The influence of the sitting position on the condition of the spine. Facts and myths

Wpływ pozycji siedzącej na stan kręgosłupa. Fakty i mity

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INTRODUCTION

In order to better understand the myth believed in medical environments, it is worth to analyse one simple example of dealing with a patient after hips injury when the treatment usually incules strengthening of the muscles responsible for the movements and stabilization, to prevent re-injuries [1]. In case of an anterior cruciate ligament (ACL) injury, the procedure is to strengthen the muscles to ensure adequate stability and protect against re-injury [2]. In case of a muscle rupture, the physical exercises in a painless range of movement is recommended because after the body activates the proliferation process (which is the third stage of tissue regeneration after inflammation and bleeding). It boosts muscle repair and regeneration process and limits scar tissue formation through activation of stem cells [3-5]. The situation is quite similar when we deal with the state after the bone fracture. Then the axial load is introduced, as it is consistent with the function of the bone and supports its faster

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ABSTRACT

Over the last decades, many beliefs about the spine, its diseases and therapeutic management in case of their occurance have become established in medical science. Many of these beliefs have been formed around scientific research, or theoretical assumptions made by the authors of textbooks, which reliability and compliance with the facts could be questioned. As science has adopted the principle that science can be refuted by the better science, over the next decades many reliable scientific studies have been conducted, showing the existing assumptions from a completely different perspective. This paper aims to present the aforementioned myths and compare them with more recent scientific reports. The authors discussed the physiology of the intervertebral disc and how it behaves under load; the role of the musculus transversus abdominis as a stabilizer of the spine and its weakness as a cause of the low back pain; and the pressure in the intervertebral disc when taking different body positions, as the golden standard for all assumptions of ergonomics at work.

Keywords: *spine, ergonomics, sitting work position, musculus transversus abdominis, scientific myths*

STRESZCZENIE

Przez ostatnie dziesięciolecia w naukach medycznych utrwaliło się wiele przekonań dotyczących kręgosłupa, jego chorób i postępowania terapeutycznego w przypadku ich wystąpienia. Wiele z nich utworzonych zostało wokół badań naukowych lub teoretycznych założeń autorów podręczników, których rzetelność i zgodność ze stanem faktycznym można by kwestionować. Jako, że w nauce przyjęło się stosować zasadę, iż naukę może obalić lepsza nauka, przez kolejne dekady powstało wiele rzetelnych badań naukowych, pokazujących dotychczasowe założenia z zupełnie innej perspektywy. Niniejsza praca ma na celu przedstawienie wcześniej wspomnianych mitów i zestawienie ich z nowszymi doniesieniami naukowymi. Autorzy poruszyli tematy fizjologii krążka międzykręgowego i jego zachowania pod wpływem obciążenia; roli mięśnia poprzecznego brzucha, jako stabilizatora kręgosłupa oraz jego osłabienia, jako przyczyny dolegliwości bólowych dolnego odcinka kręgosłupa; a także ciśnienia w krążku międzykręgowym podczas przyjmowania różnych pozycji ciała, jako złotego standardu wszelkich założeń ergonomii pracy.

Słowa kluczowe: kręgosłup, ergonomia, siedząca pozycja pracy, mięsień poprzeczny brzucha, mity naukowe

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regeneration [6]. However, as a frequent recommendation in case of spine injury or pain that exists in medical community is not to load, lift, or run. During the rehabilitation proces the patients undergo a movement therapy in special exercise cages equipped with suspension lines. However, this therapy does not ensure optimal movement pattern for the limbs as well as for the spine.

