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Diagnostic Methods

Functional postural-stabilization tests according to Dynamic Neuromuscular Stabilization approach: Proposal of novel examination protocol

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ABSTRACT

This paper presents a set of eleven functional Dynamic Neuromuscular Stabilization (DNS) tests corresponding with specific infantile developmental stages, clarifying desired postural-locomotion patterns from a developmental perspective, while also describing frequently-observed disturbances of these patterns.

1. Introduction

1.1. Clinical methods of postural assessment and documentation

Clinical management of locomotor system dysfunction requires the establishment of a diagnostic foundation upon which to construct a therapeutic strategy. Manual assessment methods to localize tender points in soft tissues, perform pain provocation tests and joint motion palpation, determine tissue tone and use of “low-tech” device assessments such as goniometry or inclinometry designed to quantify mobility can be combined with visual inspection of posture and basic movements (Lemeunier et al., 2018). Several functional assessment protocols have been proposed, and despite reliability and validity issues regarding subjective manual (Koppenhaver et al., 2014; Telli et al., 2018; van Trijffel et al., 2014; Wong and Kawchuk, 2017) and/or visual evaluation methodologies (Elgueta-Cancino et al., 2014; Lemeunier et al., 2018; O'Leary et al., 2015; Rathinam et al., 2014; Roussel et al., 2007), clinicians tend to utilize them routinely because sophisticated laboratory tests to examine motor behavior have limited utility in clinical practice (Elgueta-Cancino et al., 2014). This suggests that practicality remains a priority as practitioners require clear and simple evaluation protocols using sheets to record and monitor their patients over time during clinical interventional management.

Various rehabilitation concepts utilize customized functional diagnostic documentation to evaluate a patient's posture and movement patterns as the basis for their therapeutic interventions. For example, the Mechanical Diagnosis and Therapy (MDT) concept encompasses postural assessment that is recorded on copyright-protected forms. The MDT assessment system is reported to have acceptable inter-rater reliability when applied

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Fig. 1. ***Definition of optimal pattern from developmental perspective***: When observing a healthy child, we can see that during tidal breathing (in any position) the individual's spine is upright, the trunk is held in "neutral" position, i.e. does not move cephalad with inspiration, auxiliary respiratory muscles are relaxed because only primary inspiratory muscles, i.e. the diaphragm and external intercostal muscles perform inhalation. Widening of lower intercostal spaces and proportional expansion of all sections of the abdominal wall occurs during inhalation.

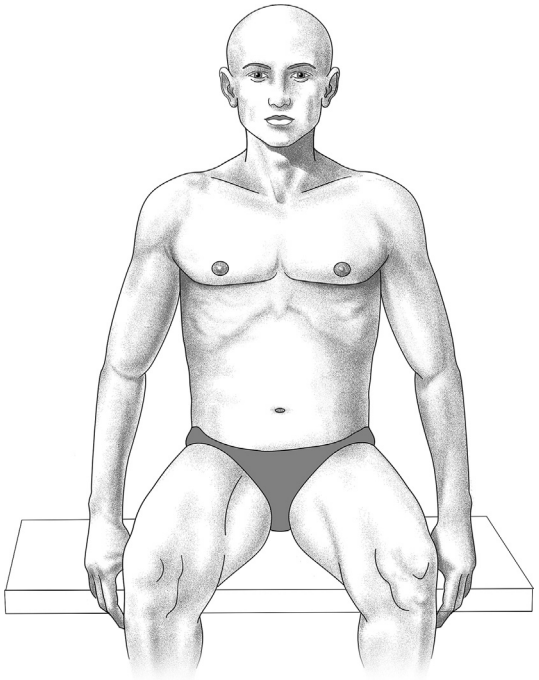

Fig. 2. ***Testing procedure:*** A sitting individual is instructed to take several deep breaths in and out while keeping the spine upright and shoulders relaxed. During the test the assessor performs visual observation from the front, focusing on the lower ribs and shoulder movement. At the same time, the assessor may palpate the lower intercostal spaces and/or above the groin. *Picture depicts optimal pattern.*

by therapists who have completed the credentialing examination (Garcia et al., 2018). Another model for comparison is an approach based upon the assessment strategies of Janda, which incorporates a clinically useful algorithm for systematic assessment of posture, balance and gait, movement patterns, muscle length and soft-tissue (Page et al., 2010). However, this concept does not provide one screening sheet for all assessment domains, where patient's test results could be marked and stored. Furthermore, intra and inter-examiner reliability for the Janda protocols have not yet been determined. The Functional Movement Screen (FMS™) assesses ten fundamental movement patterns. Based upon FMS scores, at-risk individuals can be identified to subsequently determine prevention strategies and a functional training program for performance improvement. The FMS scoring sheet records patient movement patterns both quantitatively and qualitatively (Cook et al., 2014a, 2014b) and is reported to be a reliable screening tool when used by even untrained practitioners (Leeder et al., 2016).

