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Review Article

Physical Medicine and Rehabilitation Section

The Effect of Dynamic Neuromuscular Stabilisation on Core Strength: A Literature Review

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ABSTRACT

Training to improve the stability of the core is a routine component of the injury prevention regimen in the musculoskeletal conditions. The strength of the core muscles is significantly impacted by obesity. Obesity is linked to several physiological changes that reduce flexibility and cardiovascular fitness and slow down a person's activities. Dynamic Neuromuscular Stabilisation (DNS) which is an approach for optimising the movement system is a rehabilitation approach founded on the original concept of developmental kinesiology. The DNS therapy method is based on a thorough analysis of the quality of stability and/or movement, to restore the integrated spinal stabilisation system through specialised functional exercises. All elements of the integrated spinal stabilisation system are co-activated in this, making it a holistic approach to treating any ailment. It's been tried and tested for a variety of neurological and musculoskeletal problems. The approach of DNS has recently gained popularity. This method is mostly used to strengthen the core. The aim of the review is to find out effect of DNS on core strength in various neurological and musculoskeletal conditions. Further research is mandated in terms of interventional studies to prove its efficacy in various orthopaedic and neurological conditions.

Keywords: Developmental kinesiology, Integrated spinal stabilisation system, Posture, Strengthening, Training

INTRODUCTION

Training to improve the stability of the core is a routine component of the injury prevention regimen in musculoskeletal conditions [1]. Core strength is essential for improving body balance and postural control during actions like landing and contact [2]. The pelvis, spine, and kinetic chain all require stability of the core for optimal load balance. The collection of muscles of the trunk that surround the abdominal viscera and spine is referred to as the core. Core strengthening is a word used to describe control over the muscles necessary to preserve functional stability around the lumbar spine. To produce spinal stability, the abdominal, paraspinal, hip girdle, gluteal and other muscles work together. Core strengthening has become a popular rehabilitation technique. Motor control training, lumbar stabilisation and other regimens have all been referred to as lumbar stabilisation. Stability of the core is required for adequate load balancing within the spine, pelvis and kinetic chain [3]. The strength of the core muscles is significantly impacted by obesity. Obesity is linked to several physiological changes that reduce flexibility and cardiovascular fitness and slow down a person's activities [4]. Obesity leads to functional impairment in strength, mobility, and static, as well as dynamic balance. Muscle performance is reduced in such individuals [5]. Obesity causes issues with the motor and cardiorespiratory systems that result in disability [6]. Since the early 1960s, researchers have been studying core stability and strength. According to Wickstrom RL, some motor actions such as gripping, turning, crawling, and finally, the ability to walk are produced automatically in healthy babies without any special instruction. Activating peripheral regions or zones can trigger the neural circuitry that drives these complicated developmental processes. During an infant's development, these zones are usually generated from balancing and stabilising points. Professor Pavel Kolar used the terminology Dynamic Neuromuscular Stabilisation (DNS) to describe how he applied Vojta's approach to the treatment and rehabilitation of athletes [7]. The DNS therapy method is based on a thorough analysis of the quality of stability and/or movement, restoring the integrated spinal stabilisation system through specialised functional exercises focused on developmental kinesiological postures displayed by a normal baby. All such activities should focus on both the closed kinetic chain's ideal patterns for stabilisation (support) and the open kinetic chain's dynamic movements, such as reaching, throwing, stepping forward, or kicking. The central control eventually develops an automatic model that is a vital element of everyday movement and abilities as a result of the repetition of the exercises. Incorporating an optimum pattern of stabilisation into sports activities would not only minimise the likelihood of injuries and subsequent pain syndromes caused by overloading, but it might also help athletes perform better [8].

Science behind DNS

A rehabilitative technique founded on the original concept of developmental kinesiology is DNS, which is given manually for optimising the movement system [8]. The theory of reflex locomotion describes how firm pressure stimulation over specific muscle zones causes distinct reflexive motor response patterns. These generic movement patterns have been coined as global patterns. The global pattern elicited from the prone lying is known as reflex creeping, whereas the other one elicited from the side-lying or supine posture is known as reflex rolling. The coordination of this complex system for dynamic stability relies heavily on neuromuscular control. According to Frank C et al., and, Kobesova A and Kolar P, there are three levels of sensorimotor control: a) brainstem and spinal level; b) subcortical level; and c) cortical level [7,9]. Central Nervous System (CNS) motor control at the subcortical level begins and grows mostly over the first year of life after the newborn period. This facilitates fundamental trunk stability, which is required for any rhythmic movement and extremity locomotor functioning. Muscles of the orofacial region and afferent signals are naturally incorporated into postural locomotor patterns at the subcortical level. Finally, the cortical which is the highest motor control level becomes highly active. Control from the cortex is essential for movement characteristics and qualities [10].

