Correlation of diaphragmatic breathing control and hip extension firing patterns

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Abstract

Objective: This study aims to find a link between prone hip extension and breathing patterns.

Methods: Fifteen subjects who failed a prone hip extension screen and breathing screen were given either core stability training or breathing instruction twice weekly four weeks. The subjects were rescreened after completion of all eight training sessions.

Results: There was no significant difference in performance in the screens before and after breathing or stability training.

Conclusions: This limited study demonstrated no significant change in hip extension and breathing patterns after eight training sessions over four weeks.

Key Indexing Terms: Breathing, Stabilization, Hip Extension

Introduction

Movement screens are widely used in the clinical setting to assess local and global movement patterns.[1,2] Janda's prone hip extension screen is used to assess muscle activation in the posterior chain and a breathing screen can be used to assess muscle activation through the locomotor system during respiration.[1,3] One study found 75% of participants had aberrant breathing patterns including chest breathing, deep clavicular grooves and decreased lower rib cage movement.[4] As Karel Lewit has explained, no other movement patterns can be corrected unless breathing is normalized.[5]

This study seeks to demonstrate a link between changes in muscle activation patterns during a prone hip extension screen and breathing pattern screen after training either for breathing pattern correction or core stabilization.

A breathing screen including observation and palpation can be used to assess a patient's ability to breath with an ideal pattern. Breathing instruction has been used with clinical success to develop proper motor control patterns.[3]

The hip extension screen was developed by Janda and allows the observer to determine patterns and degrees of activation of the hamstrings, gluteus maximus, spinal extensors, and shoulder girdle muscles.[1,3,6] To train the spinal stabilizers, one of McGill's "Big Three" was chosen: the side bridge. McGill's research has demonstrated activation of spinal stabilizers occurs with this exercise.[1]

Since we know stabilization is never a local event because chains of muscles are always involved, it was hypothesized that changing the activation of the spinal stabilizers by exercise will have an effect on activation during other activities, such as breathing. Also, because respiratory mechanics must be intact for the coordination of movement patterns, a normal motor program for respiration must be cortically set in the nervous system.[4] Studies have shown that activation of the diaphragm prior to the initiation of a motor command is due to preprogramming within the central nervous system.[7,8] Therefore, it is postulated that retraining respiration to normal diaphragmatic respiration and therefore reprogramming this function in the central nervous system could cause a change in abnormal prone hip extension.

Methods

Fifteen participants completed the study. Subjects were recruited through announcements to students at Logan College of Chiropractic. Screening was performed after subjects read and signed a consent form and filled out an inclusion/exclusion criteria form. Subjects with a history of low back pain, scoliosis, hip pain or structural deformity, lung disease, cardiovascular disease, or symptoms of intervertebral disc pathology were excluded as well as subjects who reported being pregnant or with a body mass index indicating obesity. The investigation was approved by the institutional review board of Logan College of Chiropractic.

Hip extension screening was completed by having the subject lie prone and actively raise one leg off of the table without flexing the knee causing hip extension. Failures include: dysfunctional muscle firing sequencing if subject recruits the lumbar erector spinae excessively and/or primarily during active hip extension or if subject recruits the hamstrings excessively and/or primarily during active hip extension, contralateral shoulder raising during active hip extension, lumbar spine or pelvis torque by excessive movement of the pelvis and/or lumbar spine in the transverse and coronal planes during active hip extension.[9]

Respiration pattern was observed by having the subject sit and breathe normally and then lie supine and breathe normally. The investigator observed and palpated the ribs and abdomen. Inspection was for abdominal expansion in anterior, lateral, and posterior directions and pressure on all sides of the abdomen with normal breathing and full inhalation and exhalation. Failures include: excessive clavicular and/or thorax movement in a cephalad direction during inspiration, paradoxical breathing pattern with the abdomen being sucked in (moving in a dorsal direction) with abdomen protrusion in a ventral direction during expiration, inability of the subject to maintain ribs in a caudal position during respiration, inability of subject to exert outward pressure against investigator's palpation in an anterior, lateral, and posterior direction.[2,3]

The subjects were divided into two groups. One group was taught side bridges and the other was instructed on breathing pattern. All subjects met with an assigned investigator two times for each of four weeks.