Increasingly, therapists who routinely perform postural and functional movement assessments have started to use modern screening tools available such as mobile applications (Boland et al., 2016; Szucs and Brown, 2018). Such tools use photographic analysis to identify positioning of anatomical landmarks. The use of these posture screening mobile applications demonstrates good rater reliability (Boland et al., 2016; Szucs and Brown, 2018). Furthermore, it is possible to evaluate not only standing or sitting posture but also other positions such as

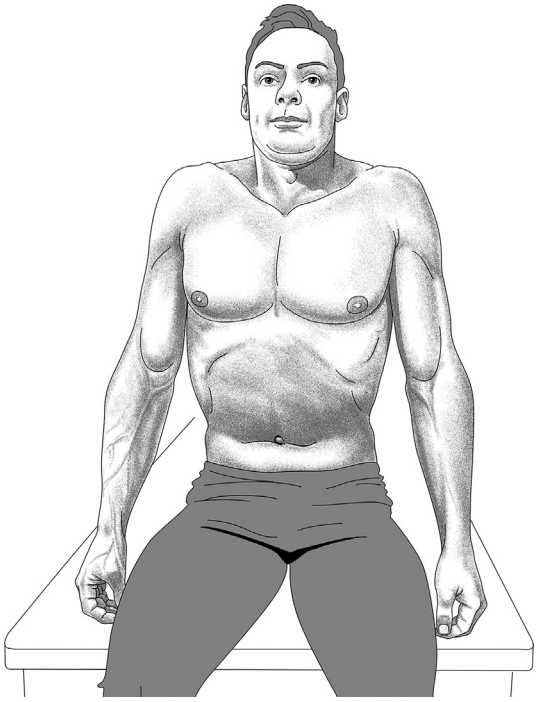

Fig. 3. ***Common signs of pathological stereotype:*** The chest moves superiorly; no or very little, widening of the lower intercostal spaces; shoulders move superiorly and into protraction during inhalation; the inhalation wave does not reach as far as the lower abdominal wall (groin).

Fig. 4. ***Definition of optimal pattern from developmental perspective***: Intra-abdominal pressure is a result of coordinated activity of the diaphragm, pelvic floor and abdominal wall. Abdominal bracing consists of proportional tensing of the abdominal wall in all its sections. Such balanced activity of all abdominal parts can be seen in a healthy child from 3 months of age in all postural positions, including the sitting position corresponding to 9 months of development *(depicted in the picture).*

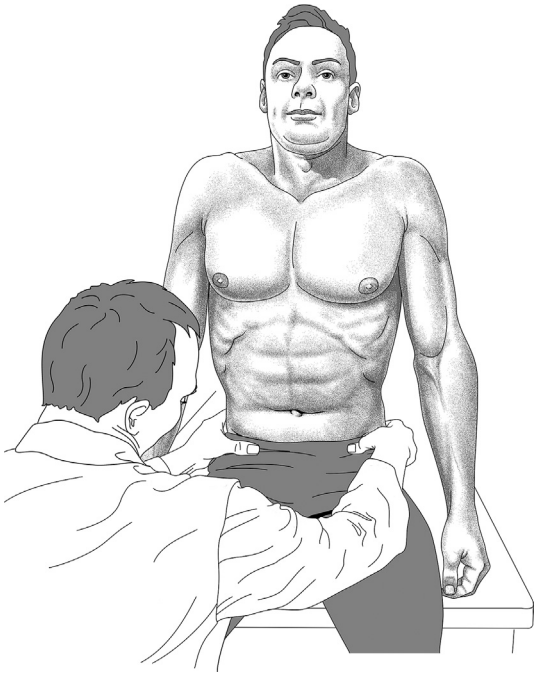

Fig. 6. ***Common signs of pathological stereotype:*** Inability to expand the lower abdominal wall or asymmetrical activation; the umbilicus does not remain in a neutral position but moves inward and cephalad as a result of upper rectus abdominis over-activity; ribcage elevation.

squatting or pushup-plank. Remote screens allow for virtual assessment and it can be reasonably envisioned that inexpensive digital postural screening tools requiring minimal formal training will soon become widely utilized. These examples of structured functional assessments, allowing for consistent objective baseline determinations for both diagnoses and later comparison of efficacy, can reasonably be considered significant clinical advancements in the evolution of locomotor system treatment.

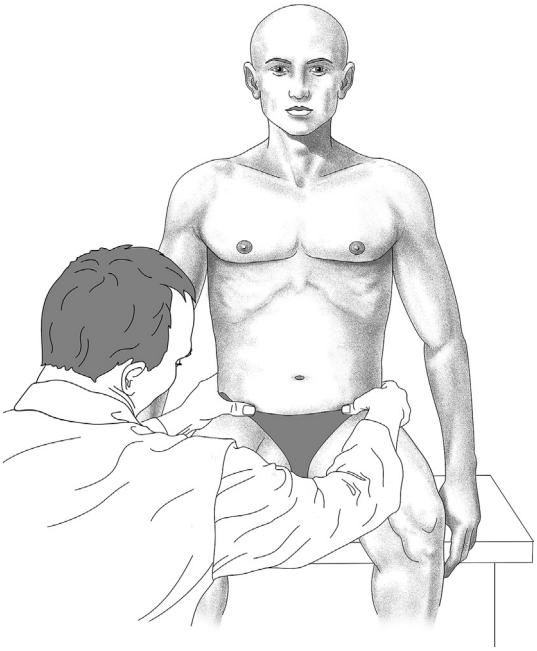

Fig. 5. ***Testing procedure:*** The individual being assessed is seated, arms and legs relaxed, spine upright. Clinician palpates the lower abdominal sections above the groin and instructs the individual to be tested to activate intra-abdominal pressure by pushing against the clinician's fingers placed above the inguinal ligaments. The assessor evaluates the amount and symmetry of activation while visually observing the abdominal contour and any umbilicus movement at the same time. *Picture depicts optimal pattern.*

Fig. 7. ***Definition of optimal pattern from developmental perspective***: After 3 months the diaphragm fulfills a postural function that is interdependent with its respiratory function. While the diaphragm activates concentrically and descends caudally, pushing on intraabdominal content, the abdominal wall must adjust to it with controlled eccentric contractions in all its sections while the pelvic floor supports intrapelvic contents caudally to control intra-abdominal pressure allowing for optimal spinal stabilization.