The development of body posture is defined as postural ontogenesis, with the primary purpose of establishing efficient physical movements. The maturity of the CNS is required for the activation of postural

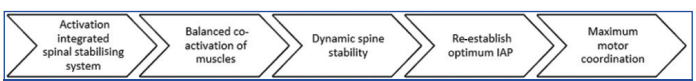
muscles [11]. The ideas in developmental kinesiology are based on the concept that the individual motor functioning which is developed in the initial phase of life is genetically predetermined and follows a predictable pattern. As the CNS matures, these motor patterns or programs are developed, allowing the newborn to control posture, attain upright posture against gravity, and move deliberately through muscle activity. The maturation of the CNS is also closely linked to the anatomical or structural development of soft tissues, muscles and bone. In other words, brain maturation affects motor patterns development, which in turn affects structural development. Joint position, morphological development, and eventually the overall posture are all affected by altered motor coordination, surrounding structures, and joint development [8]. In DNS's perspective, a deficit in motor development during infancy causes neuromuscular abnormalities, which manifest as biomechanical abnormalities later in life. Anatomic impairments may result from biomechanical abnormalities. As a result of this concept, the movement repair procedure should begin with the rehabilitation of neuromuscular disorders [12].

LITERATURE SEARCH

A total of 24 articles were taken into consideration for this review article. Literature search was performed from 2013 to 2022 by using database including Scopus, PubMed and Web of Science. Keywords such as DNS, core strength and strengthening were utilised. Boolean terms such as AND, OR NOT was used.

Mechanism of DNS

Dynamic neuromuscular stabilisation is a technique for providing dynamic muscle stability [13]. Every joint position relies on stabilising muscle contraction as well as synchronisation from both distant and local muscles to provide a central or neutral joint position within the kinetic chain, according to the DNS approach [8]. Intra-abdominal Pressure (IAP) is one factor that influences spinal mechanics and stiffness. Although there is a strong consensus that increasing IAP stabilises the spine, the role of IAP in spine unloading is still questioned. According to Kolar, the integrated spinal stabilising system is constituted of balanced co-activation of the extensors of the spine and deep flexors in the cervical and upper thoracic regions, and the diaphragm, as well as the pelvic floor, all segments of the abdominals, and extensors of the spine in the lower thoracolumbar regions. The intrinsic spinal stabilising muscles produce stiffness in the spine in conjunction with the IAP, resulting in dynamic spine stability. The DNS method aims to activate the integrated spinal stabilising system and re-establish optimum IAP control to improve movement efficiency and avoid joint overloading [8]. IAP is a crucial mechanism for spine and trunk stabilisation. The coordination of the abdominal, diaphragm and pelvic floor muscles is required for IAP modulation [14]. The objective is to achieve the maximum motor coordination achievable by positioning the patient in different developmental postures while allowing the supporting segments and joints into a functionally centered position. The individual is initially coached verbally and manually to detect the differentiation between the optimal and poor stabilising stereotypes. The individual is then advised to maintain the ideal pattern in various positions, as well as during mobility. Because the stability stereotype is closely linked to the pattern of breathing, the DNS evaluation always involves a breathing pattern examination. Simultaneous stabilising and breathing functions are also addressed in the training. The ultimate objective of DNS is to educate the patient on how to integrate an appropriate pattern of breathing and stabilisation into daily activities and athletic performance [10]. Mechanism of DNS is described in [Table/Fig-1] [8].



[Table/Fig-1]: Mechanism of DNS [8].
Intra-abdominal pressure (IAP)

