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EFFECT OF PROLONG SITTING ON ABDOMINAL CORE STRENGTH: AN OBSERVATIONAL STUDY

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ABSTRACT Modern workplaces have shifted the nature of occupations from active to sedentary and promote lengthy sitting behaviour. One cause of this change is the transition from paper-based work to computerized and paperless work. Most researchers have assessed the activity of the transversus abdominis (TrA) muscle through direct and indirect measures such as fine wire electromyography and rehabilitative ultrasound imaging. The pressure biofeedback unit (PBU) is a tool developed by physiotherapists to measurement of TrA activity through abdominal wall pressure changes. Our hypothesis was that prolonged sitting would be associated with a significant decrease in muscle activation. 50 subjects were selected from a multinational company with sitting working hours more than 5 hours a day.Subjects included were given a consent form and a Nordic musculoskeletal questionnaire. Subjects who had back pain in past 7 days were excluded and those who were included were taught how to draw in their abdomen to check their transverse abdominis strength and their activation score and performance index was recorded. The results of the present study suggested that the mean performance index of 50 participants was 69 6.2 SD. The mean age of the participants was 38.22 1.28 SD The mean performance index for females was 54 2.5 SD and for males was 65 8.5 SD. The mean activation score for all the 50 participants was 7.25 1.58 SD. Our results showed that the activation of transverse abdominis was reduced in people who have to sit for prolong period of time. This change in posture for long duration leads to decrease activation which affects the spinal stability in turn leading to low back pain.

KEYWORDS : Prolong sitting, low backpain, abdominal core strength, pressure biofeedback

INTRODUCTION:

Since the middle of the last century the physical, economic and social environments in which modern humans sit or move within the contexts of their daily lives have been changing rapidly. The demand for physical activity has been significantly reduced due to the changes in transportation, communications, workplace and domestic-entertainment technologies. Sedentary behaviours (typically in the contexts of TV viewing, computer and game-console use, workplace sitting, and time spent in automobiles) have emerged as a new focus for research on physical activity and health. The sedentary modern employment lifestyle encourages greater use of computers and subsequent longer periods of sitting.[1]

Modern workplaces have shifted the nature of occupations from active to sedentary and promote lengthy sitting behaviour. One cause of this change is the transition from paper-based work to computerized and paperless work[2,3]. It was estimated that about 40.7 % of the global population was surfing the computers in the year 2012 as compared to 2006 of only 26.2%. Human beings were not made to sit in a chair for 8 hours per day, yet with the commonplace "desk job," sitting in front of a computer has become a way of life. It has been reported that people sit more than 8 hours per day.[4] For about two-third of their working hours, these people remain in a sitting posture and their bouts of sitting periods typically last at least 30 minutes.[5]

Sitting for a long time can cause discomfort in the lower back[6], and maintaining the sitting posture for extended periods is reportedly associated with the endurance of lower back muscles . A reduction in back muscle endurance could be an independent predictor of back pain[7]. In recent years, due to the flexibility of mobile devices, people are increasingly using portable equipment without a desk[8,9,10]. In unsupported sitting conditions without a backrest or desk, people often adopt poor sitting postures that increase the risk of musculoskeletal disorders [11,12]. In a review on posture by Raine and Twomey (1994), it was concluded that there are still controversies and little evidence supporting claims on the benefits of ideal posture or the suggestion that poor posture will lead to musculoskeletal pain. However, in a more recent systematic review, Prins et al. (2008) concluded that musculoskeletal pain may be influenced by sitting posture in children and adolescents.

Although some epidemiological studies and systematic reviews determined that sitting time and posture are not significantly associated with the development of LBP[13,14], other studies showed that sitting in a bad posture for a long period increases LBP and lumbar discomfort[12]. Sitting posture can affect the trunk muscle activity, and different muscles are predominantly stimulated, depending on the sitting posture[15,16]. Studies comparing the activity of trunk muscles based on posture reported that slumped sitting significantly decreased the activity of the internal obliques (IO)/transversus abdominis (TrA), when compared to upright sitting [17,18,19]. In recent years, studies indicated that muscular fatigue is present in the trunk muscles of healthy individuals who maintain a slumped sitting posture for a long period[9,15,20]. The influence of lumbar stability on poor posture versus upright posture has also been studied.[21] It has been reported that there is a significant decrease in activity of the internal oblique (IO) and multifidus muscles in poor sitting and standing postures (Snijders et al., 1998; O'Sullivan et al., 2002, 2007). In these studies however, the activity of TrA was not measured. The effect of sitting postures on TrA has been studied by Ainscough-Potts et al. (2006), but a lumbo-pelvic neutral spine appeared not to be controlled. Moreover Reeve et al. in 2009 studied the thickness of transverse abdominis in slouched sitting and sway standing which are commonly adopted poor standing and sitting posture as compared to erect lumbo pelvic neutral standing and sitting positions, and he concluded that in both erect lumbo-pelvic neutral standing and sitting postures there was an increase in TrA thickness compared to sway-back standing or slouched sitting, respectively.[22,23,24,25]

