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Review Article

Dynamic Neuromuscular Stabilization- A Narrative Review

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ABSTRACT

Background: Dynamic Neuromuscular stabilization is an evolving concept in the field of rehabilitation. It works on the entire stabilizing system of the spine along with optimal activation of the diaphragm enabling the appropriate movement of the extremities. This review article is designed to give an insight on Dynamic Neuromuscular Stabilization technique and its clinical application.
Methods: A range of databases including Google Scholar, Pubmed and Medline were searched to identify articles on core stabilization, integrated spinal stabilization system, Vojta's reflex locomotion, dynamic neuromuscular stabilization.
Results: According to the searched literature Dynamic neuromuscular stabilization is an evolving concept given by PavelKolar. It is based on the principles of developmental kinesiology focus on correct breathing pattern and stabilizing role of the diaphragm and correct activation of the integrated spinal stabilization system before any movement at the extremities. Now, it has been used successfully in clinical practice for the rehabilitation of a wide variety of neurological and musculoskeletal conditions.
Conclusion: Dynamic neuromuscular stabilization is a technique which focuses on activation of the intrinsic stabilizers of the spine along with correct breathing pattern before any purposeful functional movement. It is used for the rehabilitation of various musculoskeletal, neurological, pediatric as well as sports injury cases.

Key words: Dynamic neuromuscular stabilization, developmental kinesiology, core stabilization

INTRODUCTION

Dynamic Neuromuscular Stabilization or DNS is an evolving concept in the field of rehabilitation, given by Professor PavelKolar after getting influence from the work done by Vojta on Reflex locomotion (RL). [1] The concept of reflex locomotion explains that specific involuntary motor reactions/ movement patterns are seen on giving firm pressure stimulation over certain zones in the muscles. These movement patterns are generic and were termed "global patterns". The global pattern evoked from prone position is called "reflex creeping" while the one from supine or sidelying is called as "reflex rolling". According to Wickstrom RL, [2] in healthy (free of developmental disorders) newborns certain motor movements like grabbing, turning, crawling and eventually walking are developed automatically without any specific training. [3] Evidently, the neuronal circuitry that guides these complex developmental behaviors may be activated by stimulating peripheral areas, or zones. These zones are generally derived from balance and stabilizing points during an infant's development. Professor PavelKolar employed this Vojta's concept for the treatment and rehabilitation of athletes and termed it as Dynamic Neuromuscular Stabilization (DNS). DNS works on the principles of Developmental Kinesiology (DK). [4] According to DNS the posture, breathing pattern and joint centration (posture which influences the joints to be in maximum congruency) should be studied and treated from neurodevelopmental perspective. [1] In this approach the main focus is on core stability which is provided mainly by the neck flexors and extensors, diaphragm, transverse abdominis and multifidus. [1,5] Great emphasis is put on the correct activation of the diaphragm, breathing pattern and core stability before any purposeful movement. [6] Nowadays, DNS is used successfully for the rehabilitation of various neurological, musculoskeletal, pediatric and sports injury cases. [5-7] Thus, the aim of the current review is to gain an insight on the DNS principles, assessment, treatment and its use in clinical practice.

METHODS

In the current study the articles were searched using databases i.e., Google scholar, Pubmed and Medline. The key words used for search were Dynamic neuromuscular stabilization, developmental kinesiology, core stabilization, integrated spinal stabilization system, reflex locomotion. This is a narrative review and thus the appropriate evidences were selected based on our experience.

RESULTS AND DISCUSSION

Principles of DNS

Dynamic neuromuscular stabilization involves precise co-activation of the intrinsic muscles of the spine which forms the Integrated spinal stabilization system (ISSS) and includes cervical flexors and extensors, diaphragm, transversusabdominis, multifidus and pelvic floor. [6] Fundamentally, the concept of DNS is derived from the principles of developmental kinesiology (DK), highlighting the existence of central movement patterns which exists innately. [4,6] Following are the basic principles on which DNS works:-

Developmental Kinesiology [4]

The developmental kinesiology is based on the three levels of sensorimotor control as discussed by Kobesova and Kolar [4] i.e., (1) brainstem and spinal level at which general movements are displayed with gross movement of body parts at variable speed and amplitude, (2) subcortical level in which synergistic activation of the diaphragm, pelvic floor, abdominal wall and spinal extensors occur before any movement of the extremity/ head/ neck and (3) the cortical level of motor control in which development of locomotor pattern occur.

Development of human motor function in early childhood is genetically pre-determined and follows a predictable pattern. [7] Along with the maturation of the central nervous system these motor patterns or programs are formed and thus allowing the infant to activate the muscles optimally which is required to control posture, achieve erect posture against gravity and to move purposefully. [5]

Joint Centration [4]

The subcortical level of the CNS controls the core stability as well as the locomotor function of the extremity. [4] Adequate CNS control and optimal balanced activation of the muscles leads the joints to come in a functionally centered position during every movement and posture. [8] This centrated position of the joint is a dynamic neuromuscular strategy and provides mechanical advantage for optimal joint motion throughout the range. [4] In a centrated joint, the interosseous contact is maximum allowing adequate transfer of the load across the joint and optimal functioning of the kinetic chain. [4] This infers greatest loading, least strain in the joint capsule and the tendons, and every joint structure will be protected while loading.

