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Conductive heat and myofascial release in treating painful restricted costovertebral expansion in post-atelectasis

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Author Note

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Declaration of a Conflict of Interest

The participant and researcher share a personal relationship preceding the project. The researcher has taken steps to minimise biases.

Informed Consent

Informed consent and a release of audio-visual material were obtained from the patient prior to commencing the study.

Abstract

Thoracopulmonary lesions can cause atelectasis: the collapse of pulmonary structures. The causes range from external compression to internal obstructions, from pulmonary disease to post-operative complications. Medical intervention successfully resolves atelectasis and its causes. Once a lesion has been resolved, its residual effects can lead to myofascial dysfunction.

The principle objective of this clinical case study was to investigate whether conductive heating agents in conjunction with myofascial release techniques and myofascial trigger point therapy can increase restricted costovertebral expansion and alleviate discomfort upon inhalation in a post atelectatic patient.

The primary outcome measures of costovertebral expansion and patient discomfort were obtained using a flexible measuring tape and the McGill pain questionnaire respectively. Costovertebral expansion increased and the results of the McGill pain questionnaire improved.

The study's positive and conclusive results warrant further exploration of the effects of conductive heat and myofascial release on the diaphragm and inferior intercostal muscles in a post atelectatic patient.

Keywords: Hydrocollator®, respiratory muscles, myofascial trigger point, massage, pneumonia

Conductive Heat and Myofascial Release in Treating Painful Restricted Costovertebral Expansion in Post-Atelectasis

Atelectasis is defined by Cavallaro Goodman and Fuller (1) as the collapse of air-filled pulmonary structures such as chest walls, bronchi or at a much smaller level, alveoli. It is commonly caused by obstruction of airways, dysfunctional lung expansion, inadequate pulmonary surfactant or compression (1). Aside from being caused by pulmonary pathologies and crush injuries, for up to 90% of patients undergoing general anesthesia atelectasis will be a complication due to impaired airflow dynamics (2). Clinical practices exist to prevent and attenuate the effects of atelectasis, especially in a post-operative setting (3) or after critical illness (4). The researcher did not find any studies on the musculoskeletal aftereffects of atelectasis or other clinically resolved respiratory lesions.

The continuous nature and necessity of breathing inherently means any lesion to the respiratory system causes continuous pain and autosplinting. The chronic implications of this are far reaching as restricted movement leads to adhesions. Studies have demonstrated that the presence of adhesions within synovial joints and abnormal collagen cross-linking and decreased elasticity in connective tissue are due to immobilisations (5). According to Raoof et al. (6), within the pulmonary system itself, immobilisation can cause atelectasis, which may lead to stagnation of pulmonary secretions, allowing development (6) and aggravation of infections (7).

Reiterating Keane’s (1978) minimum mobility requirement for proper physiologic functioning, Raoof et al. (6) discuss the natural tendency to change position every 11.6 minutes during sleep. A patient autosplinting due to thoracopulmonary trauma will sleep in the one position offering relief, and alter their breathing patterns. Goodman (1) describes how hypoventilation, the most common form of altered breathing from pulmonary lesions, causes hypoxemia which leads to respiratory muscle dysfunction.

Once the offending infection is cleared, the resulting musculoskeletal adhesions and immobilisations remain. Muscles become increasingly shortened due to contractures, which Travell and Simons (8) define as a sustained intrinsic contraction of muscle fibres without motor nerve stimulation; this gives rise to myofascial trigger points. General fascial adhesions can occur through postural imbalances as well as trauma, both being important factors in thoracopulmonary lesions. Since the intercostal muscles are muscles of respiration as well as posture (9; 8), dysfunction in either role will have an effect on the other. Travell and Simons (8) describes the symptoms of the intercostal trigger points as reduced thoracic rotation and pain on deep respiration. Respiratory diaphragm trigger points present themselves as shortness of breath.

Once thoracopulmonary infections and critical lesions are resolved, the residual respiratory muscle contracture and resulting chronic pain is allopathically managed using muscle relaxants and analgesics.

Manual therapies can address fascial adhesions and myofascial pain patterns using myofascial release (MFR) techniques, myofascial trigger point (MFTP) therapy and superficial conductive heat. Michlovitz (5) notes that heat relieves muscular contractures and, as per Melzack and Wall’s gate theory (1982), excites thermoreceptors that block nociceptive input. Heat stimulates systemic relaxation which also gives relief from pain. Another important effect of heat is the increase in circulation and nutrients supplied to the area, promoting healing and removing the by-products of injury that stimulate the pain-spasm cycle. MFR techniques promote thixotropic softening of connective tissue, by re-establishing flexibility (10).