The subjects in the side bridge group were taught to start in a side-lying position with the shoulders perpendicular to the ground and as centrated as possible. The hips were stacked and the top foot was slightly more anterior than the bottom foot. Instructions were given to lift the pelvis off of the floor until shoulders, hips, and knees were in alignment (neutral trunk angle with no lateral flexion). The position was held for 30 seconds for 3 sets and performed bilaterally. Those subjects unable to perform this way were offered an alternative starting position with the hips flexed 45 degrees and the knees flexed to roughly 90 degrees. Heels were stacked on top of each other and the pelvis was lifted off of the floor bringing the pelvis into a neutral position while maintaining knee and heel contact with the ground.

The subjects in the breathing group were taught to start in a supine position with the hips and knees flexed comfortably to roughly 45 degrees. Self-cueing was taught by placing each hand at the level of the anterior superior iliac spine and forming a C-shaped ring with the index and thumb. Anterior, lateral, and posterior movement of the abdomen can be palpated and cued with this hand placement. The subjects were also instructed to initiate breathing as low as possible in the abdomen during inspiration. The investigator cued this by holding their ribs in a caudal direction to prevent chest movement with inspiration. Subjects were instructed to try to attain a 1:2 ratio of time of inhalation to exhalation. The subjects were also instructed on breathing when seated.

Results

A total of 15 subjects completed all of the training session, seven in the side bridge training group, eight in the breathing retraining group. Upon the post-intervention screening, one of the eight in the breathing retraining group was found to pass the hip extension screen and the breathing screen. The second screening of the participants assigned to the side bridge training group revealed two subjects passed both the hip extension and breathing screens.

A 2x2 chi square (x^2) calculation was performed for each intervention using a significance level of $p<.05$. The breathing training group had a $x^2=.35$ and $p=.55$. The side bridge training groups had a $x^2=.57$ and $p=.45$.

Discussion

This study looked at the effect of two interventions to correct faulty breathing and hip extension patterns in 15 subjects. Only two participants from the side bridge training group and one from the breathing training group changed their patterns enough to pass both screens after four weeks of training. Based on the results of this trial, there does not appear to be a significant relationship between training core activation with side bridges or breathing and a change in results of a hip extension or breathing screen.

The hip extension screen has been used as a means by which assessment of muscle activation patterns by clinicians can quickly and easily be observed.[1] As McGill teaches, improper activation of stabilizing muscles of the torso can lead to decreased stiffness of the spine.[10,11]

The diaphragm is an important muscle for not only respiration, but also stabilization.[12-15] With attachments to the ribs and lumbar vertebra, it mechanically supports the trunk.[12,14,16] This function is used for posture control as well as limb movement.[12,17] When the diaphragm moves caudally during inspiration, it and other abdominal muscles effectively increase intraabdominal pressure and stabilize the spine.[12,16,17] If there is poor activation of the diaphragm and its actions are not in coordination with other abdominal muscles, stabilization may be decreased.[12]

Kapandji explains an ideal pattern used during inspiration as contraction of the descending parts of the diaphragm with lifting of the lower ribs and broadening of the thorax.[14] There are several reasons for faulty breathing patterns including biomechanical fixations and muscle imbalance, biochemical imbalances, psychological influences, nociception, central coordination disturbance, and postural habits.[18,19] An extreme pattern of aberrant breathing is seen when the abdomen is drawn in during inspiration and relaxed on exhalation and considered to be one of "paradoxical respiration".[2,3]

Although there is little research comparing the effects of respiration on prone hip extension (none to the authors' knowledge), evidence does show direct correlations between increased intraabdominal pressure due to diaphragmatic contraction and postural control during upper limb movements.[13] Hodges, et al conclude that contraction of the diaphragm aids trunk stability and stiffness in multiple studies.[13,15,17,20] One could argue then that poor respiratory function, specifically one in which vertical chest expansion dominates, would fail to create the appropriate trunk stiffness to effectively perform Janda's prone hip extension due to failure in increasing desired intraabdominal pressure. However, it is also important to consider that an increase in intraabdominal pressure due to diaphragmatic contraction alone is unable to create the desired stiffness of the lumbar spine, as may be the case with abdominal contraction and poor diaphragmatic contraction and respiration.