Core stabilization- Integrated spinal stabilization system (ISSS)

The integrated spinal stabilizing system (ISSS) as described by Kolar, [6] is comprised of balanced co-activation between the deep cervical flexors and spinal extensors in the cervical and upper thoracic region, as well as the diaphragm, pelvic floor, all sections of the abdominals and spinal extensors in the lower thoracic and lumbar region. [6] The diaphragm, pelvic floor and transversus abdominis regulate IAP and provide anterior lumbopelvic postural stability. The activity of these spinal stabilizers (cervical flexors and extensors, diaphragm, transversus abdominis, multifidus, pelvic floor) must be preceded by any simple purposeful movement and these stabilizers work together and not in isolation. [10, 11, 12] This activation of core before movement is automatic providing stable base (punctum fixum) for the movement and known as "Feed forward mechanism". Thus, if any one segment of this stabilizing system is disturbed it affects the entire stabilizing system, compromising the quality of purposeful movement. [6]

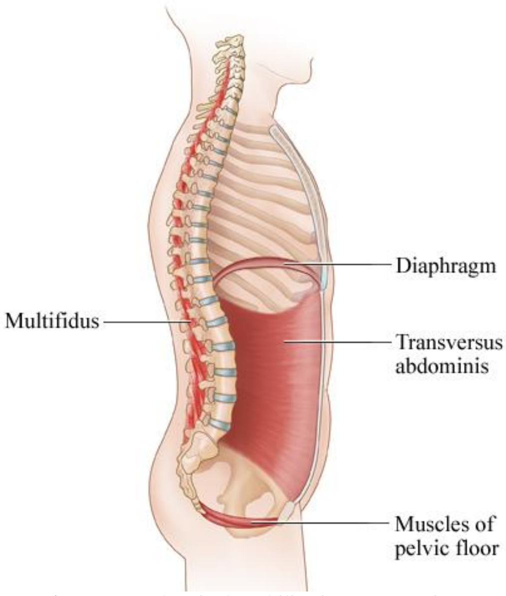


Figure 1: Integrated spinal stabilization system i.e., Intrinsic flexors and extensors of the neck, diaphragm, transversusabdominis, pelvic floor muscles, multifidus. (Available from https://www.google.com/search?q=integrated+spinal+stabilization+system&rlz=1C1CHBF_enIN902IN902&sxsrf=ALeKk03IWzqDo5jljNOod81k5hLYckV5uw:1598160133437&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjfxLC4yrDrAhXkX3wKHVdMA7gQ_AUoAXoECA0QAw&biw=1366&bih=625#imgrc=Ck5e6ObBm7Yo0M [32])

Stabilizing function of the Diaphragm

Proper stabilization of the spine is provided by the correct breathing pattern. During the early phase of development, diaphragm serves respiratory role only. [13] The antigravity postural role of the diaphragm develops when the infant begins to lift his head in prone position or lifts the lower extremities in supine. [14] The link between the stabilization function and pattern of breathing is provided by the symmetrical co-activation of all parts of the integrated spinal stabilization system (dia-phragm, abdominal, back and pelvic muscles). [15-17] This combination of the stabilizing as well as the respiratory function is relatively demanding and is possible when there is perfect motor control i.e., in a healthy CNS. [18,19] It has been demonstrated experimentally that diaphragm is activated tonically while lifting objects. [14] Various researchers have reported the coordinated synergistic activity of the diaphragm, transverse abdominis, pelvic floor and the multifidus muscles during postural tasks. [19]

During inspiration the dome of the diaphragm flattens [16] and the degree of flattening depends upon the breathing pattern and postural task performed. [14] This caudal descent of the diaphragm during inspiration and postural task increases the intra-abdominal pressure while increasing pressure on the internal organs. This caudal descent causes expansion of the abdominal wall eccentrically increasing the abdominal and thoracic wall volume. This eccentric contraction is followed by the isometric contraction of the abdominal wall in order to maintain the volume of the abdominal wall. Under ideal conditions, this 'eccentric-isometric' muscle activity occurs in proportion to the level of work exerted by the muscle and to the motion demands. In case of greater muscle activity there is flattening of the diaphragm with smaller excursions during breathing. Thus, in this condition the postural function is favoured by the diaphragm. [20]

During inspiration there is eccentric activity of the muscles inserting into the thoracic and abdominal wall causing the abdominal wall to expand cylindrically in all directions. However, there is concentric contraction of the diaphragm and the pelvic floor against the abdominal cavity content. Once there is optimal eccentric contraction on flattening of the diaphragm, the isometric contraction of the abdominal muscles serves as a stabilizing role for the movement of the extremities. [6, 20]