DISCUSSION

DNS in Neurological Condition

DNS is a novel idea in the rehabilitation area. All elements of the integrated spinal stabilisation system are co-activated, making it a holistic approach to treating any ailment. It's been tried and tested for a variety of musculoskeletal and neurological problems [7]. DNS exercises use subconscious activation of specific zones to reflexively moderate the diaphragm as well as other core stability muscles, making them especially useful for people who have low somatosensory or movement awareness [15]. Cerebrovascular accident is the most common cause of impaired core-postural control, which increases the risk of falls which can be fatal. In individuals suffering from subacute hemiparetic stroke, deep abdominal muscle and poor diaphragm function have been found as critical indicators for core-postural control during daily activities [15]. A clinical trial conducted by Yoon HS et al., showed that DNS training was more efficient as compared to Neurodevelopmental Therapy (NDT) training in the improvement of controlling postural movement in those with stroke by utilising a balanced co-activation of the transverse abdominis or Internal Oblique (IO) and diaphragm [16]. Lee NG et al., in their study concluded that DNS exercise improves balance function, with DNS giving additional enhancement in anticipatory postural adjustment time delay and associated fear of fall in those who have had a chronic hemiparetic stroke. It offers theoretical and clinical understanding for assessing and addressing postural core stability in chronic hemiparetic stroke patients with reduced anticipatory postural adjustment control, balance dysfunction, and a high risk of falls [16]. DNS is a technique that uses subconscious trunk stimulation to reflexively moderate the diaphragm and other core stabilisers. It's especially useful for those who have difficulty with sensorimotor or movement awareness. When compared to conscious activation by NDT in participants with stroke, DNS, a reflex mediated core muscle, and diaphragmatic activation employing developmental positions based on ontogenesis can be effective in improving trunk function concluded by Raghuveer R et al., in a study [17]. Francio VT et al., in a case report concluded that posterior cortical atrophy is a rare progressive neurodegenerative condition characterised by atypical symptoms such as balance difficulty, chronic pain syndrome, body orientation, and abnormal motor patterns. With the restored functioning neuromuscular pattern, posture, improvements in locomotion, pain management, tolerance to daily living, mood activities, and overall satisfactory development in the quality of life, DNS can be used as adjuvant care to conservative medical treatment of posterior cortical atrophy. It resulted in a 60% improvement in the patient's health perception [18]. Chiropractic therapy combined with DNS therapy reduced functional impairments poststroke, according to a case study by Oppelt M et al., and also advised to be included in advanced care studies [19]. Son MS et al., studied cerebral palsy and concluded that core instability is a prevalent neuromuscular dysfunction that is frequently associated with postural and dynamic locomotor deficits. DNS is a potential, effective strategy for improving age appropriate ability to stand, walk, and jump in persons with spastic diplegic Cerebral Palsy (CP) by increasing activation in the deep core muscles of the underactive chain of the muscle that includes the Internal Oblique (IO), transversus abdominals, and diaphragm [20]. Summary of the studies in neurological conditions is given in [Table/Fig-2] [15-20].

DNS in Musculoskeletal Conditions

Frank C et al., concluded that DNS is recommended for optimum performance for an athlete is achieved not solely through the strength of extensors of the spine, abdominals, gluteals, or any other musculature; rather, core stabilisation is achieved through precise coordination of all muscles and central nervous system

S. No.	Author	Year	Study type	Study population	Intervention	Study findings	Conclusion
1.	Oppelt M et al., [19]	2014	Case study	Stroke	Chiropractic therapy combined with DNS therapy	The patient improved significantly in balance and mobility pattern over the course of treatment, and low Back Bournemouth evaluation scores dropped from 43% to 23%.	DNS is a promising, effective approach for facilitating deep core muscle activation of the underactive muscle chain
2.	Son MS et al., [20]	2017	Clinical trial	Cerebral palsy	DNS	Activation of the IO and transversus abdominals were initially not substantial but significantly enhanced following the intervention (p-value=0.012), as well as diaphragm descending movement (p-value=0.0001). Following the intervention, Gross Motor Function Measure (GMFM) scores considerably increased (p-value=0.05).	DNS is a potential, effective strategy for improving age appropriate ability to stand, walk, and jump in persons with spastic diplegic CP.
3.	Francio VT et al., [18]	2015	Case report	Posterior cortical atrophy	DNS	The patient's perception of about health improved by 60% as a result of their functional neuromuscular pattern being restored, along with changes in their posture, locomotion, pain management, mood, and capacity to perform daily activities (ADLs).	DNS can be used as adjuvant care to conservative medical treatment.
4.	Lee NG et al., [16]	2018	Randomised controlled trial	Chronic hemiparetic stroke	Conventional core stabilisation and DNS	Following the treatments, the DNS group's anticipatory postural adjustment times for the bilateral transverse abdominis (TrA)/ IO, External Oblique (EO), and Erector Spinae (ES) were shorter than those of the traditional core stabilisation group (P=.008). Both groups reported improvements in their baseline Berg Balance Scale (BBS), Falls Efficacy Scale (FES), and FES scores (p-value=0.008, p-value=0.003 and p-value=0.003, respectively), but only the DNS group's FES remained stable during the 2-year follow-up period (p-value=0.003).	Improves balance function anticipatory postural adjustment control, balance, and fear of falls.
5.	Yoon HS et al., [15]	2020	Clinical trial	Subacute hemiparetic stroke	DNS and Neurodevelopmental Therapy (NDT)	In comparison to NDT, DNS had superior effects on diaphragm movement, abdominal muscle thickness, clinical Berg Balance Scale, and functional ambulation category tests (p-value=0.05), according to analysis of covariance.	DNS was more efficient in comparison to NDT.
6.	Raghuveer R et al., [17]	2021	Randomised controlled study	Hemiplegia	DNS and NDT	Walking Ability (WA), the Modified Rankin Scale (MRS), the Trunk Impairment Scale (TIS), and the Stroke Specific Quality of Life (SSQOL) were evaluated before and after the intervention. With a p-value of 0.05, the data analysis revealed substantial improvements for all variables in both groups. Significant improvements were seen in TIS and SSQOL between groups, whereas MRS and WA revealed no significant changes.	DNS is more useful in improving trunk function.