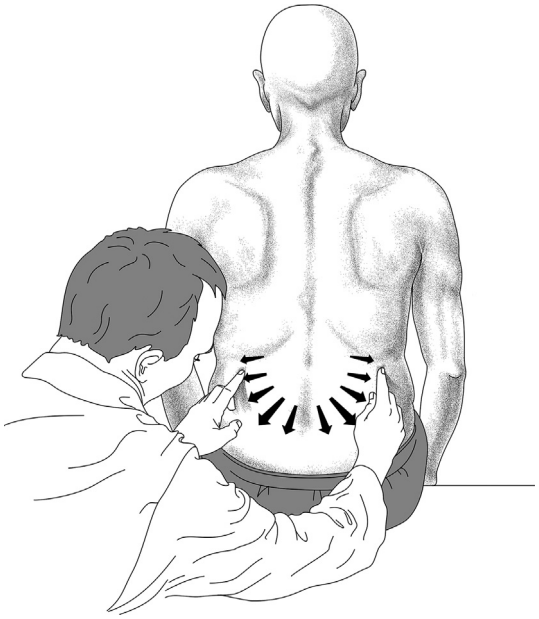

Fig. 8. ***Testing procedure:*** The individual being assessed is seated, arms and legs relaxed with spine upright. The examiner is situated behind the patient, placing their fingers between and inferior to the patient's lower ribs while instructing the tested person to take a deep breath in toward the clinician's fingers to activate the latero-dorsal sections of the abdominal wall. The examiner assesses both visually and by palpation any lateral movement of the lower ribs, the amount and symmetry of activation of the latero-dorsal sections of the abdominal wall *(arrows on the picture)*. The examiner also monitors visually if the spine is kept upright and stable and if any shoulder movement or pathological synkinesis is present. *Picture depicts optimal pattern.*

1.2. Optimal posture and core stabilization

Despite the organizational progress as evidenced by the various clinical functional evaluation models above, one rather glaring inadequacy arises: what is an ideal posture? After all, postural assessment is considered a critical determination among these approaches. Since one can only determine what is pathological in relation to what is physiological, the importance of establishing cogent parameters of physiological posture cannot be overstated.

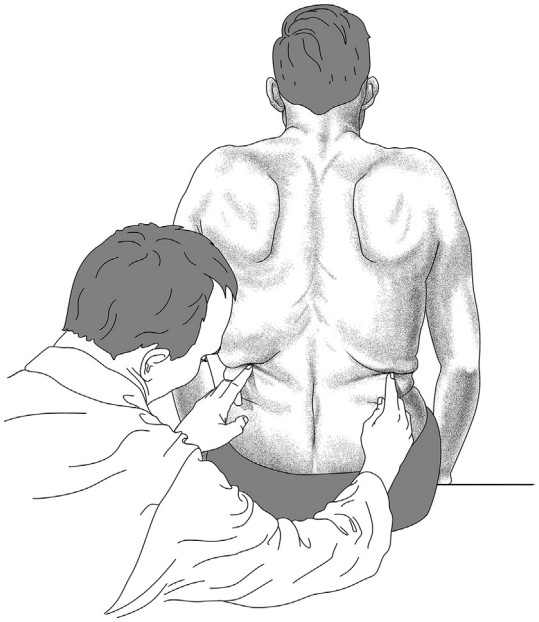

Fig. 9. ***Common signs of pathological stereotype:*** Inability to expand latero-dorsal sections of the abdominal wall or asymmetrical activation; rib cage and shoulder elevation; loss of spinal uprighting (spinal kyphosis or lateral shift, anterior or posterior pelvic tilt).

Fig. 10. ***Definition of optimal pattern from developmental perspective***: At 9 months the infant can sit with full control and a stable posture. The chest and pelvis remain in the neutral position, their axes parallel and spine upright, with ideal coordination among all stabilizers as described above that is maintained at all times. Infant can lift one leg above the support surface during which isolated hip flexion occurs without simultaneous movement of the spine or pelvis.

Boland states that novel, commercially sold photographic mobile applications enable the identification of deviations from the ideal standing posture (Boland et al., 2016). Unfortunately, that paper fails to provide any details defining what an optimal posture may be. In a

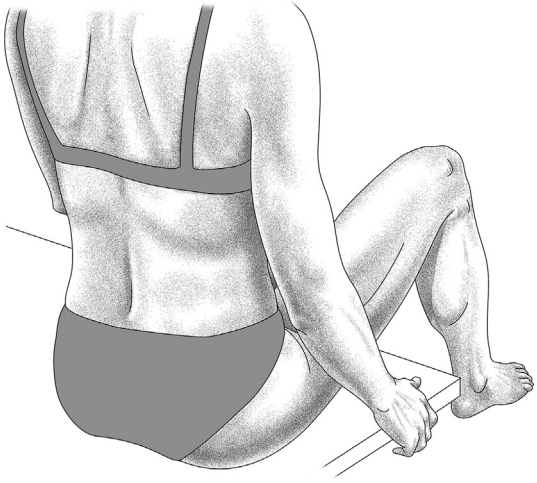

Fig. 11. ***Testing procedure:*** The individual being assessed is seated, arms and legs relaxed, legs don't touch the ground, the spine is upright. Clinician instructs the individual to slowly lift up one leg (approximately 10–20 cm) and then the other leg. The clinician visually assesses any spinal and pelvic movements and palpates latero-dorsal sections of the abdominal wall (as in the diaphragm test). *Picture depicts optimal pattern.*

