

THE EFFECTS OF NEUROMUSCULAR STABILIZATION ON INCREASING THE FUNCTIONALITY AND MOBILITY OF THE LOCOMOTOR SYSTEM

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Abstract: The general concept of dynamic neuromuscular stabilization (DNS) is, among other things, directly aimed at core stabilization as well as proper and “stable breathing”. DNS is based on the integration of the stabilization system which is mainly composed of intersegmental spinal muscles, deep neck flexor muscles, the diaphragm, abdominal muscles, and the pelvis. Although it is a relatively recent rehabilitation and training concept, a lot of researchers focus on DNS due to its positive effects. The review started with the hypothesis that the DNS concept achieves high and positive results on the locomotor system in terms of better core stabilization, increasing the functionality of the locomotor system and quickening the rehabilitation process. The method included searching Google Scholar, PubMed and Web of Science for scientific material. Out of 50 reviewed scientific papers, the sample was consisted of 12 papers that are, according to their research topic, compatible with the review in question. The results of the review indicate that the DNS concept has positive effects on the functionality of the locomotor system.

Key words: dynamic neuromuscular stabilization, rehabilitation, motoric control.

INTRODUCTION

Dynamic neuromuscular stabilization (DNS) is a contemporary concept in the rehabilitation process and generally in improving the functionality of a locomotor apparatus. Any insufficiency of the bone-joint apparatus can be seen as a mismatch between the internal and external forces acting on the body and thus impairing the functionality of the locomotor apparatus (Mahdiah et al., 2020). Thus, if there is no clear synergy between the agonist and antagonist followed by an non-centered joint position, it may lead to impaired function of the entire locomotor apparatus. Dr. Pavel Kolar (according to Kobesova, 2014) points to the importance of the neurophysiological principles of DNS from the perspective of the proper functioning of the locomotor apparatus. The essence of the DNS concept is based on the application of ontogenetic developmental patterns of motion, thereby stimulating the key segments responsible for the proper functioning of the locomotor apparatus. Such patterns of motion are characteristic for the first year of the child's developmental phase which witnesses intensive development of the motor control. In this way, a proper redistribution of internal forces occurs and thus contributes to the greater functionality of the motions. Ontogenetic patterns or homologous positions (Figure 1), proper manual centering of the joints, as well as proper activation of the diaphragm are used as key means of DNS therapy. Centering the joints and properly activating the diaphragm with pelvic floor contributes to better stability of the entire open kinetic chain.



Figure 1. Homologous positions

Also, the proper redistribution of all internal and external forces acting on each segment of the body contributes to better motor control (movement efficiency). Postural control is directly dependent on breathing function as well. Improper posture results in irregular breathing the same way the irregular breathing affects postural stability. Proper breathing and activation of the diaphragm directly affect the formation of intra-abdominal pressure, thus contributing to greater trunk stability. The postural respiratory connection is not fully under “voluntary” control and can hardly be influenced by the standard rehabilitation approach. Postural control, i.e. trunk stability, as well as underlying extremity movements are assumed to be largely controlled by the subcortex. If the CNS function is appropriate and the muscles are activated in a timely manner, this directly affects the proper centering of all the joints, which is crucial for good postural control. If the interosseous contact is greater, there will be better transfer of force from one to another part of the kinetic chain (Figure 2). Thus, the optimal joint position is not a static contraction, but a neuromuscular strategy of movement and stabilization.