In light of the lack of accessible research on the use of manual therapy in decreasing post-atelectatic dysfunction, the researcher was interested in investigating whether conductive heating agents in conjunction with MFR and MFTP therapy increase restricted costovertebral expansion and alleviate discomfort upon inhalation.

Method

Research Participant Profile

The research participant is a 32 year old male measuring at a height of 169 centimetres and weighing 75 kilograms. The participant is a mechanical engineer who works at a desk 8 hours a day, 5 days a week. For exercise, the patient goes for 45 minute brisk walks thrice weekly, sails thrice monthly and performs heavy yard work weekly. The patient experiences light sleep and wakes up feeling unrested at three a.m. and is unable to fall asleep again. The patient developed alopecia areata in 2007, which has its origins in autoimmune hyperactivity; he has seen a dermatologist for this and has not required treatment. He does not have any other systemic conditions or a family history of conditions.

Chief Complaint

The patient presented with discomfort in the inferior anterior costal area. The discomfort was placed at five on a 10-point scale, and described as “diffuse and radiating”. This discomfort was experienced daily and described as moving to different areas of the inferior anterior thorax. The symptoms were produced upon deep inhalation. The patient has previously seen a chiropractor, a physiotherapist, a traditional Chinese medical practitioner and a massage therapist, all providing varying degrees of resolution, but with some discomfort remaining.

Mechanism of Injury

The first week of March 2010, the patient presented with sharp persistent interscapular pain, described as eight on a 10-point pain scale. The pain was exacerbated by deep inspiration, coughing, laughing or sleeping in any position other than semi-fowlers. Radiographs showed atelectasis with concomitant pneumonia. It is possible the atelectasis was triggered by the patient's cat sleeping on his chest two nights in a row. This initial compression injury, resulting autosplinting and immobilisation likely led to the development of pneumonia which was treated with antibiotics. A radiograph taken eight weeks after the initial injury showed residual atelectasis, but the pneumonia was cleared. Since then the patient has experienced continued discomfort upon inhalation, which was the chief complaint. The patient's desired outcome was relief from the discomfort.

Working Diagnosis and Investigation

Based on the research presented and the clinical presentation, the therapist assessed the patient as having contractures of the diaphragm and anterior inferior intercostal muscles as sequelae to atelectasis and pneumonia.

The patient showed similar clinical signs to that of a case described by Triano, Erwin and Hansen (11), in which the signs of atelectasis imitated signs of costovertebral pain; therefore, a differential diagnosis was made to rule out vertebral involvement using the Evjenth and Gloeck method (12).

Research Design

This clinical case took a mixed methods approach using qualitative and quantitative data. The research protocol outlined an exact framework for pre-treatment assessment, clinical treatment, post-treatment assessment, and homecare activities.

Sampling Procedure

The participant volunteered for the study upon hearing the therapist was searching for participants with thoracopulmonary dysfunction. The therapist ensured the patient did not have any contraindications to conductive heat (13), or myofascial modalities (9).

Measures and Covariates

Primary outcomes measured in the study were costovertebral expansion (CE) and patient discomfort. CE was measured using Magee's protocol by recording upper, mid and lower thoracic expansion. Patient discomfort was measured using the McGill pain questionnaire (MCP) (14).

Assessment

Evjenth and Gloeck Method

Thoracic spine pain was differentiated from rib pain by asking the patient to inhale and hold their breath and then move into active extension until pain was felt. Once the pain was felt the patient exhaled, if further extension was available after exhalation, the ribs were the likely source of dysfunction. The same was then done with flexion (12).

Costovertebral Expansion (CE)

CE was measured on three levels: upper thoracic expansion at the fourth lateral intercostal space; midthoracic expansion at the xiphisternal junction and lower thoracic expansion at the level of the tenth thoracic vertebra. The examiner placed a tape measure around the patient's chest. The patient was asked to exhale completely, and a reading was taken. The patient then inhaled as deeply as possible and another reading was taken. The difference was recorded. The normal range is 3 to 7.5 cm (12). CE measurements were taken using a flexible Hoechstmass Standard 10 EL™ metric tape measure.

McGill Pain Questionnaire

This pain rating index measures not only quantity but also quality of pain and has shown sufficient test–retest reliability (15) to be clinically applied.

Experimental Manipulation

All experimental manipulation occurred within the context of a massage therapy clinic, for a total of ten 70-minute long appointments, over a period over three weeks. The treatments were scheduled every other day and consisted of a pre-treatment assessment, treatment, post-treatment assessment and homecare shown in Table 1.