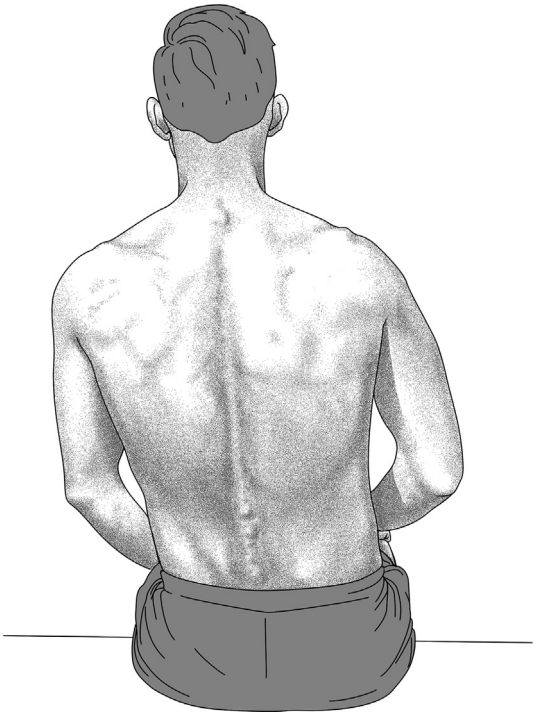

Fig. 12. ***Common signs of pathological stereotype:*** Inability to keep the spine upright and pelvis stable; lateral shift of the trunk; insufficient or asymmetrical activity of the latero-dorsal sections of the abdominal wall.

paper entitled "A short essay on posture and movement" published more than 40 years ago, author JP Martin states that posture should be regarded as a function on its own and not merely as a component of movement (Martin, 1977). Posture is a fundamental human function that typically requires minimal conscious awareness, addresses physical forces, the principles of mechanics and also the need for voluntary movement (Martin, 1977). Each voluntary movement requires the postural support within the gravitational field, during which we are not, or only minimally, aware (Martin, 1977). Still, more than 40 years later, the exact definition of optimal posture remains nebulous due to extreme postural variability. Numerous authors emphasize the most common postural situations such as standing and sitting (Claus et al., 2009; Czaprowski et al., 2017; D'amico et al., 2018; Korakakis et al., 2019; MD, 1974), evaluating muscle activity and tone (Korakakis et al.,

Fig. 13. ***Definition of optimal pattern from developmental perspective***: At the age of 3 months in the supine position, the infant can hold the legs above the ground. Such a task increases intra-abdominal pressure forcing the lower back towards the mat, with the low back connecting to the mat. The whole spine, including the cervical spine, is upright (i.e. straight). The head is supported across the nuchal line and is in a neutral position. Chest and pelvis are in the neutral position, their axes parallel, with proportional activity of all sections of the abdominal wall maintained. .

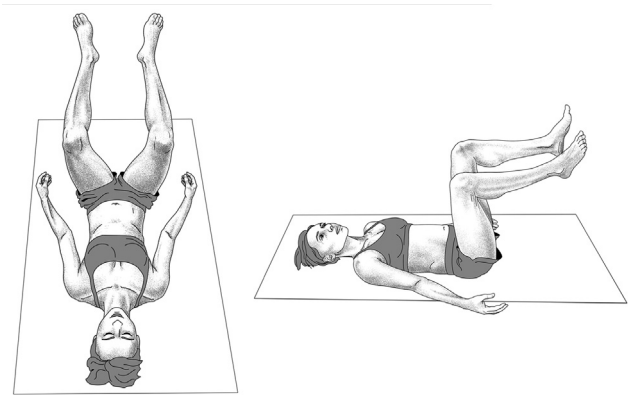

Fig. 14. ***Testing procedure:*** The individual being assessed lies in the supine position with arms relaxed. The clinician lifts the patients' legs above the table positioning hips and knees to 90° flexion. Then the examiner slowly removes the legs' support and the individual being tested is asked to maintain this position actively for 30–60 seconds. The examiner visually assesses the head position and spinal stability by checking if the spine remains on the mat, observes activation of all the parts of the abdominal wall and monitors any rectus abdominis diastasis. The assessor evaluates the stabilization pattern from above and from the side. *Pictures depict optimal pattern.*

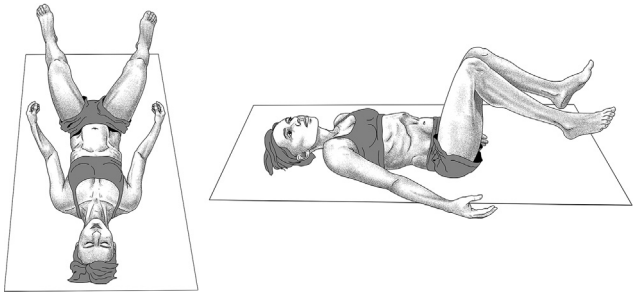

Fig. 15. ***Common signs of pathological stereotype:*** Hyperextension of the cervical and lumbar spine; disproportionate activation of the abdominal wall with concavities occurring above the groin; rectus abdominis diastasis.

Fig. 16. ***Definition of optimal pattern from developmental perspective:*** Isolated head flexion in the supine position starts between 4 and 6 weeks of age, but trunk flexion is performed later at the 5th month. During this movement the deep cervical flexors perform essential stabilization and synergistic, non-dominant activation of sternocleidomastoideus (SCM) and scalenes contribute to neck flexion. Neck flexion is performed proportionally in all cervical spinal segments, including the upper thoracic segments, with the chin moving toward the jugular fossa. Head movement is of an arc trajectory, while the chin tucks. Balanced activity of all abdominal sections occurs in a manner as described in the previous tests, while the umbilicus remains in a neutral position. The rib cage remains stable, caudal, and doesn't migrate cranially. Thoracolumbar junction adheres to the table as a result of increased intra-abdominal pressure. The oblique abdominal muscle slings (obliquus abdominis externus and internus, transversus abdominis muscles) stabilize the lower ribs, preventing their elevation during the flexion movement. The whole movement is smooth and effortless.

