Journal of Sport Rehabilitation, 2014, 23, 12-17
http://dx.doi.org/10.1123/JSR.2012-0059

JOURNAL OF
SPORT REHABILITATION
www.JSR-Journal.com
ORIGINAL RESEARCH REPORT

The Importance of a Normal Breathing Pattern for an Effective Abdominal-Hollowing Maneuver in Healthy People: An Experimental Study

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Context: A normal breathing pattern while performing the abdominal-hollowing (AH) maneuver or spinal-stabilization exercise is essential for the success of rehabilitation programs and exercises. In previous studies, subjects were given standardized instructions to control the influence of respiration during the AH maneuver. However, the effect of breathing pattern on abdominal-muscle thickness during the AH maneuver has not been investigated. ***Objective:*** To compare abdominal-muscle thickness in subjects performing the AH maneuver under normal and abnormal breathing-pattern conditions and to investigate the effect of breathing pattern on the preferential contraction ratio (PCR) of the transverse abdominis. ***Design:*** Comparative, repeated-measures experimental study. ***Setting:*** University research laboratory. ***Participants:*** 16 healthy subjects (8 male, 8 female) from a university population. ***Measurement:*** A real-time ultrasound scanner was used to measure abdominal-muscle thickness during normal and abnormal breathing patterns. A paired *t* test was used to assess the effect of breathing pattern on abdominal-muscle thickness and PCR. ***Results:*** Muscle thickness in the transverse abdominis and internal oblique muscles was significantly greater under the normal breathing pattern than under the abnormal pattern ($P < .05$). The PCR of the transverse abdominis was significantly higher under the normal breathing pattern compared with the abnormal pattern ($P < .05$). ***Conclusion:*** The results indicate that a normal breathing pattern is essential for performance of an effective AH maneuver. Thus, clinicians should ensure that patients adopt a normal breathing pattern before performing the AH maneuver and monitor transverse abdominis activation during the maneuver.

Keywords: abdominal-muscle thickness, ultrasonography, rehabilitation

Trunk stabilization and strengthening programs that target the abdominal muscles are designed to improve motor control, strengthen the trunk muscles, and decrease low back pain.[1–6] Although a variety of these exercises exist, the first stage in the therapy process typically involves teaching patients to perform sustained, isolated contractions of the deep-lying abdominal muscle using the abdominal-hollowing (AH) maneuver.[1] The AH maneuver has been suggested to be a preferential contraction exercise for the transverse abdominal (TrA) and internal oblique (IO) muscles over the external oblique (EO) and rectus abdominal muscles.[6,7] The AH maneuver is usually performed in various positions (supine, prone, standing, and quadruped).[6,8,9]

While performing the AH maneuver or spinal stabilization exercise, a normal breathing pattern is essential for the success of any rehabilitation programs or exercises.[10] The breathing patterns or types are typically classified according to the expansion of the abdominothoracic region during inspiration at rest[11,12] as follows.

- *Normal breathing pattern:* A costodiaphragmatic breathing type is observed when the abdominal and lateral costal expansion is predominant over the superior thoracic expansion during inspiration at rest. This is considered the optimal or normal breathing type because it allows maximum lung expansion and, therefore, maximum lung capacity and gas exchange.
- *Abnormal breathing pattern:* The upper-costal breathing type takes place when superior thoracic expansion exceeds the abdominal and lateral costal expansion during inspiration at rest. This breathing type produces a smaller expansion of the rib cage and thus reduced lung capacity and gas exchange. Hence, excessive use of accessory muscles may be required to compensate for insufficient gas exchange.

Excessive use of accessory respiratory muscles leads to chronic cervical overstrain, reduced activity of the intercostal muscles, reduced rib movement, and an inhibited diaphragm.[13] An inhibited diaphragm may compromise the harmony between the diaphragm and TrA during functional tasks or movement.[14] The diaphragm plays a role in respiration and lumbar stabilization.[15] It acts to increase the mechanical stability of the spine indirectly via increased intra-abdominal pressure in conjunction with contraction of the abdominal and pelvic-floor muscles.[16–19]

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