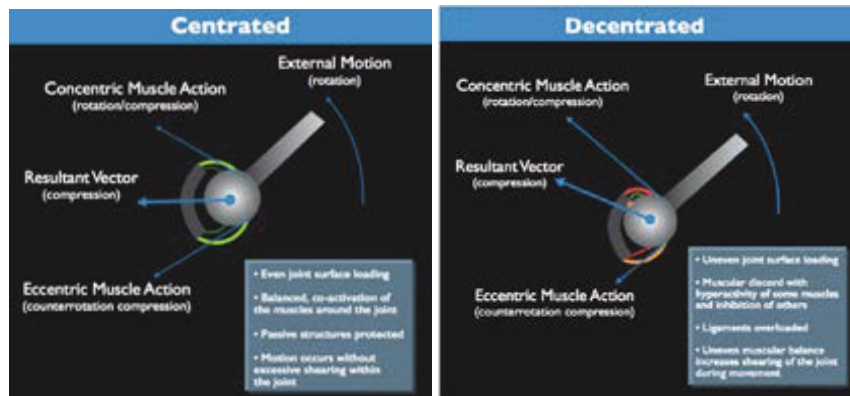


Figure 2. Transfer of force with the centered and non-centered joint

Besides the improved breathing and centering of the joints in a neutral or more optimal position, there are several other key points that actually contribute to the overall stabilization system. Therefore, the integral part of the stabilization system is also composed of deep neck muscles, abdominal wall and intersegmental spinal muscles (*multifidi*). Essentially, the DNS concept is the use of ontogenetic patterns, proper breathing functionality, intra-abdominal pressure control (IAP) and other parts of the stabilization system in order to improve the general and specific functionality of the locomotor apparatus. Accordingly, the defined goal of this document relates to determining the effects of DNS therapy on the functionality of the locomotor apparatus.

METHOD

In order to provide more relevant overview of the previous research in the field of sports therapy and kinesiotherapy, the author has primarily opted for scientific papers exploring the various effects of dynamic neuromuscular stabilization. Available scientific literature was used through Google Scholar, PubMed, Scopus and Web of Science, while the keywords were “dynamic neuromuscular stabilization, motor stability, motor control, postural control, DNS, sports rehabilitation, physical therapy”. The search was limited to studies conducted in the last 10 years. The study started with the assumption that DNS therapy gives positive results to the locomotor apparatus in terms of better stabilization of the trunk, improvement of the functionality of the locomotor apparatus and speeding up the rehabilitation process.

RESULTS

Table 1. An overview of research on the effectiveness of DNS method

| A study with the original title | Objective of the study | Intervention | Conclusion |
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| Kobesova, A., Kolar, P., Mlckova, J., Svehlik, M., Morris, C. E., Frank, C., ... & Kozak, J. (2012). Effect of functional stabilization training on balance and motor patterns in a patient with Charcot-Marie-Tooth disease. <i>Neuroendocrinol Lett</i> , 33(1), 3-10. | Enhancement of balance and movement patterns to increase the quality of life | Use of the DNS method according to Kolar | Improvement observed in modified clinical trials with sensorimotor balance interactions |
| O'Driscoll, J., Kerin, F., & Delahunt, E. (2011). Effect of a 6-week dynamic neuromuscular training programme on ankle joint function: a case report. <i>Sports Medicine, Arthroscopy, Rehabilitation, Therapy & Technology</i> , 3(1), 13. | Effects of a 6-week DNS treatment on ankle function in athletes | Six-week DNS programme | Improvement of all sensorimotor parameters related to the ankle in athletes |
| Frank, C., Kobesova, A., & Kolar, P. (2013). Dynamic neuromuscular stabilization & sports rehabilitation. <i>International journal of sports physical therapy</i> , 8(1), 62. | Understanding developmental kinesiology, interconnections between joints and muscles during movement. | Examination work - no intervention | The DNS approach serves as a very important method for assessing muscle condition as well as for developing their physiological function |
| Lee, J., Kim, D., Shin, Y., & You, S. (2016). Differential effects of abdominal drawing-in maneuver, abdominal bracing, and dynamic neuromuscular stabilization on core stability and diaphragm-abdominal core muscle activation. <i>Journal of Orthopaedic & Sports Physical</i> , 46(1). | Comparison of diaphragm movement, abdominal muscle thickness, and abdominal movement in an adult population with unstable trunk | Application of three different techniques ADIM, AB, and DNS | The results indicate that the DNS technique gives the best effects when it comes to increasing the stability of the trunk in coactivation with the diaphragm |
| Kobesova, A., Dzvonik, J., Kolar, P., Sardina, A., & Anđel, R. (2015). Effects of shoulder girdle dynamic stabilization exercise on hand muscle strength. <i>Isokinetics and Exercise Science</i> , 23(1), 21-32. | Determining the effect of rotator cuff stabilization on arm strength | Application of six specific DNS exercises five times a week. Exercises designed to achieve maximum shoulder stability. | Shoulder region exercises based on the DNS method can significantly and clinically increase arm strength. |
| Son, M. S., Jung, D. H., You, J. S. H., Yi, C. H., Jeon, H. S., & Cha, Y. J. (2017). Effects of dynamic neuromuscular stabilization on diaphragm movement, postural control, balance and gait performance in cerebral palsy. <i>NeuroRehabilitation</i> , 41(4), 739-746. | Effects of DNS technique on the functionality of movement, movement of the diaphragm and abdominal muscles in children with cerebral palsy | Application of DNS technique 30 minutes a day, three times a week for a period of 4 weeks | DNS technique is a good method for activating deep muscles of the trunk, diaphragm and abdominal muscles in a population with cerebral palsy |
| Kim, D. H., An, D. H., & Yoo, W. G. (2017). Effects of 4 weeks of dynamic neuromuscular stabilization training on balance and gait performance in an adolescent with spastic hemiparetic cerebral palsy. <i>Journal of physical therapy science</i> , 29(10), 1881-1882. | Effects of four-week DNS treatment on balance in children with cerebral palsy | Application of DNS technique for a period of four weeks | The results indicate that a four week DNS training provides positive results for balance in children with cerebral palsy |
| . Miketa, T., Ivančić, N., & Kuzmanić, B. (2017). Relationship of breathing exercises with improvement of postural stability in healthy adults. <i>Acta kinesiologica</i> , 11(2), 59-62. | Establishing whether breathing exercises three times a week for ten minutes increase intra-abdominal pressure, i.e. postural balance | Breathing exercises on a sample of 16 children divided into experimental and control groups | Breathing exercises increase postural stability over a period of 15 days |

