4%	68.3%
1 week Post Treatment	65.1%	69.3%
2 weeks Post Treatment	68.3%	71.2%
Total Increase	7.9%	2.9%

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