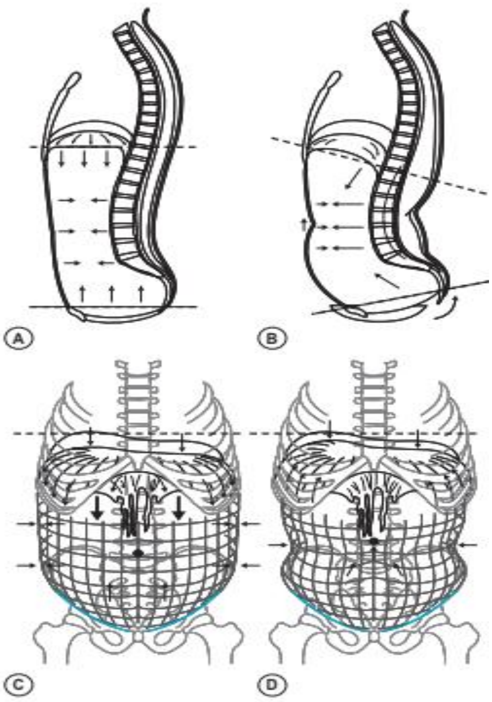


Figure 2: Balanced coordination between the diaphragm, abdominal muscles and pelvic floor in A and C, Inappropriate coordination in Band D [20]

A. Correct alignment of the diaphragm and pelvis- their axis are parallel to each other
B. During postural disturbance the pelvic and the diaphragm axis are not parallel to each other as well as the diaphragm is at a cranial position and the abdominal expansion is inappropriate
C. The abdominal cavity expands during postural activity, the diaphragm descends downwards, eccentric activation of the abdominal muscles occurs which is followed by the isometric contraction.
D. Inappropriate muscle coordination does not allow the central tendon to descend downwards, hollowing of the abdominal wall.

DNS Assessment [20]

In DNS approach the assessment of dual function of the diaphragm i.e., the respiratory and the postural function are done. The assessment is based on the neurodevelopmental postures.

1. Evaluation of the diaphragm

a) Respiratory Function

The position of patient corresponds to 8 months sitting position, sitting on ischial tuberosities on a table without feet supported, spine elongated and upper extremities supported on thigh. Movement of the ribs and abdominal cavity is observed. There should be symmetrical expansion of the thoracic and abdominal cavities. During physiological diaphragmatic breathing, the lower aperture of the thorax also expands in addition to the abdominal cavity and ventral movement of the sternum occurs. On palpating the ribs, there is expansion of the intercostal spaces and the lower portion of thorax expands laterally, ventrally and in dorsal direction in a proportionate manner. Thus, as the abdominal cavity expands there should be separation of the ribs which can be identified by palpating the intercostal spaces. During inhalation, the inhalation wave reaches as far as the lower abdominal wall, i.e. the patient can also breathe into the abdominal wall just above the groin. There is no change in the position of the sternum in transverse plane. There is minimum expansion of the thorax and no expansion of the intercostal spaces in pathological conditions. [20]

b) Postural function- Activation of the diaphragm

The position of the patient is sitting at the edge of the table with trunk relaxed, feet unsupported and the upper extremities should be positioned freely without the patient leaning on them. At first the natural pattern of the patient is observed and then the patient is instructed and taught to make the required corrections in his pattern. Now, palpate the posterolateral aspect of abdominal wall below the lower ribs from behind and from the front the groin area is palpated above the femoral heads medial to the anterior superior iliac spine. The patient is asked to inhale and exhale, after exhalation the breath is hold and the patient is asked to expand the abdominal wall posteriorly and laterally or caudally and ventrolaterally while the therapist is giving tactile cues by applying pressure with thumbs against which the abdominal cavity is asked to expand. During this test, the correct pattern is indicated by symmetrical pressure of the abdominal wall against the therapist's thumb. During abdominal expansion there is activation of the diaphragm and eccentric elongation of the abdominal wall which is followed by the abdominal muscles' isometric contraction.

The test is considered to be positive if the patient cannot activate the abdominal muscles freely or there is asymmetric pressure against the examiner's thumb, upward migration of the umbilicus, drawing in of the upper half of the abdomen. The patient may compensate with a posterior pelvic tilt by activating the lower abdominal muscles. [20]

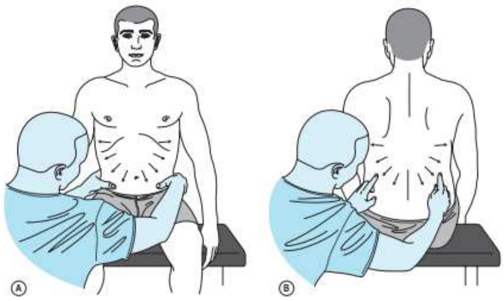


Figure 3: Assessment of the respiratory–postural function of the diaphragm. With inspiration, the individual should be able to expand all sections of the abdominal wall while maintaining an upright sitting position and relaxed shoulders. The clinician palpates the area above the groin from the front (**A**); and between and below the lower ribs from behind (**B**). To assess solely the postural diaphragmatic function, the client is asked to exhale and push actively against the clinician's fingers. The expansion should be relatively strong, symmetrical and without any pathological synkineses (i.e. the chest, pelvis and spine position remain neutral). The same position can be used for training. The clinician guides the patient manually and verbally. [20] (Photo courtesy: Kolar P, Kobesova A, Valouchova P, Bitnar P. Dynamic neuromuscular stabilization: assessment methods. Recognizing and treating breathing disorders: A multidisciplinary approach. 2014 Jan 1:93-4).

