ORIGINAL ARTICLE

Correlation between core strength and breath holding time in normal young adults

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ABSTRACT

Introduction: The diaphragmatic movements cause continuous changes in the intra-abdominal pressure. Whereas, static contraction of the diaphragm, breath holding, maintains the intra abdominal pressure which helps in stabilisation of the vertebral column. The contraction the abdominal core muscles, namely the transversus abdominis, the obliques both internal and external, have shown contribution to the rise in intra-abdominal pressure. Is it possible that there exists a correlation between the breath holding time and the core strength, thereby making it evident that adequate strength of abdominal core may be necessary to increase the breath holding time?

Material and Mmethods: Sixty young healthy adults were taken in the study. The breath holding time was measured using a stop watch. Three trials were done and the highest breath holding time was recorded. The core strength was measured using aneroid sphygmomanometer. The fall in mercury was measured. The values of the maximum breath holding time, and the core strength were compared.

Results: There was significant correlation between the breath holding time and the core strength. The mean age of the subjects was 20.63±1.9. The mean maximum breath holding time was 44.6±14.86 seconds. And 3±2.4 mmHg, was the mean core strength (r=0.351).

Conclusion: It was concluded that core strength training should accompany activities that require good breath holding time. Hence, better the core strength more efficient is the functioning of the diaphragm.

Key words : Core strength, breath holding time, transversus abdominis, diaphragm

INTRODUCTION

The muscles of the neck and trunk not only act as prime movers or as antagonists to movement caused by gravity during dynamic activity, they are important stabilizers of the spine.1-9 Without dynamic stabilization from trunk muscles, the spine collapse in the upright position.10 Both superficial (global) and deep (core) muscles function to maintain upright posture.11 The deeper, core muscles, which have segmental attachments, respond regardless of direction of motion.7 They provide dynamic support to individual segments in the spine and help maintain each segment in a stable position so the inert tissues are not stressed at the limits of motion. The lumbar core muscles include transversus abdominis (TrA), mutifidus, quadratus lumborum (deep portion) and deep rotators.11 The stabilizing function of the core muscles(TrA) works in conjunction with the diaphragm in a feed forward response to rapid arm movements. Contraction of the diaphragm and increased intra-abdominal pressure occur prior to rapid arm movement, irrespective of the phase of respiration or the direction of the arm motions.7,12 The tonic activities of the core muscles (TrA) and diaphragm are modulated to meet the respiratory demands in both inspiration and expiration and provide stability to the spine when there are repetitive limb movements.13,14 Three techniques for abdominal muscle activation have been described and used in clinical practice; the drawing in maneuver; abdominal bracing; and posterior pelvic tilt.15 the drawing in maneuver is more selective in co-activating the core muscles (TrA) and the mutifidus muscle than the abdominal bracing and posterior pelvic tilt techniques.15,16 This maneuver also increases intra-abdominal pressure by inwardly displacing the abdominal wall, thus helping in spine stabilisation.17

Breath holding is an unstable state with changes occurring in many inter-related variables.18 Breath holding time may vary in the same subject, it can be increased 13-19% with distractions [mental and arithmetic (Alpher et al.1986)] or 37% with successive trails. The simplest objective method of breath holding is the duration, but even this is highly invariable. A powerful involuntary mechanism overrides the voluntary breath- holding and causes the breath called the breaking point.18 The period of breath holding in most subjects can be divided into two parts: the first; characterized by voluntary inhibition of respiratory muscles activity; the second, by involuntary respiratory efforts.19Stange found that average healthy person could hold the breath for from 45 to 50 seconds. The factors affecting breath holding (a) PCO 2 20(b) lung inflation18 (c) initial lung volume18 (d) prior O2 levels.18

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The tonic activities of the core muscles (TrA) and diaphragm are modulated to meet the respiratory demands in both inspiration and expiration.13, 14 The action of the diaphragm, not balanced by an antagonist muscle, causes alteration in the intra-abdominal pressure (IAP). It has been found that, non-respiratory exercises (including sit-ups and biceps exercises against resistance) strengthen not only the muscles performing the movement, but also muscles used for inspiration and even expiration, with hypertrophy of the diaphragm.21 Similarly, it has been demonstrated that weightlifters are capable of generating a greater inspiration pressure and have hypertrophied diaphragms compared to the control group.22 Diaphragm movement shown on MRI images during voluntary breath holding is not only the result of pressure changes in the abdominal cavity but also of its active contraction.23 During valsalva maneuver (breath holding), contraction of core muscles (TrA), internal obliques and external obliques muscle increases intra-abdominal pressure.24 Contraction of the core muscles (TrA) alone pushes the abdominal content up against the diaphragm and the pelvic floor muscles contract in synchrony with TrA.17 This technique is frequently used by weight lifters. Drawing in of breath, leads to co-activation of the core muscles, thus stabilizing the spine providing leverage to lift weight. However no studies have reported correlation between the breath holding time and core muscles strength.

This study aims to assess the correlation of breath holding time with core muscles strength measured by sphygmomanometer.

METHOD AND MATERIALS

Ethical approval was received from the institution ethical committee. Sixty subjects between the age group of 18-25yrs were selected according to their availability and interest to participate in the study. Prior consent from all subjects was taken. The subjects selected had no history of backache and any kind of respiratory problem. The subjects with musculoskeletal problems like trauma and those with recent abdominal or back surgeries were excluded from the study. A plinth was used to make the subjects lie on in supine position. An aneroid sphygmomanometer was used to measure lumbar core strength, and a stopwatch was needed to measure the breath holding time.