Several limitations influence the results of this trial. There was a small study size and the subjects came from a small population. Further studies should use a larger study size and include subjects with a history of pain or current pain. Interventions to train core stabilization could be used instead of side bridges, and the frequency of training could be increased. A study by Bullock-

Saxton, et al compared prone hip extension in individuals with previous ankle sprain injuries to a matched normal control group. The individuals who had previously experienced an ankle injury demonstrated a significant delay in gluteus maximus contraction as compared to the control group. Such findings reveal an important consideration for inclusion/exclusion criteria that were not taken into consideration in this study.[21] It is also important to consider the effects of postural changes as complicating factors such as Janda's lower crossed syndrome and glute activation.

Conclusion

Breathing training has been used with clinical success to retrain poor patterns and side bridges have been used to train core stabilization. Our results indicate breathing control training or side bridge training administered eight times in four weeks does not result in a significant change in prone hip extension firing patterns or breathing patterns. The data presented here is limited by small sample size.

References

1. Saharmann S. Diagnosis and treatment of movement impairment syndromes. Saint Louis:Mosby 2002:145-6.

2. Sahrmann S. Movement system impairment syndromes of the extremities, cervical and thoracic spines. Saint Louis:Elsevier. 2011. p. 1-2, 120-1.

3. Leibenson C. Rehabilitaiton of the spine a practioner's manual. 2nd ed Philadelphia:Lippincott Williams & Wilkins. 2007. p. 369-87.

4. Perri M, Halford L. Pain and faulty breathing: a pilot study. J Bodywork Mov Ther 2004;8:297-306.

5. Lewit K. Manuipulative therapy in rehabilitation of the locomotor system. 3rd ed. Oxford: Butterworth-Heinemann; 1999. p. 26-9.

6. Lewis C, Sahrmann S. Muscle activation and movement patterns during prone hip extension exercise in women. J Athlet Train 2009:44;238-48.

7. Cordo, P. J. and Nashner, L.M. Properties of postural adjustments associated with rapid arm movements. J Neurophysiol 1982:47;287-308.

8. Bouisset, S. and Zattara, M. Biomechanical study of the programming of anticipatory postural adjustments associated with voluntary movements. J Biomech 1987:20;735-742.

9. Morris C, Chaitow L, Janda V. Low back syndromes: integrated clinical management. New York: McGraw-Hill; 2006. p. 382-3.

10. Cholewicki J, McGill S. Mechanical stability of the in vivo lumbar spine: implications for injury and chronic low back pain. Clin Biomech 1996;11:1-5.

11. McGill S, Karpowicz A. Exercises for spinal stabilization: motion/motor patterns, stability progressions, and clinical technique. Acrh Phys Med Rehabil 2009;90:118-26.

12. Kolar P. Analysis of diaphragm movement during tidal breathing and during its activation while breath holding using MRI synchronized with spirometry. Physiol Res 2009:59;383-92.

13. Hodges P, Butler J, McKenzie D, Gandevia S. Contraction of the human diaphragm during postural adjustments. J Physiol London 1997;505:239-48.

14. Kapanji L. The physiology of the joints, volume 3, 6th ed.. Edinburgh: Livingston; 152-165.

15. Hodges P, Gandevia S. Changes in intra-abdominal pressure during postural and respiratory activation of the human diaphragm. J Appl Physiol. 2000;89:967-76.

16. Lewit, K. Relation of faulty respiration to posture, with clinical implications. J Am Osteopath Assoc 1980;79:525-9.

17. Hodges P, Gandevia S. Activation of the human diaphragm during a repetitive postural task. J Physiol 2000:522.1;165-75.

18. Gilbert C, Seals C, Wyka K, Bradley D. Breathing retraining: advice from three therapists. J Bodywork Mov Ther 1999:3;159-67.

19. Gilbert C. Emotional sources of dysfunctional breathing. J Bodywork Mov Ther 1998:2;224-30.

20. Hodges P, Eriksson A, Shirley D, Gandevia S. Intra-abdominal pressure increases stiffness of the lumbar spine; J Biomech 2005:38;1873-80.

21. Bullock-Saxton J, Janda V, Bullock M. The influence of ankle sprain injury on muscle activation during hip extension. Int J Sport Med 1994:15;330-4.