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| Cho, M., & Gong, W. (2017). The effects of dynamic exercise using the proprioceptive neuromuscular facilitation pattern on posture in healthy adults. <i>Journal of physical therapy science</i> , 29(6), 1070-1073. | Effects of dynamic exercise with the PNF method on posture in healthy adults | The treatment consisted of five sets of dynamic exercise with proprioception, three times a week for a period of six weeks. | The treatment influenced the posture resulting in improved trunk stabilization. |
| Yoon, H. S., & You, J. S. H. (2017). Reflex-mediated dynamic neuromuscular stabilization in stroke patients: EMG processing and ultrasound imaging. <i>Technology and Health Care</i> , 25(S1), 99-106. | Effects of the DNS concept on trunk stabilization, muscle activity as well as trunk muscle thickness in stroke patients | DNS concept of exercise | The results indicate that the DNS concept is much more efficient than the NDT concept in both healthy and stroke population. |
| Lee, N. G., You, J. S. H., Chung, H. Y., Jeon, H. S., Choi, B. S., Lee, D. R., ... & Yoon, H. S. (2018). Best Core Stabilization for Anticipatory Postural Adjustment and Falls in Hemiparetic Stroke. <i>Archives of physical medicine and rehabilitation</i> , 99(11), 2168-2174. | Comparison of the DNS Method with the conventional therapy for postural adjustment, balance, and fear of fall in stroke population | The treatment consisted of twenty sessions of conventional therapy and twenty sessions of DNS exercise for thirty minutes, five times a week, for four weeks. | The first clinical study proving the importance of trunk stabilization for balance and reducing fear of falling |
| Bae, W. S., Lee, K. C., & Lee, D. Y. (2019). The Effects of Dynamic Neuromuscular stabilization Exercise on Forward Head Posture and spine Posture. <i>Medico-Legal Update</i> , 19(2), 670-675. | The aim of the study is to investigate the influence of the DNS concept on the head movement in the sagittal plane. | The treatment involved applying the DNS concept to the experimental group. | The DNS concept of exercise affects the posture of the head. |