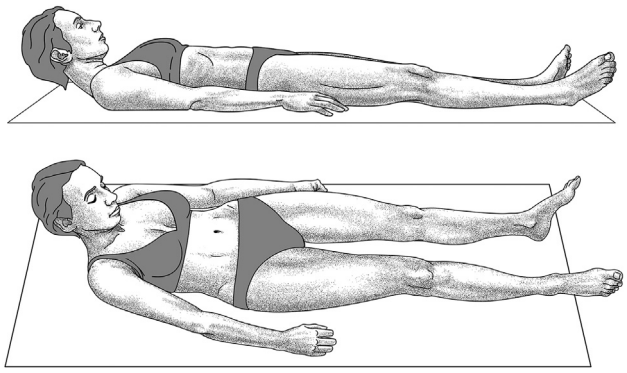

Fig. 17. ***Testing procedure:*** The supine individual, with arms relaxed along the trunk, is instructed to slowly flex the neck and trunk, until the lower scapular angles come off the table. *Pictures depict optimal pattern.*

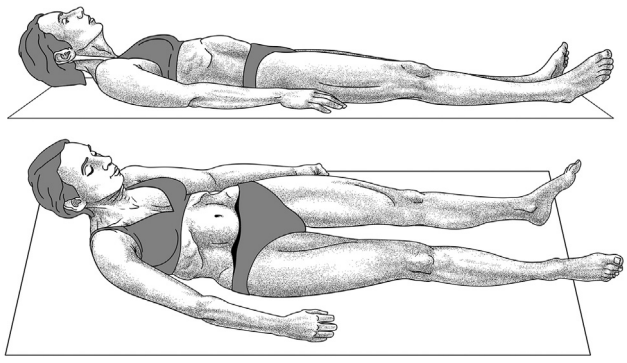

Fig. 18. ***Common signs of pathological stereotype:*** Protrusion of the mandible due to weakness of deep neck flexors which is compensated by sternocleidomastoideus hyperactivity; chest elevation as a result of imbalance between upper chest fixators (pectorales, upper trapezius, SCM, scalenes) and lower chest fixators (abdominal muscles, diaphragm) with the upper fixators predominant; flaring of the lower ribs, cephalad movement of the umbilicus due to hyperactivity of the upper part of rectus abdominis. The assessors may evaluate the stabilization pattern from the side and from above.

2019; Koskelo et al., 2007; O'Sullivan et al., 2012, 2006), assessing spinal curves and measuring various body angles (Boland et al., 2016; Claus et al., 2009; D'amico et al., 2018; Korakakis et al., 2019; O'Leary et al., 2015; O'Sullivan et al., 2006) or analyzing balance parameters (D'amico et al., 2018; Hsu et al., 2007).

Postural control is directly related to core stabilization (Dastmanesh et al., 2011). Kahraman and his team proposed the following five different components testing core stability: strength, endurance, flexibility, motor control, and function. Among these, they suggested endurance stability tests are the most reliable (Ozcan Kahraman et al., 2016). But here again, the exact definition of optimal core stability stereotype is lacking because a functional evaluation standard remains non-existent (Cook et al., 2014b). Nevertheless, ongoing progress regarding optimal postural and core function is a priority because many individuals may train around faulty patterns or simply fail to correct these compromises during rehabilitation, strength and conditioning programs (Cook et al., 2014b). Ergo, such training of poor pattern may reinforce the problem (pain, weakness, compromised performance) rather than optimizing function. Recognizing faulty motor patterns and defining the "weak links" is considered reasonably compulsory for foundational core and postural correction and improvement.

Fig. 19. ***Definition of optimal pattern from developmental perspective***: Isolated arm raise over 120° is related to verticalization process when the infant pulls up on the furniture and stands up at the age of 10 months. Proper stabilization of the thoracolumbar junction, which depends on an adequate increase in intra-abdominal pressure, is critical for this movement. Abdominal muscles work in balance with chest fixators keeping the ribcage in a neutral position.

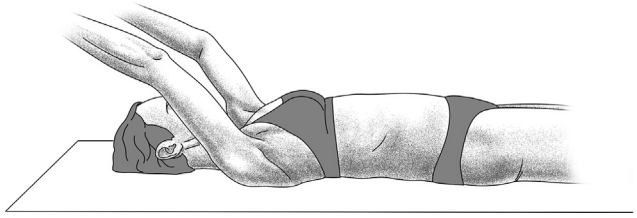

Fig. 20. ***Testing procedure:*** The individual being assessed lies supine with arms and legs relaxed. The clinician instructs the tested individual to raise the arms into flexion. The assessor evaluates the stabilization pattern from the side and from anterior perspective. *Picture depicts optimal pattern.*

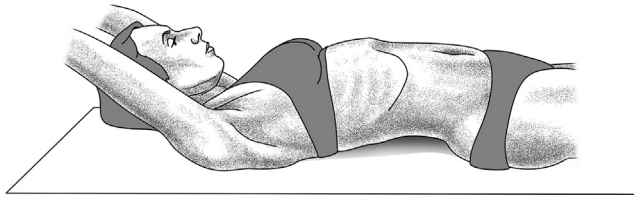

Fig. 21. ***Common signs of pathological stereotype:*** Chest elevation; thoracolumbar instability, T/L junction does not connect to the table, the individual arches his/her back.