[Table/Fig-2]: DNS studies in neurological conditions [15-20].

regulation of IAP. Performance training and muscle rehabilitation should not only emphasise training muscles in their dynamic anatomical function but also in their stabilising role. The DNS technique is a valuable tool for assessing and training muscles in all aspects of their physiological function [7]. Flatwater kayaking has grown in popularity as a recreational and competitive sport all around the world. Painful shoulder girdle syndromes and repetitive strain injuries have grown increasingly common as competitive engagement has increased. While DNS combined with regular training may enhance maximal Paddling Force (PF), it may not have the same effect on pain perception as was given by Davidek P et al., [21]. Rahimi NM et al., concluded that DNS breathing exercise is a proven method for improving respiratory function. Furthermore, DNS breathing exercises focusing on breathing methods and an integrated spinal stabilisation system can be used as a perceptive way to reduce the likelihood of malalignment [22]. Breathing and postural stabilisation and function depend primarily on alignment and chest wall mobility. The chest may move independently of the thoracic spine in a physiologically normal state and the straightening of segments of the thoracic spine is independent of the chest co-movement. DNS breathing exercise improves respiration and the integration of local and global muscle complexes, which is a precondition for an integrated corrective programme. DNS breathing exercises based on optimum ontogenetic patterns are recommended by Rahimi NM et al., for use on the subject who were students, particularly when the improvement effect is expected to grow with decreased muscular and postural problems [23]. Obesity and low back pain have lately risen tremendously over the world, with postpartum women taking the burden, resulting in several negative health implications. A study on DNS by Ghavipanje V et al., has shown to enhance prognosis in postpartum mothers who are obese with pain in the lower back. DNS is scientifically recommended to get the best results for postpartum women who are obese with low back pain, based on appropriate ontogenetic patterns [24]. Summary is given in [Table/Fig-3] [7,21-24].

Therefore, DNS is an effective approach and can be used as an adjuvant therapy along with conventional treatment. It helps in improving quality of life by reducing functional improvement. There is a dearth of literature to prove its effectiveness in different study population, which gives a further scope for research.

Author	Year	Study type	Study population	Intervention	Study findings	Conclusion
Frank C et al., [7]	2013	Review	Athlete	DNS	The review explained how developmental influences play a role in maturation. DNS is a key link in finding the dysfunction and assess integrated spinal stabilising system.	DNS is a valuable tool for assessing and training muscles in all aspects of their physiological function.
Davidek P et al., [21]	2018	Randomised controlled trial	Flatwater kayakers	DNS combined with regular training	During the 6-week intervention disabilities of the arm, shoulder and hand questionnaire was used and maximum Paddling Force (PF) was calculated using kayak ergometer and no significant changes were seen in the initial phase, but later improvement was observed. Experimental group improved significantly compared to the control group on maximum PF (p-value=0.004).	DNS may enhance maximal PF, but may not affect pain perception.
Rahimi NM et al., [22]	2019	Clinical trial	Sedentary students with poor posture	DNS breathing exercises	The study's results show that after six weeks, there was a significant difference in the mean values of the MVV, FEV1, FVC, and FEV1/FVC ratios between the pre-test and post-test.	DNS helps in improving respiratory function.
Rahimi NM et al., [23]	2020	Randomised controlled trial	Students	DNS breathing exercises	With regard to UCM, LCM, trunk muscular endurance, and thoracic kyphosis, substantial improvements were seen in the DNS breathing exercise group in the post-test compared to the pre-test (p-value<0.001). In contrast, the change in these measures in the control group was not significant statistically.	DNS aids in enhancing lung capacity. It focuses on the integrated spinal stabilising system and techniques for breathing.
Ghavipanje V et al., [24]	2022	Randomised controlled trial	Postpartum women with LBP	DNS and general exercise	The Modified Oswestry Disability questionnaire, the fear-avoidance beliefs questionnaire, the inspiration and expiration breath hold time, and the respiratory rate outcomes all showed significant group-by-time interactions overall. There were significant differences between the groups in the global change (p<.05). In each of the six tests, the DNS group showed a faster rate of progress than the general exercise group.	DNS was found to be more effective than general exercise.

[Table/Fig-3]: DNS studies in musculoskeletal conditions [7,21-24].

CONCLUSION(S)

The approach of DNS has recently gained popularity. This method is mostly used to strengthen the core muscles. It has proven to be more effective than many other core stabilisation methods. It can help with a wide range of neurological and musculoskeletal issues. Sports rehabilitation is one of its principal applications. More studies are needed to determine its efficacy in other conditions including obesity.

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