SPINE PHYSIOLOGY

The spinal column – known also as spine or backbone – is formed of more than two dozen bones (vertebrae), that protect nerve tissue of the spinal cord. Between each of the vertebra there are *cushions* called intervertebral discs made up of cartilage, collagen fibres and water. The physiology of the intervertebral disc indicates that it is fed by aquaporins through osmosis with vascularized vertebrae [7]. According to the research the nucleus is a viscoelastic structure which, in a no-loaded environment, takes fluid nature. However, when the disc is exposed to external forces, it takes solid-like nature, becoming compact and performing its function [8]. Some still may think that the intervertebral disc is rather of a delicate nature but the reality is completely different the pressure of 500 Ibs (about 227 kg) on the disc cannot do any damage to it [9]. Here, the weightlifters are perfect example of how solid the intervertebral discs are. If the intervertebral discs were delicate, then athletes performing snatches with a load exceeding 200 kg would suffer serious injuries. Also, regeneration and restoration of the intervertebral disc height, contrary to common myths, is possible, providing that the disc is given enough time to rest. Even if the end plate connecting the disc with the vertebrae is blocked, the disc still has the ability to return to its original height [10].

In the experimental research of W.J. Virgin, the theory that the fluid goes out of the disc was refuted. During the experiment the researcher made the incision perforating the disc to the nucleus. The final outcome of the experiment showed that the nucleus did not have the tendency to spill out. Even after making U-shaped and Z-shaped incisions in the annulus still there were no significant fluid spills [9].

Many patients are advised by the doctors to avoid rapid and sudden movements in case of spine conditions, which is apparently unjustified and is not supported by scientific research. As demonstrated by a very reliable study on runners in 2017 [11], joggers (20-40 km per week) and long-distance runners (over 50 km per week) revealed that they have much better hydration, nutrition and height of intervertebral discs, comparing to the control no-running group. Within the running groups the long-distance runners had better results, but these differences were not statistically significant. The most advantageous values of the discussed results were achieved by athletes during a 2 m/s run, within the overload range 0.44-0.59 g. A walk with a speed of 1.5 m/s was below this value, and a run of 2.5 m/s and faster as well as the jumps were above it. This means that the best speed to improve the health of the discs is 2 m/s. The remaining speeds will also have a positive effect on the health of the intervertebral discs, although to a lesser extent.

For years weightlifting has been marginalized as a proper and safe activity for patients with spinal problems. As it was presented in the study [12], powerlifters performing deadlift with weights up to 335 kg did not suffer any spinal injuries, despite the fact that the pressure generated by the weight was theoretically higher than that which causes injuries according to as the academic publications state. In addition, the bone mineral content (BMC) value in the L3 vertebrae of the athletes increased with the number of tons lifted annually.

TRANSVERSUS ABDOMINIS ON THE DOCK

The myth examples discussed above, are not proved by scientific research. However, when it comes to the transverse abdominal muscle, the situation looks differently and is illustrated as an overinterpretation of available scientific research. In this case, the work of Hodges and Richardson from the 90's [13, 14], in which (with the use of electromyography EMG) the musculus transversus abdominis among low back pain (LBP) sufferers activated later during the movement of the upper and lower limb in relation to the control group. This led to the thesis that weak musculus transversus abdominis is a direct cause of LBP and specific LBP healing exercises experienced a renaissance among the medical industry. Many training methods were created and many books were written basedvon the assumption that the strenghtening transversus abdominis muscle will help to maintain a healthy spine. This suggests, however, that the cause of pain lies in spinal instability, which is a great simplification and, in a way, generalization of the patients' problems. Joseph Pilates (the creator of a popular exercises) never suggested such approach in his works.