Table 1: Other assessment tests based on developmental kinesiology used are as follow:- [21]

	Tests	Test position	Correct activation	Incorrect activation
1	Intra-abdominal pressure test	Positioned in 3 month supine developmental position with hip, knee and ankle in 90 degree of flexion, mild abduction and external rotation at the hip with legs supported on a chair or by the therapist. Chest is taken into neutral position passively. Gradually the support from the legs will be removed and the examiner look for the activation of the abdominal muscles, chest movement, position of the pelvis, cervical spine and head.	There must be balanced activity of all the abdominal muscles, chest in caudal position, widening of the lower chest, diaphragm and pelvic floor should remain parallel.	There is hyperactivation of the rectus abdominis, insufficient activation of the lower abdominal wall, cranial migration of the umbilicus, chest not in caudal neutral position. There may be hyperextension in thoracolumbar junction, abdominal hollowing above the groin, shoulder protraction, hyperextension of the cervical spine, overactivity of hip flexors showing incorrect activation.
2	Arm-lifting test	The patient is in crook lying or standing position and asked to take the shoulder in 120 degrees of flexion. The examiner notices for the activation of the abdominal muscles, movement of chest and thoracolumbar junction stability.	Correct activation indicates isolated flexion of the arms without any movement at the chest, thoracolumbar junction in stable position, fixed lower ribs without any flaring of them.	Cranial movement of the chest with shoulder flexion, increased lordosis at the thoracolumbar junction and increased activation of rectus abdominis, upper trapezius indicate incorrect activation.
3	Neck/trunk flexion test	Patient is in supine lying with legs extended and is asked to and is asked to flex the neck and trunk slowly. The movement of the head and chest as well as the position of the cervical spine and shoulder girdle is observed during the test. The therapist palpates the abdominal wall and the neck muscles to see whether they are activating or not.	Correct activation reveals fluent flexion of the cervical and thoracic spine, activation of the deep neck flexors, balanced activity of abdominal wall and chest in neutral position.	In incorrect activation there will be lateral movement of the ribs, bulging at the lateral aspect of the abdominal wall, hyperactivation of the rectus abdominis. There may be cranial movement of the chest, protrusion of the chin
4	Hip flexion test	Starting position is 8 months sitting position with spine straight, upper extremity resting on thigh with palm facing upward. Test is performed by asking the patient to lift one knee upto 5 cm by flexing the hip. While performing the test the spine should be maintained in upright position, thoracolumbar junction should be in stable position i.e no kyphosis or lordosis, chest and pelvis in neutral position.	The spine should be maintained in upright position, thoracolumbar junction should be in stable position i.e no kyphosis or lordosis, chest and pelvis in neutral position.	During incorrect activation, there will be flexion or extension of the spine, increased activity of the paraspinal muscles, absent or weak activation of the posterolateral abdominals, increased activity of the rectus abdominis, pelvis rotation, internal rotation of the hip. Instability in the thoracolumbar junction may show lateral shift towards the side of hip flexion, lateral flexion of trunk and posterior shift of the non-weightbearing hip.

5	Head/neck extension test	The assessment position is 3 month prone developmental position, forehead on the table or in rotation to one side, legs relaxed on the table, feet off edge, arms alongside the body. Ask the patient to gradually lift the head and upper trunk sequentially. In correct activation the cylindrical shape of the abdomen should be maintained, head in elongation of the spine, scapula parallel to spine in neutral position, pelvis supported on pubic symphysisin neutral position, sacrum in stable position.	In case of incorrect activation, there will be anterior pelvic tilt, increased lumbar lordosis, increased activation of the paraspinal muscles, bulging of lateral sides of the abdominal wall, stiff thoracic spine kyphosis, increased activation of gluteal muscles and hamstrings, asymmetrical position of shoulder blades.	Incorrect activation also reveals increased activity of the cervical extensors causing hyperextension at neck showing insufficiency of the deep neck flexors, elevation/adduction of the scapulae, shoulder protraction, any kind of asymmetry of the muscles.
6	Quadruped rock-forward test	The testing position corresponds to the end of the 6 months prone developmental position. All the 4 extremities serve for support, upper and lower extremities perpendicular to the ground. In this test the patient slightly shifts the head and trunk forward (rocking forward) to load upper extremities more. The therapist should observe for the hand spport on ground, position of shoulder blades, thoracolumbar junction stabilization, thoracic spine, cervical spine, pelvis rotation or shift, hips position.	Correct activation shows centrated stabilized scapulae, balance support of the hand (thenar and hypothenar), spine and pelvis uprighted (without lordosis or kyphosis or anterior or posterior tilt of the pelvis), head in alignment.	Incorrect activation will depict winging or hyperabduction of scapula, hand support on hypothenar with fingers flexed, kyphosis or lordosis at spine, head hanging down, hyperextension at spine.
7	Six month prone test	All four extremities serve for support. Support is on open palms and distal thighs. Observe for the position of the thoracolumbar junction and low back, activity of the laterodorsal group of abdominal wall, position of shoulder blades, position of the head.	The whole spine should be in centered position, head and pelvis well centered, proportional activity of all the sections of the abdominal wall, paraspinal muscles and diaphragm, centration of shoulder blades, minimal activity of the muscles of dorsal aspect of lower extremity.	During incorrect activation there is hyperextension of the lumbar spine, hypercativation of the paraspinal muscles, elevation of shoulder blades, protraction of shoulders