Most researchers have assessed the activity of the transversus abdominis (TrA) muscle through direct and indirect measures such as fine wire electromyography and rehabilitative ultrasound imaging. However, the high cost, risk of being painful and risk of causing infection limit the use of these methods in clinical practice.[26] An alternative approach may be the indirect measurement of TrA activity through abdominal wall pressure changes using a pressure biofeedback unit (Stabilizer, Chattanooga Group Inc., Hixson, USA).[27-31] The pressure biofeedback unit (PBU) is a tool developed by physiotherapists to aid the retraining of stabilising muscles using specific exercises, and detects movement of the lumbar spine in relation to an air-filled reservoir (Jull *et al*, 1993). [32] The use of such pressure sensors can provide useful visual biofeedback during treatment, and an objective measure of the fatigue time of the deep abdominal muscles. The PBU is a simple pressure transducer consisting of a three-chamber air-filled pressure bag, a catheter and a sphygmomanometer gauge. The pressure bag has 16.7×24 cm in size and made from non-elastic material. The sphygmomanometer scale ranges from 0 mmHg to 200 mmHg, with 2 mmHg intervals on the scale. Movement or change in position causes volume changes in the pressure bag, which is registered by this device. [33]

As the working environments are upgrading day to day and the musculoskeletal issues have been increasing especially LBP, this study is undertaken to find the effect of prolong sitting on TrA muscle strength. So as to help train `people to prevent the musculoskeletal and postural strains. Based on the literature reviewed, our hypothesis was that prolonged sitting would be associated with a significant decrease in muscle activation. If verified, this hypothesis may explain why people using sitting workstations report lower low back discomfort over time.

Methodology:

Following the ethical approval, consent was obtained from 50 subjects [32 males and 18 females]. The subjects were selected from a multinational company with sitting working hours more than 5 hours a day. Subjects were excluded if there was a history of abdominal surgery, a spinal deformity such as scoliosis, a history of low back pain within last 2 months and if they were pregnant.

Procedure:

Each subject was given a consent form and a Nordic musculoskeletal questionnaire. After filling up the form the subjects who had back pain in past 7 days were excluded and the rest were included in the study.

Subjects were given standardised instructions on how to position themselves. Chattanooga pressure biofeedback unit was used to assess the TrA strength. The inflatable bag from the PBU was placed between the anterior superior iliac spine and the navel. Before starting the contractions, the bag is inflated to a pressure of 70 mmHg with the valve closed. Participants were instructed to breathe using mainly the abdominal wall and then the inflatable bag was adjusted to 70 mmHg again. Prior to testing, each subject was taught (with the aid of demonstration, visualisation) how to contract the muscle. Participants were requested to perform three TrA muscle contractions with the following verbal commands standardized by the examiner: “Draw in your abdomen without moving the spine or pelvis” and maintain these contractions for 10 sec (Costa et al., 2004). Reading from the sphygmomanometer gauge were taken at the beginning and end of 10 seconds of contraction, and the activation score and the performance index were calculated. Activation Score: It is the pressure level that subject can achieve and hold for 10 repetitions and in each repetition for 10 seconds. Performance index: It is calculated by multiplying the activation score by number of successful repetitions. The highest performance index score is 100.

RESULT:

The results of the present study suggested that the mean performance index of 50 participants was 69 6.2 SD. The mean age of the participants was 38.22 1.28 SD The mean performance index for females was 54 2.5 SD and for males was 65 8.5 SD. The mean activation score for all the 50 participants was 7.25 1.58 SD, tabulated in table -1.

Also it was found from NMQ that out of 50 participants that were included in the study 48 participants have had low back pain in past 12 months.