1.3. Developmental kinesiology aspects

One strategy to define optimal posture is based on developmental kinesiology. Postural ontogenesis defines maturation of body posture, with the primary goal being the establishment of efficient human locomotion. Activation of postural musculature depends on maturation of the central nervous system (CNS) (Ivanenko and Gurfinkel, 2018; Kobesova and Kolar, 2014; Safarova and Kobesova, 2016). Humans are skeletally immature at birth and

Fig. 22. ***Definition of optimal pattern from developmental perspective***: At 6 months the infant may use both hands for support in the prone position but has yet to acquire single hand support. With both hands required for support and none available for reaching and grasping, the infant may display the "swimming pattern" in an effort to, for example, reach for a toy. In the swimming pattern, the whole spine extends with both arms moving away from the table towards extension while externally rotating the shoulders.". Proportional extension of all spinal segments occurs with the head in a neutral position. The movement is brisk but smooth, the pelvis maintains its neutral position with the lower chest, anterior belly, pubic symphysis and anterior superior iliac spines serving as support. Movement is secured by coordinated activity of the paraspinal muscles, dorsolateral sections of the abdominal wall and the ischiocrural muscles. Shoulder blades remain in a neutral position, with the medial scapular borders parallel to the spine.

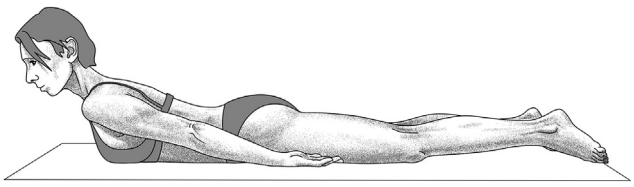

Fig. 23. ***Testing procedure:*** The individual being assessed lies in prone position with relaxed arms along the trunk. The individual then lifts their head and slightly extends the spine. The assessor visually evaluates the stabilization pattern from the side and from above and may also palpate latero-dorsal sections of the abdominal wall. *Picture depicts optimal pattern.*

optimal osteogenic morphologic maturation is heavily influenced by muscle coordination among local and distant muscles during all phases of movement (Croix and Korff, 2013). The quality of muscular coordination heavily influences joint function, which subsequently defines developmental, anatomical, and biomechanical joint parameters. According to Cook, "postural development occurs from proximal to distal, the infant learning to first stabilize the proximal joints in the spine and torso and eventually the distal joints of the extremities. This progression occurs due to maturation and learning. The infant learns fundamental movements by responding to a variety of stimuli, through the process of

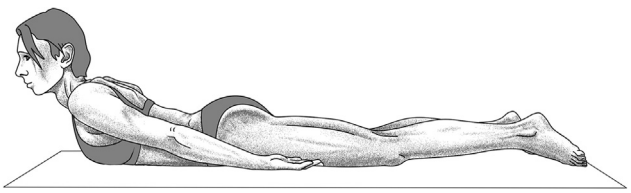

Fig. 24. ***Common signs of pathological stereotype:*** Movement is not smooth, most extension occurs at the cervico-cranial and cervico-thoracic junctions while extension in the upper and mid thoracic segments is limited or non-existent; anterior pelvic tilt; elevation and retraction of the shoulder blades with protruding medial borders, insufficient or asymmetrical activity of the latero-dorsal sections of the abdominal wall, hyperactivity of the ischiocrural muscles.

Fig. 25. ***Definition of optimal pattern from developmental perspective:*** When infants first reach the quadruped support, typically at the age of 7 months, they have yet to acquire the differentiated support and stepping forward function of crawling, and will instead perform rocking movements. The spine is elongated with the head in the neutral plane and proportional weight bearing on palms, thenar and hypothenar are equally loaded with fingers extended. Shoulder blades adhere to the ribcage in a neutral position with the medial borders nearly parallel to the spine. Thoracolumbar junction is firm and stable. The pelvis remains in a neutral position due to balance between the paraspinal muscles and the activity of all the muscles regulating intra-abdominal pressure.

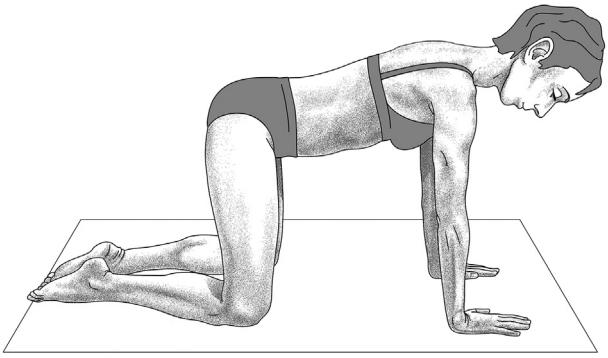

Fig. 26. ***Testing procedure:*** The individual being assessed is in a quadruped position using hands and knees for support. Then, he or she slowly shifts his head and trunk forward and stays in this position for 30–50 s. The assessor evaluates the stabilization pattern from the front and from the side. *Picture depicts optimal pattern.*

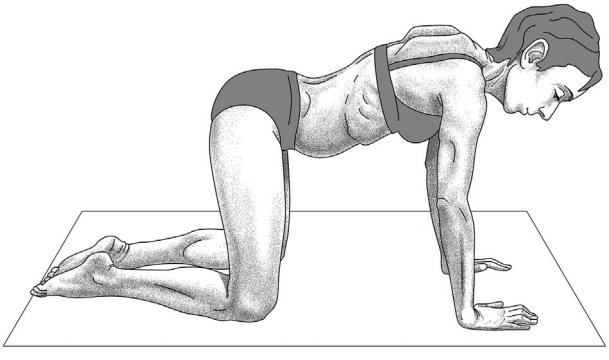

Fig. 27. ***Common signs of pathological stereotype:*** Cervical hyperextension, bringing head to reclination; uneven loading of the palms, usually with the hypothenar being over loaded while the thenar eminences lose contact with the support surface, finger flexion; scapular dyskinesis ('winging'), scapular elevation and external rotation; thoracolumbar junction drops down; anterior pelvic tilt.