DNS Treatment [22]

As discussed earlier core stabilization is pre-requisite which provides a stable base for the movement of extremities. Therefore, the exercises must begin by influencing the stabilization of the trunk or integrated spinal stabilization system before the function of the extremities. Before applying the DNS treatment, any tight structure or hypomobile segment must be released/ mobilized. The physiological movement of the diaphragm constitutes an essential part of any movement or exercise. During inspiration the ribs move laterally, lower aperture of chest expands, sternum moves ventrally and does not elevate with breathing. The abdominal muscles serve as a support for the diaphragm. It is important for the abdominal wall to expand not only in inferior direction but rather in all directions i.e., posteriorly and laterally. Umbilicus should not move cranially.

Following points should be kept in mind for influencing the correct breathing pattern and stabilization of the trunk :

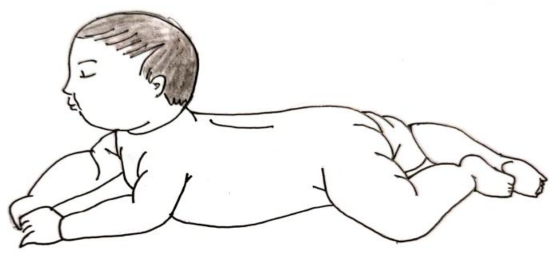
1. To regulate reduced mobility and dynamics of the thoracic wall.
2. Focusing on straightening of the spine
3. Stabilization of posture (Vojta's Reflex locomotion)
4. Exercising the postural breathing pattern and stabilizing function of the diaphragm(intra-abdominal pressure control)
5. Exercising postural stabilization of the spine in the positions related to developmental sequences – in modified positions and versions.

Regulating hypomobility and thoracic wall dynamics [22]

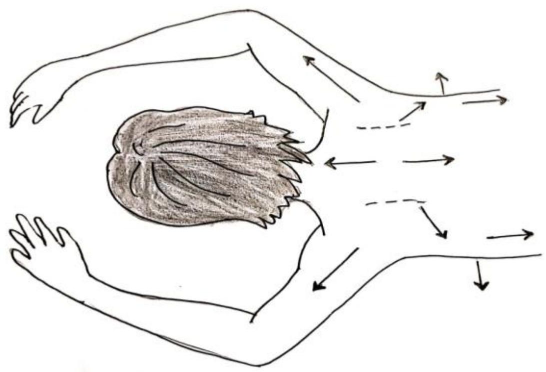
The correct activation of the diaphragm which is responsible for the optimal expansion of the thoracic wall particularly between the lower ribs is brought about by releasing the thoracic fasciae especially in the region of the lower intercostal spaces. Other tight or hypomobile structures like costovertebral joints, scalenes, sternocleidomastoid, pectoral muscles and upper trapezius are released/ mobilized in order to get the neutral position of the joints and structures.

Focusing on straightening of the spine [22]

For physiological stabilization of the spine straightening of the spine is a necessity. [23] In most of the patients, the incorrect stabilization is seen as hypomobile thoracic segment in which the thorax moves as a rigid unit. Thus, the treatment technique includes traction, mobilization of the spine, active straightening of the thoracic spine and movement of the spinal segments into extension and rotation. In order to achieve this, appropriate stabilization of the scapula is required which can be adapted in prone position supported on elbows to practice thoracic extension (Figure 4).



A.



B.

Figure 4: Stabilization in prone. A. 4 month old healthy baby with spine in upright position, extension and the support is on the both elbows and pubic symphysis.
B. An adult is positioned in the same way with support on both elbows and pubic symphysis, spine straight, scapulae in neutral position. Segmental extension and rotation with proper breathing pattern can be practiced in this position. [22]

Exercising appropriate stabilization of the respiratory pattern by using reflex locomotion

Optimal synergistic activation between the abdominal muscles (diaphragm, abdominal and pelvic floor muscles) and the back muscles is achieved by reflex activation during the initial phases. [23] In phase I of reflex rolling, there is stimulation of the thoracic region in which contraction of the diaphragm occurs as a stretch is transferred to the insertions of the diaphragm. This contraction acts on the thorax through the ribs while the intra-abdominal pressure increases simultaneously. This is similar in reflex crawling, during which the first reaction of the stimulated zones elicits deepening of lower costal breathing and abdominal wall expansion in all directions. Individual components required for physiological stabilization are integrated within this reflexively stimulated model. These include automatic alignment of the thorax into a neutral position, spinal straightening, postural diaphragmatic breathing with expansion of the lower thoracic region, eccentric stabilization function of the abdominal muscles, centrated support function of the extremities based on positions, symmetrical facilitation of the deep and superficial muscles, etc. The goal of reflex stimulation is to elicit an optimal stabilization muscle synergy and to facilitate an experience during activation that encourages somato-aesthetic perception which can later be implemented into exercises with volitional control.