Due to the fact that the subject was very popular among scientists, they decided to check whether the assumptions are true or not. Numerous scientific studies dated from 2006 to 2016 indicate that exercises aimed at deep abdominal muscles did not give significantly better results of reduction of LBP than general physical exercises or manual therapy [15-18]. One study showed that motor control exercises were more effective than general physical exercises, but to quote the authors: "It is to date not known if the effect of motor control exercises (MCE) on pain and physical impairment in LBP is due to the isolated activation of the local musculature or subsequent stages of the intervention involving loaded postures engaging all trunk muscles" [19]. These doubts are confirmed by neurophysiology, according to which the brain 'does not perceive a single muscle, but

the movement', which means that it is impossible to activate only one muscle during functional movement [20]. The effectiveness of these assumptions in clinical practice was also checked. A study was conducted among 402 people without LBP and with weak muscles where they were divided into two groups. In one of them people were subjected to back health education and the and others were additionally trained with exercises aimed at abdominal muscles. Then both groups were observed for one year and LBP episodes were counted among their members. The effects showed no statistically significant difference between the groups [21].

However, specialists working on aimed exercises, according to the assumptions based on Hodges and Richardson's research, obtained analgesic effects with their patients. The emerging question "why?" is answered by the observation that the above mentioned studies do not negate the effectiveness of aimed exercises. However, they indicate the lack of its superiority over general physical activity. This leads to the conclusion that the movement in general is the key to the prevention of pain.

WHAT IS WRONG WITH THE POOR POSTURE?

Examples of myths based on beliefs without scientific evidence as well as myths resulting from overinterpretation of research results were presented above. Later in this paper, the myths created on the basis of poor quality research on body posture will be discussed.

Golden standard of ergonomic positions, i.e. upright, with shoulders in retraction, with tension in transversus abdominis and in gluteal muscles is recommended for patients when standing and sitting to stabilize the spine and avoid pain.

The assumption of this standard is based on the previously mentioned studies of Hodges and Richardson who state that spinal pain is caused by weak stabilizing muscles, however it is not clearly reflected in the studies [19].

An extensive meta-analysis from 2010 also provides interesting insights into this subject presenting numerous scientific reports on the core as such, even going as far as to claim that people trained to use "abdominal hollowing" and "abdominal bracing" during everyday activities should forget about this practice, as it can lead to the formation of incorrect motor patterns and unnecessary stress during standing or sitting in inccorect position [22].

The natural function of the human spine is not only to protect the spinal cord, nerve roots, but also to provide suport and balance to maintain an upright posturę as well as enable flexible motion.

Of course, there are positions that in a long-term cause various ailments, such as thoracic outlet syndrome (TOS) or LBP. During an eight-hour working day, keeping unchanged position at all times will lead to high bioenergy costs. Different occupations require different positions at work, for example this of cosmetologists is with sloppy shoulders and bended head and, in long-term it will lead to soft-tissue tension imbalance, overload in the suboccipital area, increased risk of carpal tunnel syndrome, reduced functional chest respiratory ability and possible back pain. Constantly maintaining the body in a position in accordance with the golden ergonomic standard, despite its aesthetics, will also lead to muscle fatigue, soft-tissue tension imbalance, and pain due to the lack of change in muscle motor. Unfortunately, great importance is still attached to maintaining the aesthetic appearance of the posture at work, despite not only the lack of evidence of its pro-healthiness, but also important scientific evidence of the risk of harmfulness associated with its long-term maintenance. This is confirmed by scientific research, which shows that maintaining muscles in static work generates a decrease in their strength and efficiency. It also reduces phosphocreatine values [23-25]. Long-term muscle tension inhibits sufficient nutrition, which leads to muscle fatigue and a decrease in the performance of their stabilizing function. Moreover, the inability to maintain a "correct" posture at all times will have a negative impact on the patients' psyche and cause a large dose of destructive stress [22].

We may ask what do we actually understand by poor position? According to the general belief it is a position diffrent than upright with shoulders pulled backwards and with the head in the axis of the body. This myth was generated on the basis of results of the 1970 Nachemson research [26] and to this day it is the most popular thesis preached in all classes of work ergonomics. Based on Nachemson's results, a popular graphic has been created to show the percentage of load on intervertebral discs when standing, sitting, lying down, bending and lifting. Unfortunately, an important aspect has been omitted here, namely the methodology, in which guiding needle diameter 1.2 mm and transducer needle diameter 0.8 mm driven into the intervertebral disc was used. There is a high risk of bias of putting a needle in a healthy spine. Moreover, analog equipment with a high risk of inaccuracies was used for measurements. The author himself admitted that many times he could not read the exact value of the measurement. And the most important thing - the study group consisted of only 9 people, of which some positions were made by only one man.