DISCUSSION

Based on the analysis of the reviewed literature, one can immediately notice an extremely wide range of effects of dynamic neuromuscular stabilization. The application of the DNS concept is also clearly defined, so few studies address the effects observed in the training process, while other effects relate to the rehabilitation process, which also indicates widespread applicability. If we look at the results of the studies reviewed, it can be immediately concluded that most of the effects of the DNS method are related to better muscle control and better balance. Methods that apply higher IAP can, of course, be linked to a better motor response, that is, greater body stability by providing better support for the spinal column (Kobesova et al., 2012). Proper activation of the diaphragm and other muscles involved in breathing contributes to a better and stronger formation of IAP, thereby increasing the stability of the spinal column and thus the whole body (Liebenson, 2007). Research (Lee et al., 2016; Son et al., 2017) points to the importance of IAP formation in coactivation with the diaphragm during postural stability. Proper activation of the diaphragm and the formation of IAP in all directions of the abdominal region, creates a positive pressure on the spinal column, as well as greater and stronger stabilization of the pelvic floor, and therefore the pelvis. Joint centering and increasing interosseous contact is one of the key elements of DNS therapy. Proper centering contributes to greater muscular functionality and a better transition of force from one to another part of the kinetic chain. If the CNS adequately processes proprioceptive information, it is clear that the centering of the joint will be adequate. On the other hand, if there is any muscular mismatch or muscular asymmetry, incorrect force transfer from the lever to the lever can occur. Research (Kobesova et al., 2015) indicates the effectiveness of DNS treatment on the rotator cuff, in order to increase joint stability, that is, to strengthen the said proprioceptive effect. A similar study (O'Driscoli et al., 2011) conducted on athletes also indicates the importance of proper centering of the joints, where an increase in the sensorimotor response was observed and thus an increase in the general function of the ankle joint. Based on the effects of DNS on sensorimotor status and body stability, it is logical to conclude that such effects will also be also reflected on the posture, that is, the better ratio between the segments of the locomotor apparatus. Increased trunk stabilization obtained through proprioceptive facilitation influences the improvement of the posture (Cho et al., 2017). This points directly to the connection between body stability and body posture, which can again be linked to DNS therapy and how it prioritizes the abdominal region or the entire trunk.

Activation of the deep muscles of the trunk also contributes to better stabilization in conditions such as cerebral palsy (Son et al., 2017). Activation of the intercostal and transversal abdominal muscles contributes to better

stabilization of the whole body. Research (Kim et al., 2017) points to the positive outcomes of DNS therapies for balance in children with developmental disabilities. The inability to isolate movement in children with cerebral palsy results in significantly worse postural control. If this muscles are specifically targeted, a better motor response in the movement itself is achieved as well as better kinesthesia, and therefore improved postural balance. As a therapeutic tool, the DNS method is also used in the stroke population. The effects are reflected through better motor control and enhanced postural balance (Yoon et al., 2017). The study (Lee et al., 2018) points to the significant contribution to reducing the fear of falling in stroke patients, which again is associated with better motor control and a greater degree of postural stabilization.

CONCLUSION

Based on the facts presented and the literature reviewed, it can be said as a general conclusion that dynamic neuromuscular stabilization contributes to the overall improvement of the functionality of the locomotor apparatus. Whether it is the rehabilitation or training process, DNS through stabilization, joint centering, proprioception and proper trunk activation, provides all of its positive effects. Isolated muscular contractions with a properly centered joint system enable an adequate redistribution of all internal forces, thus providing greater functionality of movement. Muscle isolation and elimination of excess synergistic movements contribute to a better motor response in children with cerebral palsy as well as in stroke patients. Based on the literature reviewed and the analysis of studies in the field of DNS therapy, it can be safely concluded that such an approach, both in rehabilitation and in training, has its positive effects on different parts and systems of the locomotor apparatus viewed through general functionality.

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EFEKTI DINAMIČKE NEUROMUSKULATORNE STABILIZACIJE NA PODIZANJE FUNKCIONALNOSTI I MOBILNOSTI LOKOMOTORNOG APARATA

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Apstrakt: Generalni koncept dinamičke neuromuskulatorne stabilizacije (DNS) je između ostalog direktno usmeren na stabilizaciju trupa kao i na pravilno i “stabilno disanje”. DNS-a se zasniva na integraciji stabilizacionog sistema koji je u prvom redu sačinjen od intersegmentarnih kičmenih mišića, dubokih mišića fleksora vrata, dijafragme, trbušnog zida kao i karlice. Iako relativno mlad rehabilitacioni i trenažni pravac, veliki broj autora pridaje veliku pažnju DNS zbog njegovih pozitivnih efekata. U preglednu studiju se pošlo sa pretpostavkom da DNS koncept daje visoke i pozitivne rezultate na lokomotorni aparat u smislu bolje stabilizacije trupa, podizanje funkcionalnosti lokomotornog aparata, ubrzavanje rehabilitacionog procesa. Metodski postupak je podrazumevao pretraživanje naučne građe preko pretraživača Google Schoolara, PubMeda i Web of Sciense. Od 50 pregledanih naučnih radova u uzorak istraživanja je ušlo 12 radova koji po svom predmetu istraživanja odgovaraju aktuelnom preglednom radu. Rezultati preglednog istraživanja ukazuju na pozitivne efekte DNS koncepta na funkcionalnost lokomotornog aparata.

Ključne reči: Dinamička neuromuskulatorna stabilizacija, rehabilitacija, motorna kontrola.