Exercising respiratory and postural function of the diaphragm [23]

The goal is to achieve the respiratory as well the stabilization function of the diaphragm simultaneously without participation of the accessory muscles of the breathing. In order to achieve this, the thorax should be positioned caudally and straight spine. The patient is guided verbally and manually to inhale into the lower intercostal spaces and into the abdomen so that the abdominal wall expands in all directions (anterior, lateral and posterior). There should be no cranial movement of the umbilicus should not move cranially (an undesirable muscle pull in a cranial direction). The correct breathing pattern should be practiced in supine and in sitting positions [23]. The training is performed in various positions. During this exercise, the patient learns to include the diaphragm, whose function we are normally not aware of, during stabilization.

Exercising in various developmental sequences focusing on the stabilization of the spine [23]

The starting position is supine with the hips and knees flexed to 90 degrees (developmental position at 4 months) as demonstrated in figure 5.

For the correction of the respiratory pattern the patient is positioned in the given position,

Respiratory pattern correction: In the given position, the thorax is manually positioned into neutral alignment during respiration. Lateral movement of the thoracic wall during inspiration is facilitated by a firm manual contact and the patient consciously inhales laterally and caudally towards the pelvis without the thorax moving cranially. Expansion of the abdominal wall in all directions, including the area of the lower abdomen above the groin, is palpated as shown in figure 5.

Figure 5: The patient is positioned with hip and knee in 90-90 degree flexion corresponding to a 4 month old baby position. Spine should be straight. Patient is asked to inhale against therapist's fingers towards the groin. This increases the intra-abdominal pressure and the spine is stabilized. Initially the legs of the patients will be supported and gradually the support is removed once he/she learns proper stabilization. [23]

Postural activation of the diaphragm – practicing intra-abdominal pressure control [23]

In the same position as above, the abdominal wall above the groin is palpated using both thumbs and the patient is asked to briefly hold their breath after expiration and to push against the examiner's thumb. This increased intra-abdominal pressure is maintained for several breathing cycles. The optimal and symmetrical activation of the abdominal wall is examined by palpating the posterior abdominal wall under 11 and 12 ribs. Once the patient learns the correct coordination of the abdominal wall and the diaphragm, the movement of the upper or lower extremities against resistance can be incorporated to increase the demand on the intra-abdominal pressure control. This technique can be used in other developmental positions, such as in prone with a differentiated position of the extremities (5 months), in side-sitting (8 months), in quadruped (9 months), in a tripod position (10 months), etc. to train the postural function of the diaphragm. [23, 24]

DNS in clinical practice

DNS is used in clinical practice to treat a variety of musculoskeletal and neurological disorders and the results are favorable.

DNS in sports

Davidek and colleagues [9] evaluated the effect of DNS on maximum paddling force in Kayakars. DNS-based core stabilization exercise program (quadruped exercise, side sitting exercise, sitting exercise and squat exercise) were given to the experimental group for 6 weeks at a frequency of 5 days in a week. In this study, the following developmental positions were used to train the optimal coordination among all muscles stabilizing the trunk: the quadruped exercise, the side sitting exercise, the sitting exercise and the squat exercise. They concluded that incorporating a DNS-based exercise approach into regular kayak training may promote optimal trunk and shoulder girdle stabilization, whereby increasing maximum paddling force.

DNS in rehabilitation of neurological conditions

A case report was done by Francio and co-workers [25] to see the effect of DNS on a patient with posterior cortical atrophy (PCA) who was a 54 year old male with non-specific low back pain associated with visual and memory deficits. Patient was treated in crawling position and stabilization of the core was done with proper alignment of the spine. He was treated for 43 weeks at varied frequency of 3 days/ 2 days in a week. The outcome measures were various activities of daily living which included the ability to drive, dress, perform household chores, climb stairs, play golf, motor behavior, and overall global health status. The patient showed 60% improvement in the outcome measures.

Another study done by Yoon H S and co-workers, [26] the effect of DNS was compared with NDT in 5 hemiparetic patients and on 5 normal subjects to see the activation of the core musculature that is the transversusabdominis, internal oblique and external oblique. The thickness of the TrA was also assessed by using ultrasound. Both healthy and hemiparetic stroke groups showed greater median EMG amplitude in the TrA/IO muscles, core stability, and muscle thickness values during the DNS exercise condition than during the NDT core exercise condition, respectively. They used the reflex activation of the core muscles in this study in supine position.

Do-Hyun Kim and co-workers [27] evaluated the effect of DNS on balance and gait in a spastic cerebral palsy adolescent. The intervention was given for 4 weeks. The DNS treatment involved downward movement of the diaphragm to activate its postural function along with the activation of the TrA, Internal and external oblique and pelvic floor muscles. Significant improvement was seen in all the outcome measures.