In recent years, however, some indirect methods presented completely different results than that of Nachemson's. It was conluded that the slouching position without and with lumbar support does not increase the pressure in the intervertebral disc, and also increases the height of the spine after its earlier loading [27]. This is consistent with the study of Wilke, who stated that such position generates half the pressure on the L4-L5 disc than the "normal" position [28].

SUMMARY

The intervertebral disc is a robust structure with viscoelastic properties that is capable of bearing very high loads without damage. Even if, as a result of overloading, the disc is dehydrated and its height reduced, it can reproduce the initial height level, or even increase it, under the influence of alternating load and unload. Bruce Lee's words "be water my friend" do not apply to the nucleus, which is relatively reluctant to escape from the anulus fibrosus. In the context of physical activity of patients with spinal pains, exercises that load the spine axially should be recommended. The level of training load should be adjusted individually to the capabilities of the person. In the case of people not fit, it is advised to start from a quick march and gradually diversify and impede physical activity. It is also worth to learn elementary movement patterns of strength training. The age of the patient also matters here, providing that the principles of correct training techniques have been mastered beforehand.

The most important element of LBP prevention is movement and frequent position changing during work. Thanks to this, the currently used muscles will be relaxed and thers will be activated and most importantly structures of intervertebral discs, which are irrigated during decompression, will also be nourished.

There are no single direct causes of spinal pain and there is no single universal treatment. Targeted exercises are not a panacea for LBP. If the cause of the patient's problems lies in weakness or hypotonicity of the deep muscles, then they can be strengthened by means of physical exercises, or they can be activated by being active. Nevertheless, the basis for an effective therapeutic process is a thorough diagnosis, aimed at locating the specific cause of a patient's ailment.