Table 1
Treatment layout

Pre-treatment (10 min.)	**Treatment (50 min.)**	**Post-treatment (10 min.)**
Every treatment	***Superficial conductive heat***	***Every treatment***
CE measured	Hydrocollator® lumbar pack	CE measured
	MFR technique	
	Shearing diaphragm	
Patient check in	***MFTP therapy***	Patient feedback
Treatments 1, 6, 10	Stripping intercostal muscles	***Homecare:***
Evjenth Gloeck differential	Trigger point pressure release	Open heart stretch
	Swedish massage	
	Palmar stroke	
	Lubricant	
Treatment 1	Biotone® Massage Lotion	***Treatment 10***
McGill pain questionnaire	***Modified pain scale (1-5)***	McGill pain questionnaire

Modified Pain Scale

Due to the sensitive diaphragm and intercostal area establishing clear communication with the patient was crucial, however when working on respiratory muscles the patient was unable to speak without engaging the muscle being treated. To avoid this, the therapist devised a modified pain scale rating from 1-5 which the patient was able to communicate using the fingers of one hand. The numbers signified:

1 – no discomfort

2 – feels intense

3 – feels very intense but no discomfort

4 – feels slightly uncomfortable

5 – feels very uncomfortable

It was the therapist's goal to never treat beyond a 3 to prevent muscle guarding which would interfere with the treatment.

Treatment Protocol

The treatment was administered supine. The lumbar Hydrocollator® pack was wrapped in 4 towel layers and placed lengthwise on the midthoracic area after two narrow towels were placed over the 7th costal cartilage where the anatomical elevation was prone to uncomfortable warmth. The Hydrocollator® pack was applied for ten minutes during which time the patient was redraped with a sheet and blanket. The therapist checked the tissue every two minutes and ensured the patient's comfort throughout. After the Hydrocollator® pack was removed; the therapist palpated the diaphragm bilaterally noting any changes with regards to depth of access and patient sensations.

Since the Hydrocollator® pack served to warm the tissue, the therapist immediately proceeded to shear the diaphragm off the ribs in a mediolateral direction. This was done so by standing on the contralateral side and sinking fingertips under the costal margins inferior to the xiphoid process, as the patient exhaled the therapist was able to sink in further. The therapist continued this fascial shearing of the diaphragm attachments off the ribs and the xiphoid, meeting each barrier and allowing it to soften before continuing (9). The therapist always treated the left side first. The therapist continued this for ten minutes per side.

After this, the therapist applied a quarter sized amount of Biotone® Lotion and used full contact palmar stroking to flush out the area superficial to the diaphragm and warm up the anterior inferior intercostal margins.

After warming up the intercostal area, tender points were identified by the patient by inhaling deeply and holding his breath. The therapist then exerted pressure using fingertips along the taut bands in the intercostal spaces to release the contracture, progressing no faster than the nodules releasing (8). If the nodule did not soften after 4 passes of muscle stripping, trigger point pressure release was used, where the therapist applied gentle fingertip pressure until a barrier was felt and released (8).

This process was repeated until a tender spot was felt in the left angle of the neck. At this point the treatment ended as further investigation into the angle of neck was not within the scope of this study.

Homecare

The purpose of the homecare activity was to encourage chest expansion via stretching and applying heat.

The patient was shown how to lie on a foam roller directly underneath and parallel to the spine. The cervical spine was to be extended off the foam roller and the legs placed in whichever way the patient wished. The arms were to be abducted as far as comfortably possible. The patient was instructed to place pillows wherever needed to prevent strain. This passive stretch was held for 8 minutes.

The patient was asked to place a Thermophore® (set at a temperature of 82 ˚C and 180 F) on his chest covering the upper chest as well as the lower thoracic area.

Results

McGill Pain Questionnaire

Table 2

Pain quantity

	Pre-Study	Post-Study	Decrease
MPQ Sensory	10	6	4
MPQ Affective	1	0	1
MPQ Evaluative	2	1	1
MPQ Miscellaneous	4	2	2
Pain Rating Index	17	9	8
Present Pain Intensity	1	1	0

Table 3

Pain quality

Sensory		**Affective**		**Evaluative**		**Miscellaneous**	
Boring		Tiring		Troublesome		Radiating	Radiating
Pressing	Pressing				Annoying	Tight	
Tugging	Tugging					Nagging	
Hot							
Sore	Sore						
Taut							
	Tender						