Michael Oppelt and others [28] did a case study to see the effect of DNS on stroke. The subject was a 31 year old male with left side hemiparesis. The DNS treatment was given in sidelying and 3-montn supine position (with hip and knee in 90 degree flexion) for 32 weeks. The patient demonstrated improvements in sleep pattern, mobility and body mechanics, and emotional outlook.

Son M S [29] did a study on 15 diaplegic spastic CP patients to evaluate their postural control, gait and balance after DNS intervention. The treatment was given for 4 weeks at frequency of 3 days in a week. Gross motor function, diaphragm movement, and muscle activation were determined using a gross motor function measure (GMFM-88), ultrasound, and electromyography measurements, respectively, before and after the DNS core stabilization intervention. They concluded that DNS is a promising, effective intervention for facilitating deep core muscle activation of the underactive muscle chain comprising the diaphragm, internal oblique, and transversus abdominals, thereby improving age-appropriate standing, walking, and jumping in participants with spastic diplegic CP.

DNS for Migraine

Juehring and colleagues [30] did a case study to see the effect of DNS on migraine. The patient was treated in supine position. Hyperextension at the cervical spine was noted. Hyperactive cervical extensors were released. Activation of the deep neck flexors and core stability was done. The treatment was given for 12 weeks. Subjective improvement was noted as well as the Head Disability Index score reduced from 48% to 34%.

DNS for the treatment of musculoskeletal conditions

Lim L Y and co-workers [31] published a DNS protocol for the improvement of lumbar flexion kinematics and posture in chronic non-specific low back pain. The protocol still needs to be tested for its efficacy.

Summary of the research articles found:

Author	Study Type	Sample Size	Age	Diagnosis	Treatment	Treatment Duration	Results
Davidek et al [9]	RCT	20	21.9 ± 2.4	Upper quarter body pain	DNS core stabilization	6 weeks	Significant pain reduction
Francio et al [25]	Case study	1	54 year male	Posterior cortical atrophy	DNS core stabilization	43 weeks	60% in activities of daily living
Yoon H S et al [26]	Observational	10 (5 healthy,5 hemiparetic)	50.8 ± 6.8	Hemiparetic	Reflex activation of the core	Immediate EMG recording	EMG activity of the core was better in DNS group
Oppelt et al [28]	Case study	1	31 year male	Left side hemiparesis	DNS core stabilization	32 weeks	Improved body mechanics and sleep pattern
3Son M S [29]	RCT	15	14.9 ± 3.4 years	Spastic CP Diaplegic	DNS core stabilization	4 weeks	Improved activation of the core muscles (EMG) and improvement in activities like jumping, walking standing
Juehring et al [30]	Case study	1	49 year female	Migraine	DNS	12 week	Pain reduced significantly

CONCLUSION

DNS is a new concept in the field of rehabilitation. In this there is co-activation of all the segments of the integrated spinal stabilization system and thus acting as a wholesome approach in treating any condition. It has been used and proved to be effective in various neurological, musculoskeletal conditions. Though there is a paucity of randomized control trials to test its efficacy and more research work needs to be done for the same.

REFERENCES

1. Bokarius V. Long-term efficacy of dynamic neuromuscular stabilization in treatment of chronic musculoskeletal pain. Age. 2008; 18(25):3.
2. Wickstrom RL. Developmental kinesiology: Maturation of basic motor patterns. Exercise and sport sciences reviews. 1975 Jan 1; 3(1):163-92.
3. Forslund M, Bjerre I. Growth and development in preterm infants during the first 18 months. Early Human Development. 1985 Jan 10;(3-4):201-16
4. Kobesova A, Kolar P. Developmental kinesiology: three levels of motor control in the assessment and treatment of the motor system. Journal of bodywork and movement therapies. 2014 Jan 1;18(1):23-33.
5. Myer GD, Ford KR, Brent JL, Hewett TE. The effects of plyometric vs. dynamic stabilization and balance training on power, balance, and landing force in female athletes. Journal of strength and conditioning research. 2006 May 1;20(2):345.
6. Frank C, Kobesova A, Kolar P. Dynamic neuromuscular stabilization & sports rehabilitation. International journal of sports physical therapy. 2013 Feb;8(1):62.
7. Kim DH, An DH, Yoo WG. Effects of 4 weeks of dynamic neuromuscular stabilization training on balance and gait performance in an adolescent with spastic hemiparetic cerebral palsy. Journal of physical therapy science. 2017;29(10):1881-2.
8. Novotny JE, Beynnon BD, Nichols CE. Modeling the stability of the human glenohumeral joint during external rotation. Journal of Biomechanics. 2000 Mar 1;33(3): 345-54.
9. Davidek P, Andel R, Kobesova A. Influence of dynamic neuromuscular stabilization approach on maximum kayak paddling force. Journal of human kinetics. 2018 Mar 23;61(1):15-27.
10. Borghuis J, Hof AL, Lemmink KA. The importance of sensory-motor control in providing core stability. Sports medicine. 2008 Nov 1;38(11):893-916.
11. Hodges PW. Lumbopelvic stability: a functional model of the biomechanics and motor control. Therapeutic exercise for lumbopelvic stabilization. 2004.
12. McGill SM, McDermott A, Fenwick CM. Comparison of different strongman events: trunk muscle activation and lumbar spine motion, load, and stiffness. The Journal of Strength & Conditioning Research. 2009 Jul 1;23(4):1148-61.
13. Murphy T, Woodrum D. Functional development of respiratory muscles. Fetal and neonatal physiology. 1998;1:1071-84.
14. Kolar P, Kobesova A, Valouchova P, Bitnar P. Dynamic Neuromuscular Stabilization: developmental kinesiology: breathing