REFERENCES

1. Voight ML, Robinson K, Gill L, Griffin K. Postoperative rehabilitation guidelines for hip arthroscopy in an active population. *Sports Health: A Multidisciplinary Approach*. 2010;2(3):222-230.
2. Carson F, Polman RCJ. ACL Injury Rehabilitation: A psychological case study of a professional rugby union player. *Journal of Clinical Sport Psychology.* 2008;2(1):71-90.
3. Eriksrud O, Ghelem A, Cabri J. Isokinetic strength training of kinetic chain exercises of a professional tennis player with a minor partial internal abdominal oblique muscle tear - a case report. *Physical Therapy in Sport*. 2019;38:23-29.
4. Teixeira E, Duarte JA. Skeletal muscle loading changes its regenerative capacity. *Sports Medicine.* 2016;46(6):783-792.
5. Richard-Bulteau H, Serrurier B, Cassous B, et al. Recovery of skeletal muscle mass after extensive injury: positive effects of increased contractile activity. *American Journal of Physiology - Cell Physiology.* 2008;294(2):467-476.
6. Bailón-Plaza A, van der Meulen MCH. Beneficial effects of moderate, early loading and adverse effects of delayed or excessive loading on bone healing. *Journal of Biomechanics.* 2003;36(8):1069-1077.
7. Van der Veen AJ, van Dieën JH, Nadort A, Stam B, Smit TH. Intervertebral disc recovery after dynamic or static loading in vitro: Is there a role for the endplate? *Journal of Biomechanics.* 2007;40(10):2230-2235.
8. Iatridis JC, Weidenbaum M, Setton LA, Mow VC. Is the nucleus pulposus a solid or a fluid? Mechanical behaviors of the nucleus pulposus of the human intervertebral disc. *Spine.* 1996;21(10):1174-1184.
9. Virgin WJ. Experimental investigations into the physical properties of the intervertebral disc. *The Journal of Bone and Joint Surgery.* 1951;33-B(4):607-611.
10. Schnake KJ, Putzier M, Haas NP, Kandziora F. Mechanical concepts for disc regeneration. *European Spine Journal.* 2006;15(3):354-360.
11. Belavý DL, Quittner MJ, Ridgers N, Ling Y, Connell D, Rantalainen T. Running exercise strengthens the intervertebral disc. *Scientific Reports*. 2017;7(1):45975.
12. Granhed H, Jonson R, Hansson T. The Loads on the lumbar spine during extreme weight lifting. *Spine.* 1987:12(2):146-149.
13. Hodges PW, Richardson CA. Delayed postural contraction of transversus abdominis in low back pain associated with movement of the lower limb. *Journal of Spinal Disorders.* 1998;11(1):46-56.
14. Hodges PW, Richardson CA. Inefficient muscular stabilization of the lumbar spine associated with low back pain. *Spine.* 1996;21(22):2640-2650.
15. Ferreira PH, Ferreira ML, Maher CG, Herbert RD, Refshauge K. Specific stabilization exercise for spinal and pelvic pain: A systematic review. *Australian Journal of Physiotherapy.* 2006;52(2):79-88.
16. May S, Johnson R. Stabilization exercises for low back pain: a systematic review. *Physiotherapy.* 2008;94(3):179-189.
17. Macedo LG, Maher CG, Latimer J, McAuley JH. Motor control exercise for persistent, nonspecific low back pain: a systematic review. *Physical Therapy.* 2009;89(1):9-25.
18. Rackwitz B, de Bie R, Limm H, von Garnier K, Ewert T, Stucki G. Segmental stabilizing exercises and low back pain. What is the evidence? A systematic review of randomized controlled trials. *Clinical Rehabilitation*. 2006;20(7):553-567.
19. Byström MG, Rasmussen-Barr E, Grooten WJA. Motor control exercises reduces pain and disability in chronic and recurrent low back pain. *Spine*. 2013;38(6):350-358.
20. Konturek S. *Fizjologia Człowieka - Neurofizjologia*. Kraków: Wydawnictwo Uniwersytetu Jagiellońskiego;1998.
21. Helewa A, Goldsmith CH, Lee P, Smythe HA, Forwell L. Does strengthening the abdominal muscles prevent low back pain - a randomized controlled trial. *Journal Rheumatology.* 1999;26(8):1808-1815.
22. Lederman E. The myth of core stability. *Journal of Bodywork and Movement Therapies.* 2010;14(1):84-98.
23. Koerhuis CL, van der Heide FM, Hof AL. Energy consumption in static muscle contraction. *European Journal of Applied Physiology.* 2003;88(6):588-592.
24. Sahlin K, Cizinsky S, Warholm M, Hӧberg J. Repetitive static muscle contractions in humans? A trigger of metabolic and oxidative stress? *European Journal of Applied Physiology and Occupational Physiology*. 1992;64(3):228-236.
25. Sahlin K, Ren JM. Relationship of contraction capacity to metabolic changes during recovery from a fatiguing contraction. *Journal of Applied Physiology*. 1989;67(2):648-654.
26. Nachemson A, Elfström G. Intravital dynamic pressure measurements in lumbar spine. A study of common movements, maneuvers and exercises. *Scand J Rehabil Med Suppl*. 1970;1:1-40.
27. Pape JL, Brismée JM, Sizer PS, et al. Increased spinal height using propped slouched sitting postures: Innovative ways to rehydrate intervertebral discs. *Applied Ergonomics.* 2018;66:9-17.
28. Wilke H, Neef P, Caimi M, Hoogland T, Claes LE. New in vivo measurements of pressures in the intervertebral disc in daily life. *Spine*. 1999;24(8):755-762.

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