Costovertebral Expansion

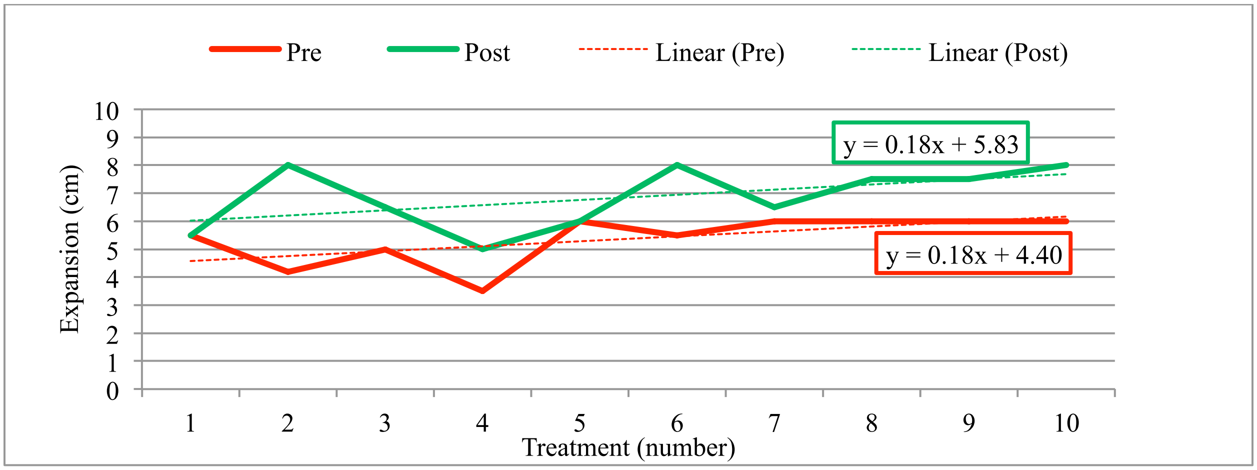

Figure 1 Upper thoracic expansion

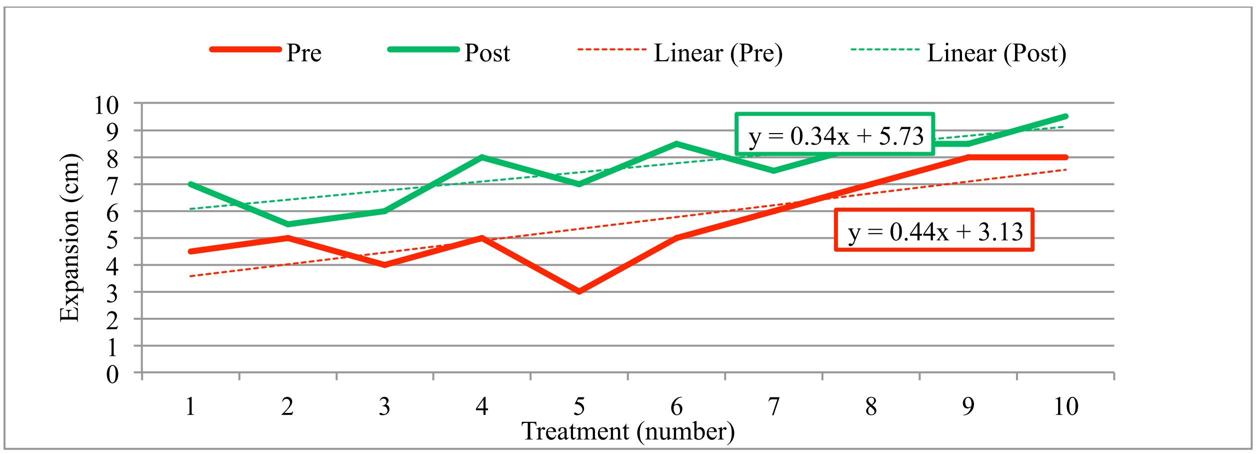

Figure 2 Mid thoracic expansion

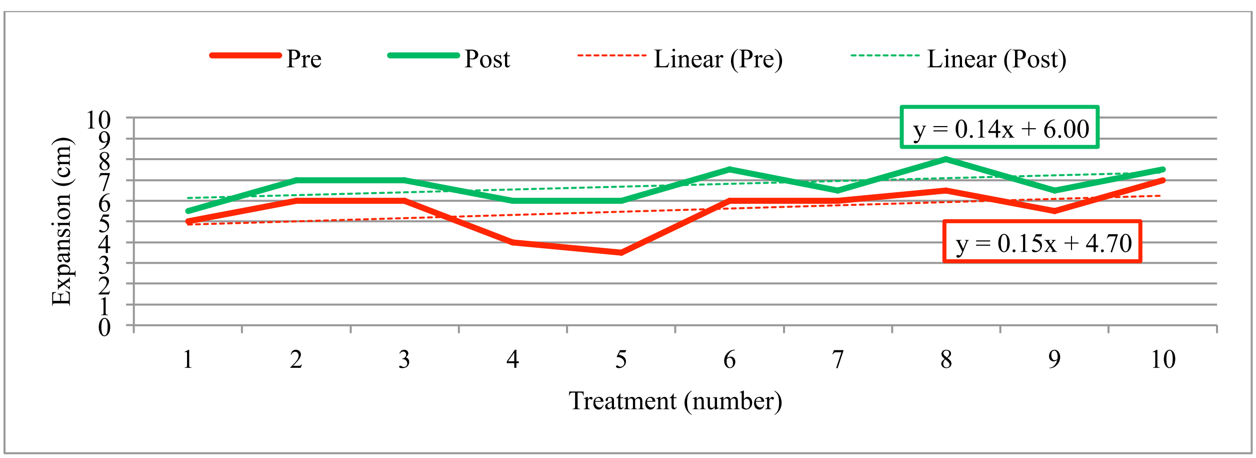

Figure 3 Lower thoracic expansion

Discussion

Outcomes

McGill Pain Questionnaire

All values decreased from pre-study to post-study except the present pain intensity which stayed at 1, indicating discomfort was still felt and remained low. The affective value decreased from 1 to 0, demonstrating the patient was not as affected post-study as they were pre-study Table *2*.

From a myofascial perspective, it is noteworthy the descriptors: "taut" and "tight" were no no longer used post-study, suggesting a softening may have occurred (8). The terms "nagging" and "tiring" no longer applied, indicating some respite was found from the discomfort. The descriptor "boring" was replaced with "tender", suggesting the discomfort may have become more superficial

Table *3*.

The application of moist heat during treatments as well as homecare may have reduced discomfort by blocking nociceptive input and reducing muscle contractures as demonstrated by Michlovitz (5).

Costovertebral Expansion

After each treatment every thoracic level increased in expansion. Additionally, all levels saw an increase over the course of the study (Figure 1-3); the midthoracic readings showing the largest improvement (Figure 2). The midthoracic improvement may be attributed to the fact that the focus of the diaphragm release was shearing off the inferior intercostal cartilages and off the xiphoid process, both structures being part of the diaphragm's origins (16).

The linear trend lines for the post-treatment upper thoracic readings show an average increase of 0.18 cm per treatment with a total increase of approximately 2 cm or 30%. The post-treatment midthoracic readings show an average increase of 0.34 cm per treatment, with a total increase of approximately 3 cm, or 50%. The post-treatment lower thoracic readings showed increase of approximately 0.14 cm per treatment with a total increase of approximately 1.5 cm or 25%.

Increasing chest expansion allows increased pulmonary compliance promoting improved ventilation of all areas of the lungs (17). In a patient with a history of thoracopulmonary lesions this increased mobility not only impacts the lungs themselves but also the surrounding musculature that is contracted (8).

Sources of Errors and Biases

