ALTERED RESPIRATION IN A CASE SERIES OF LOW BACK / PELVIC PAIN PATIENTS

Laurie McLaughlin* and Charlie H Goldsmith

Purpose and Relevance

Low back or pelvic pain patients can be resistant to traditional manual therapy and exercise interventions. The purpose of this study was to determine whether altered respiratory chemistry was present in a series of low back or pelvic pain patients and secondly whether biofeedback training could alter chemistry and symptoms. Respiratory function can be measured by end tidal carbon dioxide levels ($ETCO_2$) via capnography. Normal $ETCO_2$ values are between 35 mm Hg and 45 mm Hg with optimal being 40 mm Hg. $ETCO_2$ is a measure of CO_2 content in the alveoli which is reflective of arterial CO_2 in the presence of normal heart and lung function. (Loeppky 2001) Capnography is routinely used in critical care settings and has been shown to be a reliable, time sensitive method of determining arterial CO_2 levels. (Miner, 2002, Santos, 1994) Readings of $\leq$ 35 mm Hg constitute hypocapnia. In a study by Barton (1994) patients with hypocapnia End Tidal CO_2 and arterial CO_2 were not significantly different (d = 0.7 mm Hg, p = 0.174). Patients with respiratory or metabolic acidosis on the other hand were shown to have End Tidal CO_2 readings that were significantly different from arterial CO_2 (d = 6.0 mm Hg, p = 0.005). However, in both groups the correlation between them was in excess of 0.9.

Overbreathing where alveolar ventilation exceeds CO_2 production is thought to be the most common breathing deregulation in people with normal heart and lungs. (Levitsky, 2003, Thomson, 1997) Overbreathing results in hypocapnia, a CO_2 deficit. Hypocapnia causes a rise in pH resulting in many far reaching effects including smooth muscle contraction (vessels, gut, bronchi) (Thomson et al, 1997), increased nervous system excitability (Mogyoros et al 1997, Seyal et al 1998) , skeletal muscle hypertonus (Thomson et al, 1997) and a marked decrease in O_2 delivery due to decreased blood flow and the Bohr effect (Levitsky, 2003, Thomson, 1997). Typical resting respiratory rate is 10 -14 breaths per minute with a ratio of inhale: exhale: pause of 2:3:1.

Methods:

A case series of twenty four patients (21 women and 3 men) with low back or pelvic pain were identified from an outpatient physiotherapy setting. Most patients either did not respond or had plateaued with manual therapy and exercise (no change in pain or function for two consecutive visits). In addition another group was added whose symptoms were acute thereby limiting the use of manual therapy. Many patients with low back or pelvic pain co-contract or brace using their erector spinae and abdominal muscles (Radebold et al, O'Sullivan in press) This limits chest expansion. Since trunk muscles are both respiratory and postural muscles (Hodges 2000, 2007), testing breathing in various positions can help to quantify any posture related breathing changes. For all patients we are currently using 7 basic capnography challenges. Three of the challenges were postural including sitting, standing and supine. Sitting and standing employ the postural functions of the trunk muscles whereas with supine there are limited postural demands. Since changes in rate and depth of the breath can be problematic both were addressed in the basic challenge series by asking the patient to perform 4 deep breaths and a breath rate challenge of 20 breaths per minute for 2 minutes. Values are also recorded during a concentration task where the patient is asked to perform a mental mathematics problem. The final challenge is talking which relies on the respiratory system and therefore can elicit low $ETCO_2$ readings in people who are poor breath regulators. Symptoms were recorded during the challenges. From the readings, it was determined which aspect of breathing cycle, rate and $ETCO_2$ were disrupted and a treatment plan was then devised aimed at the patients' specific dysfunction.

The intervention included education regarding the role altered breathing can play in symptom production. One key component involves increasing body awareness to the sensations associated with altered respiratory chemistry and the linked breathing behaviours that produce these sensations. Strategies are then taught to provide them with the tools necessary to change the problematic breathing behaviours. Nose rather than mouth breathing is encouraged. The nose warms, moistens and sterilizes the air. It also sets up the appropriate pressure gradients to optimize gas exchange. Lower chest / abdominal breathing is facilitated and upper chest breathing is discouraged. Abdominal bracing, common in patients with low back pain, impedes lower chest breathing. Hands on techniques to free

tightness in the chest wall and respiratory musculature were used to facilitate lower chest breathing when indicated. Breath rate, pattern and ratio of inhale: exhale: pause of 2:3:1 were trained using capnography. Activities or positions that reproduced symptoms were tested as advanced, individualized challenges. These were retrained using capnography if altered breathing was elicited. The number of interventions varied from 3 to 15 with a mean of 6.1 and a median of 5. Following the intervention, patients reported on changes they experienced. Reports included improvements in pain, function, breathing, anxiety and relaxation.

Analysis:

Descriptive statistics included: min, max, mean, median, standard deviation, frequencies and percentages. Inferential statistics included: paired t test and matched chi square analysis. The level of significance was 0.05.

Results:

In the 24 low back / pelvic pain patients, age varied from 21 to 73, mean 44.4, median 48 and SD 13.8 years. Time from symptom onset to first breathing evaluation varied between 1 week and 13 years with 25% (n=6) in each group; 6 months or under, 6 months to 2 years, 2 to 5 years and over 5 years.

All of the patients tested were found to have lower than normal $ETCO_2$. All were able to raise their $ETCO_2$ levels with retraining and all but one attained normal values ($p < 0.001$). Improvements in CO_2 varied from 2 to 14, mean 7.2, median 8.0, SD 3.0 95% CI: 6.0, 8.5 mmHg; $p < 0.001$. Patients reported improvements in pain (75%), functional activity (50%), breathing (29%), and decreased anxiety (21%).

Conclusion

Manual therapy and exercise is thought to be a useful way to manage low back and pelvic pain patients. There are patients however who are resistant to that combination of interventions and appear to need further input to decrease pain and improve function. There is growing evidence of an association between altered respiratory function and back pain. (Smith et al, O'Sullivan in press) The ability to identify a subgroup of back or pelvic pain patients with associated respiratory dysfunction using an objective measure appears to add a beneficial element to the management of this challenging group. Capnography has been shown to have good concurrent validity when compared to arterial CO_2 measures and can provide access to this very relevant physiological information. Since decreased blood flow to the brain for example is reduced by 20% when arterial CO_2 is reduced even slightly below normal to 34 mmHg (Thomson et al), raising CO_2 to normal levels represents a clinically important difference.

Case series provide pilot data, an initial step towards exploring respiratory dysfunction as a component of low back and pelvic pain. To properly explore this intervention, a randomized – controlled clinical trial design with long term follow up would be necessary.

Implications

While these results are preliminary, this case series showed altered respiratory chemistry in all patients. Breathing dramatically improved with retraining. These results were both clinically important and statistically significant.

Capnography provides objective evidence that can be incorporated into a clinical setting. Low back and pelvic pain patients appear to benefit from breathing retraining.

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