stereotypes and postural-locomotion function. In Recognizing and treating breathing disorders 2014 Jan 1 (pp. 11-22). Churchill Livingstone.
15. Hodges PW, Sapsford R, Pengel LH. Postural and respiratory functions of the pelvic floor muscles. Neurourology and urodynamics. 2007 May;26(3):362-71.
16. Hodges PW, Gandevia SC. Changes in intra-abdominal pressure during postural and respiratory activation of the human diaphragm. Journal of applied Physiology. 2000 Sep 1.
17. Kolar P, Neuwirth J, Šanda J, Suchanek V, Svata Z, Volejnik J, Pivec M. Analysis of diaphragm movement during tidal breathing and during its activation while breath holding using MRI synchronized with spirometry. Physiological research. 2009 Jun 1;58(3).
18. Assaiante C, Mallau S, Viel S, Jover M, Schmitz C. Development of postural control in healthy children: a functional approach. Neural plasticity. 2005;12.
19. Hodges PW, Gandevia SC. Activation of the human diaphragm during a repetitive postural task. The Journal of physiology. 2000 Jan;522(1):165-75.
20. Kolar P, Kobesova A, Valouchova P, Bitnar P. Dynamic neuromuscular stabilization: assessment methods. Recognizing and treating breathing disorders: A multidisciplinary approach. 2014 Jan 1:93-4.
21. Kolar P. Clinical rehabilitation. AlenaKobesová; 2014 Feb 17.
22. Kolar P, Kobesova A, Valouchova P, Bitnar P. Dynamic Neuromuscular Stabilization: treatment methods. InRecognizing and Treating Breathing Disorders 2014 Jan 1 (pp. 163-167). Churchill Livingstone.
23. Kolar P. Facilitation of Agonist-Antagonist Coactivation by Reflex Stimulation Methods In: Craig Liebenson: Rehabilitation of the Spine–A Practitioner's Manual.
24. Kolar P, Kobesova A. 2. A. 2. Postural–locomotion function in the diagnosis and treatment of movement disorders. Clinical Chiropractic. 2010;1(13):58-68.
25. Francio VT, Boesch R, Tunning M. Treatment of a patient with posterior cortical atrophy (PCA) with chiropractic manipulation and Dynamic Neuromuscular Stabilization (DNS): A case report. The Journal of the Canadian Chiropractic Association. 2015 Mar;59(1):37.
26. Yoon HS, You JS. Reflex-mediated dynamic neuromuscular stabilization in stroke patients: EMG processing and ultrasound imaging. Technology and Health Care. 2017 Jan 1;25(S1):99-106.
27. Kim DH, An DH, Yoo WG. Effects of 4 weeks of dynamic neuromuscular stabilization training on balance and gait performance in an adolescent with spastic hemiparetic cerebral palsy. Journal of physical therapy science. 2017;29(10):1881-2.
28. Oppelt M, Juehring D, Sorgenfrey G, Harvey PJ, Larkin-Thier SM. A case study utilizing spinal manipulation and dynamic neuromuscular stabilization care to enhance function of a post cerebrovascular accident patient. Journal of Bodywork and Movement Therapies. 2014 Jan 1;18(1):17-22.
29. Son MS, Jung DH, You JS, Yi CH, Jeon HS, Cha YJ. Effects of dynamic neuromuscular stabilization on diaphragm movement, postural control, balance and gait performance in cerebral palsy. NeuroRehabilitation. 2017 Jan 1;41(4):739-46.
30. Juehring DD, Barber MR. A case study utilizing Vojta/Dynamic Neuromuscular Stabilization therapy to control symptoms of a chronic migraine sufferer. Journal of bodywork and movement therapies. 2011 Oct 1;15(4):538-41.
31. Lim YL, Lepsikova M, Singh DK. Effects of dynamic neuromuscular stabilization on lumbar flexion kinematics and posture among adults with chronic non-specific low back pain: a study protocol. InRegional Conference on Science, Technology and Social Sciences (RCSTSS 2016) 2018 (pp. 715-724). Springer, Singapore.
32. https://www.google.com/search?q=integrated+spinal+stabilization+system&rlz=1C1CHBF_enIN902IN902&sxsrf=ALeKk03IWzqDo5jljNOod81k5hLYckV5uw:1598160133437&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjfxLC4yrDrAhXkX3wKHVdMA7gQ_AUoAXoECA0QAw&biw=1366&bih=625#imgrc=Ck5e6ObBm7Yo0M

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