	Males	Females	Total
Number	32	18	50
Performance index	65 ± 8.5 SD	54 ± 2.5 SD	69 ± 6.2 SD

DISCUSSION:

Office work is sedentary work, which mainly involves computer use, participation in meetings, giving presentations, reading, and phoning. Thus, office workers are usually required to sit for long hours in front of a computer. Many individuals experience musculoskeletal discomforts particularly at the buttock and low back regions during prolonged sitting . Evidence suggests that signs of body perceived discomfort, such as tension, soreness, or tremors, are predictors of LBP. Increased discomfort from prolonged sitting has been partly attributed to muscle fatigue from sustained contraction of back muscles in seated postures. Three sitting postures commonly used by office workers are upright, slumped, and forward leaning sitting postures.[34]

The local and global muscles of the lumbopelvic region can be preferentially facilitated in different sitting posture. Transversus abdominis and Multifidus muscles represent a local system for counterbalancing compressive forces on the upper lumbar segment of the spine and to increase lumbar stability, and contraction of transversus abdominis was found to be significantly delayed in patients with LBP. Paraspinal muscle fatigue also reduces the muscular support to the spine, causing impairment of motor co- ordination and control as well as increased mechanical stress to ligament and intervertebral disks . The transverse abdominus is the deepest of the abdominal muscles and its fibers blend into the thoracolumbar fascia laterally between the iliac crest and the twelfth rib. The transverse abdominis attaches posteriorly to each lumbar vertebrae via the thoracolumbar fascia. It is responsible for increasing intra- abdominal pressure and when contracted produces a 'drawing in' of the abdominal wall. Deep muscles of the abdominal wall have a key role in the dynamic control of the lumbar spine (Hodges and Richardson, 1996, 1998). Farfan and McGill and Norman suggested that the contraction of the hoop – like TrA creats a rigid cylinder, resulting in enhancing stiffness of the lumbar spine.[35]

Muscle function in the neutral zone is important for stabilization of the lumbar spine Bergmark classified the trunk muscles into a local and a global system to understand how the muscular system acts on the stability of the lumbar spine. The local muscle system includes the deeper muscles, which have their origin or insertion points either directly or indirectly on the lumbar vertebrae. This system directly provides lumbar segmental stabilization. The transversus abdominis and lumbar multifidus are examples of local muscles. The global muscle system includes those muscles that do not directly attach to the lumbar vertebrae, such as the rectus ab- dominis and external oblique muscles. The global muscles generate a large torque across multiple segments and control trunk movement. It has been re- ported that increased vertebral stiffness by coactivation of the local and global muscles is important in improving the stability of the lumbar spine.[36]

The result of the present study suggested that prolong sitting leads to decrease in activation of Transverse abdominis muscle , leading to early fatigue. Both males and females had moderate performance index for the transverse abdominis strength, leading to decrease activation of the muscle.

In accordance with the present results, O'Sullivan et al. (2002) found a significant decrease in the EMG activity of Internal oblique in sway standing compared to erect standing. In a different study using the same methodology, EMG activity from Internal Oblique (IO) and TrA could not be distinguished (Marshal and Murphy, 2003), and therefore it was possible that TrA activity was also recorded. O'Sullivan et al. (2002) also found rectus abdominis to be the only abdominal muscle with a significant increase in activity in sway-back standing. Due to the independent anatomy of RA in comparison to the other abdominal muscles (Askar, 1977; Rizk, 1980), RA is likely to have a different role in the sway-back position.[37,38,39]

The significant increase in thickness of TrA in upright sitting compared to the slouched sitting position was consistent with the results for erect and sway-back standing, which indicated a reduction in TrA activity in the slouched sitting position (Hodges et al., 2003a; McMeeken et al., 2004). Together, these results support the idea that TrA is more active in an aligned posture.[40]

Investigations by Hodges and Richardson (1996 and 1998), using fine wire EMG, found that the transverse abdominis (TrA) became active in normal subjects prior to limb movement. However, when back pain was present they found the activity of TrA was delayed. They concluded that the early activation of TrA may be a protective mechanism for the lumbar spine, which is lost when patients have back pain. Norris (1995a) also suggested that the active muscular system should be addressed, and high- lights the need to address the deep abdominals that are stabilizers, as well as the superficial ones that act as prime movers.[41]

As it is known that transversus abdominis is a spinal stabiliser, in the present study decrease activation in the participants would lead to decrease stabilisation of spine leading to low back pain.

Hence the hypothesis is verified that prolonged sitting would be associated with a significant decrease in muscle activation. This explain why people using sitting workstations report lower low back discomfort over time.

CONCLUSION:

Our results showed that the activation of transverse abdominis is reduced in people who have to sit for prolong period of time. This change in posture for long duration leads to decrese activation which affects the spinal stability in turn leading to low back pain.

Future Implication:

Looking at the data and the modification in the working environment taking place where, modern workplaces have shifted the nature of occupations from active to sedentary and promote lengthy sitting behaviour. There is a need to start ergonomic training to all the persons who have to sit and work for hours so as to prevent musculoskeletal disorders due to prolong sitting.

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