When recording patient feedback in the MPQ, subjective bias existed in that the patient's self-perception may have altered on the days readings were taken. Measurement biases could have occurred anytime measuring tools were used. Aside from not being a sensitive testing device the use of the measuring tape depended on the therapist's ability to skillfully manipulate it. Though efforts were made to keep treatments consistent, given the small sample size and only one therapist, intervention bias was inevitable. The homecare not only gave rise to compliance bias it was an added variable that the researcher would suggest omitting in any replicating study. Additionally, the patient's activities of daily living may have impacted results. Treatments were scheduled every other day however the time of day was not consistent due to scheduling difficulties; this may have changed results. The researcher fulfilling the role of therapist created expectation bias.

Conclusion

The lack of literature on the residual effects of resolved pulmonary lesions in a manual therapy context was challenging. Having measured the long-term effects of such lesions on the patient, the therapist concludes more research in this area would be an asset in providing massage therapists with clinical tools for assessment and treatment.

During the treatments, the manner in which pain moved around the thorax implied that released areas were able to expand more and tension in other areas became apparent. At the end of the treatment after each intercostal point was released, the tender point moved into the angle of the neck, as though increased fascial movement allowed more thoracic movement and therefore a new stress line causing pain. Research using a greater sample size to investigate this phenomenon would be desirable as manual therapies can successfully address fascial adhesions and myofascial pain patterns using myofascial release techniques and superficial conductive heat.

During the course of the study the patient achieved relief in the anterior thorax and the discomfort migrated to the posterior thorax. For additional studies the therapist would include the posterior thorax in the treatment.

The study provided positive and conclusive results, warranting further rigorous studies to explore the effects of conductive heat and myofascial release on the diaphragm and inferior intercostal muscles in a post atelectatic patient.

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