The study included males and females. The procedure of the study consisted of two parts. In first part the subject's breath holding time was measured; three readings were taken with a span of two minutes between each. The best of three values was taken as the breath holding time of that individual. While taking the readings the subject was made to sit in a relaxed sitting position. The subject was then asked to take a deep inspiration and hold it for as long as possible and then exhale. Likewise the other two readings were taken and compared, and the best maximum breath hold was considered. In the second part of this study, the core strength was measured by aneroid sphygmomanometer. The subject was made to lie on the plinth in prone position; the cuff of the sphygmomanometer was placed under the abdomen. The cuff is inflated upto 70mmHg. The subject is asked to perform the drawing in maneuver. A decrease of 6 to 10mmHg during drawing in maneuver (without substitutions) indicates proper activation of the deep abdominal muscles.17 Further mean of breadth holding time in minutes and fall of hg in mm was calculated and comparison between the two groups was performed to assess the difference. All subjects were given three trials for breath holding and the longest breath hold time value was taken for that patient.

RESULTS

Pearson's correlation was used to denote the strength of association between the breadth holding time and core strength. Among sixty subjects in the study group the breath holding time and the core strength varied. The mean age of the study group taken was 20.63±1.9. The mean maximum breath holding time was 44.6±14.86 seconds. Amongst the total subjects 40% could hold their breath, till or beyond, 45 seconds. The core strength was analyzed and the mean core strength was found to be 3±2.4mmHg. Around 16.67% showed good core strength. It was graphically represented. Figure1 shows that there exists a linear correlation between the breath holding time and the core strength. The breath holding time and the core strength was correlated. The data was tested by non-parametric Pearson's correlation and the r=0.351 value was significant at p<0.05 (figure 2)

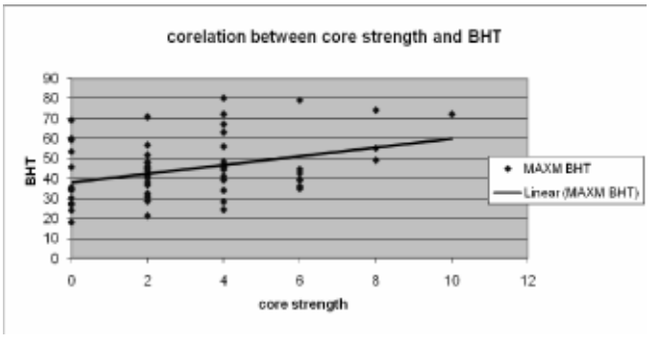

Figure 1

		Core strength	Breath holding time
Core strength	Pearson's correlation	1	0.351(**)
	Sig.(2-tailed)	-	0.006
	N	60	60
Breath holding time	Pearson's correlation	0.351(**)	1
	Sig.(2-tailed)	0.006	-
	N	60	60

Figure 2

DISCUSSION

The study was aimed at correlating the core strength and the breath holding time. Breath holding is under voluntary control within limits.26 I.A.Kapandji states that, during voluntary abdominal maneuvers especially, involving the core or the TrA, the activation of diaphragm is noted. Also, there occurs concurrent activation of both the muscles. The contraction of the diaphragm brings down the central tendon increasing the vertical diameter of the thorax; but this is soon opposed by the vertical mediastinal elements and especially the resistance of the abdominal viscera. These are contained within the 'abdominal girdle' formed by the powerful core muscles. Without these muscles the contents would be anteriorly and inferiorly displaced and the central tendon would not be stabilized to allow the diaphragm to elevate the lower ribs. This antagonistic-synergistic action of the abdominal muscles therefore is essential for the efficiency of the diaphragm.27 S.L.Legg, in the study on effect of muscle fatigue on intra abdominal pressure, states that the fatigue of rectus abdominis and ilio psoas does not have an effect on the intra abdominal pressures, since the main muscles responsible for maintenance and alteration of intra-abdominal pressure is TrA, the obliques and the diaphragm. Hence, there occurs a sustained increase in intra-abdominal pressure when there is co-activation of the diaphragm and abdominal core muscles. 28 P. Kolar, J.Neuwirth, J.Sanda, et al. studied the diaphragm movement in breath holding using synchronized MRI with spirometry. They proved that there occurs voluntary contraction of the diaphragm which leads to the stabilization of the vertebral column by increasing the intra-abdominal pressure.

In this study, the subject is asked to hold his breath in end inspiration. Thus in inspiration, there occurs shortening of the diaphragm which displaces the abdominal contents caudally while TrA is lengthened.13The static contraction of the core muscles stabilizes the vertebral column together with efficiently balancing the increasing IAP caused by the descent of the diaphragm at end inspiration. A stabilized 'abdominal cavity' allows the diaphragm to remain shortened at its effective length for a greater amount of time (stabilization effect). This is shown as an increased breath holding time (inspiration hold). Thus a direct linear correlation can be established between abdominal core strength and breath holding time also exemplified in the current study.

The intra abdominal pressure in breath holding is thus affected by both, diaphragmatic contraction as well as the abdominal core muscles. If there occurs reduced tone or decreased strength in either of the musculature the intra abdominal pressure is affected leading to increased spinal loading and increased intra disc pressure and resulting low back ache.29 Thus, in activities where breath holding is necessary esp. during weight lifting, adequate contraction of the core as well as the diaphragm is beneficial to unload the spine. Consequently, specific muscle training for core abdominals will improve results and reduce the chances of backache.

This linear correlation can be further utilized in a way that breath holding time can be increased by increasing abdominal strength.

CONCLUSION

The study thus proves that there is a linear correlation between breath holding time and core strength. Hence, the core strength will improve the efficiency of the diaphragm.

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