Fig. 28. ***Definition of optimal pattern from developmental perspective:*** At 12 months infants use the bear position to transfer from quadruped to squat and then to stand up. The support is on hands and feet. The hands are weight-bearing equally on thenar and hypothenar pads. The shoulder blades are in a neutral position, adhering to the rib cage, medial borders nearly parallel to the spine. Proportional weight bearing of feet is established, knees being in line with feet, hips are slightly flexed with pelvis situated higher than the head. The head is in neutral position. The spine is elongated and straight. The chest is situated in the neutral position.

developmental motor learning. As growth and development progresses, the proximal to distal process becomes operational and has a tendency to reverse itself. The process of movement regression slowly evolves in a distal to proximal direction. This regression occurs as individuals gravitate toward specific skills and movements thorough habit, lifestyle, and training" (Cook et al., 2014b). Therefore, both the neurophysiological and biomechanical principles are clinically important aspects in the functional diagnosis and treatment of musculoskeletal disorders.

1.4. Dynamic Neuromuscular Stabilization

This paper summarizes complex postural testing according to Dynamic Neuromuscular Stabilization (DNS). DNS is a neurophysiological, developmentally-based rehabilitative approach that utilizes a set of functional tests qualitatively assessing various postural stabilization patterns, along with a treatment approach based on those observations and subsequent developmental kinesiology models (Kobesova et al., 2016). The inspection is based on functional DNS testing, evaluating the quality of postural-locomotion function, in order to determine the key links in dysfunction. The elementary DNS functional test is the "core stability test", which forms a cornerstone for all other DNS tests. This test was shown to be a reliable and valid test to objectively quantify core stability (Cha et al., 2017).

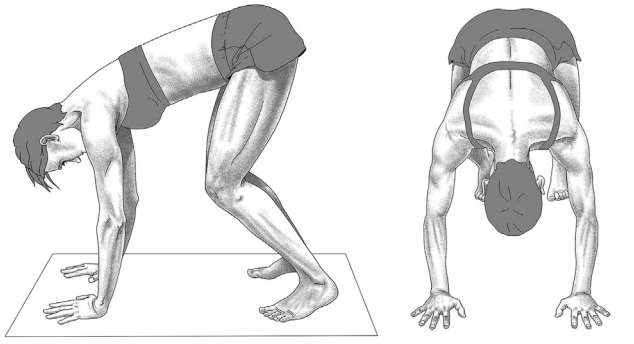

Fig. 29. ***Testing procedure:*** The individual being assessed is asked to support from hands to forefeet with slightly flexed hips and knees. Pelvis is positioned higher than the head. The position is held for about 60 seconds. The assessor evaluates the stabilization pattern from front, from behind and from the side. *Pictures depict optimal pattern.*

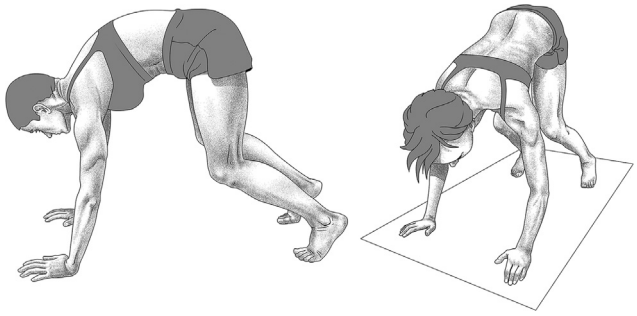

Fig. 30. ***Common signs of pathological stereotype:*** Head reclination due to weak deep neck flexors and over activity of neck extensors; thoracic hyperkyphosis or lumbar hyperlordosis; internal rotation at the hip joints bringing the knees out of the neutral position, the knees are not in line with feet but collapse medially; ankle and foot decentration causing valgus feet position.

DNS methods demonstrated efficacy in improving global trunk stabilizing patterns with noted gains in extremity movement and strength (Davidek et al., 2018; Kobesova et al., 2015). Therapeutic effects were found to train optimal spinal segmental motion, reducing back pain and improving the quality of sensory perception (Kobesova et al., 2018). DNS can also be used to improve neck muscles coordination to treat cervical instability and neck pain (Cha et al., 2018). Furthermore, DNS methods were found to be effective in the rehabilitation of balance, gait, stance and core stabilization in neurological disorders such as cerebral palsy (Kim et al., 2017; Son et al., 2017) or stroke (Yoon and You, 2017).

DNS training and treatment is based on individualized functional DNS assessments rather than rigid protocols (Davidek et al., 2018, 2018; Kobesova et al., 2018). The clients are specifically instructed to discontinue any exercise as soon as faulty stabilizing movement pattern are noted. The therapist supervises the participant's movements and provides verbal and manual corrections when necessary to ensure the optimal quality of locomotor function is emphasized (Davidek et al., 2018; Kobesova et al., 2018, 2015; Lee et al., 2018).

DNS diagnoses are based on a comparison of the individual's postural stabilization pattern with the observed developmental stabilization pattern of healthy infants (Kobesova and Valouchova, 2014). DNS manual treatment makes use of specific functional exercises to improve spinal and joint stability by focusing on the integrated stabilization system (Frank et al., 2013). Although statistical reliability of the DNS tests is limited (Cha et al., 2017), good effect of DNS therapeutic procedures (Cha et al., 2018; Davidek et al., 2018; Juehring and Barber, 2011; Kim et al., 2017; Kobesova et al., 2018, 2015; Oppelt et al., 2014; Son et al., 2017; Yoon and You, 2017) suggests clinical utility of the DNS tests since the therapy, training and individual correction of the clients in the studies listed above was always based on DNS functional tests. A study exploring reliability of individual DNS tests has been in process. The purpose of this paper is to describe DNS functional testing in details offering a practical manual for clinical work. A paper reporting inter-examiner reliability of each test will follow in the near future. Here is an overview of 11 functional stabilization tests according to the DNS concept. An optimal presentation of each test is initially explained from a developmental perspective, followed by the testing procedure description. Finally, common signs of pathological presentations are described in detail.

The goal of these functional tests is to establish the norms for ideal posture and movement with the understanding that few individuals will display the ideal pattern with all the functional

Fig. 31. ***Definition of optimal pattern from developmental perspective:*** At 12 months the baby uses the squat as a play position or as a transitory position from bear to squat to standing. The pattern of trunk stabilization and position of the head, and support function of the feet are crucial. The ideal pattern of trunk stabilization with proportional activation of the abdominal wall and co-activation of cervical flexors and extensors keeps the spine elongated and the head in the neutral position; this in combination with coordinating muscles of the lower extremity contribute to optimal lumbopelvic-hip control and support function of the feet. This is crucial for maintaining the shoulders, knees, and the 1st rays in one line, with the chest upright and behind the front edge of the knees which remain behind the 1st toe while not slipping into the valgus position, and proportionally distributed weight bearing through the feet (heel, forefoot and toes). The balanced and eccentric gluteal contraction gives them a hemispheric shape."

tests. Rather, it is important to realize that the underlying strategy for DNS functional assessments are qualitative in nature, which requires a reasonable breadth of functional variation within each test. Individual variations such as body type, age, lifestyle, conditioning and athletic activities can all influence the individual's application of efficient locomotor system function. One can appreciate such a breadth of form and function by simply observing variations in individual patterns among elite athletes, even within the same sport. With this in mind, these proposed tests help to establish a functional baseline that allow the client or patient to envision what both faulty and improved postures look like by utilizing the developing infant as a model. Instead of being stigmatized by feeling that one is “broken” or “unrepairable” by their own compromised assessment results, they can instead be encouraged by envisioning reasonably attainable functional gains within a rather broad physiological spectrum of postural and movement patterns. This is particularly important for those individuals with neurological disorders with permanent impairments where the compensations for those impairments are necessary to allow the individual to attain a higher level of function.

2. DNS functional tests

2.1. Breathing stereotype test

See Figs. 1-3

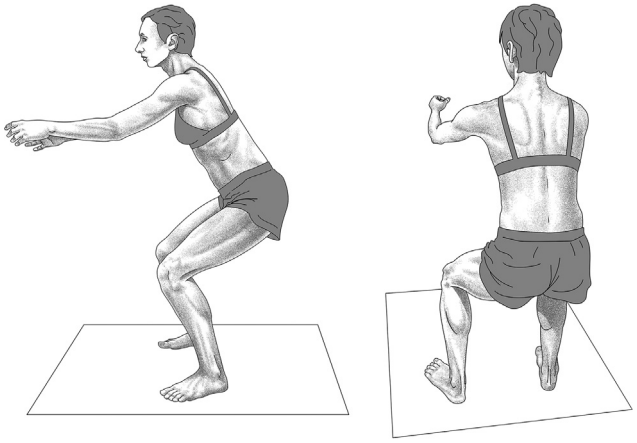

Fig. 32. ***Testing procedure:*** The individual being assessed slowly performs a squat as far as 90° angle at the knees and maintains the position for 30–50 seconds. Arms flexed 90°at shoulder and are in front of the body to balance the posture. The assessor evaluates the stabilization pattern from behind (may also palpate latero-dorsal sections of the abdominal wall), from the side and from the front. *Pictures depict optimal pattern.*

2.2. Intra-abdominal pressure regulation test

See Figs. 4-6

2.3. Diaphragm test

See Figs. 7-9

2.4. Hip flexion test

See Figs. 10-12

2.5. Supine test with legs raised up

See Figs. 13-15

2.6. Trunk and neck flexion test

See Figs. 16-18

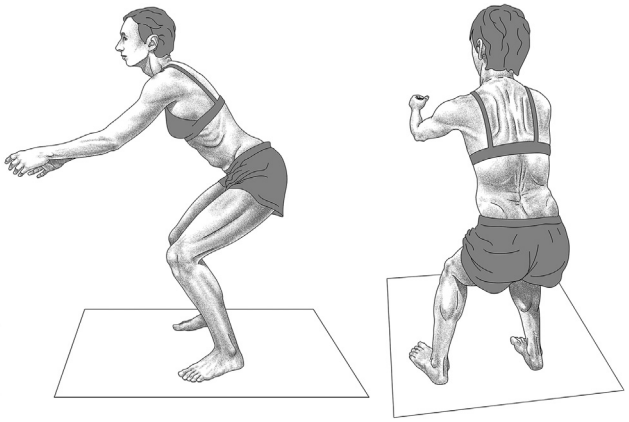

Fig. 33. ***Common signs of pathological stereotype:*** Hyperextension at the cervico-cranial junction (head reclination); shoulders reach position in front of the knees and/or elevate and protract, lumbar hyperextension and anterior pelvic tilt; knees in front of the big toes and/or collapsing medially; ankles and feet decentrate causing valgus position of feet.

1. Breathing stereotype test: Seated	Left	Right	Functional DNS tests		
Lower ribs remain in caudal position			**Mark each box:** 1= Failed, 2= Poor, 3= Sufficient but not ideal, 4=Ideal		
Shoulders remain in neutral position			**7. Arm Lifting Test: Supine**		
2. Intra-abdominal Pressure Regulation Test: Seated	**Left**	**Right**	Thorax remains in neutral position		
The lower abdominal wall activation			Neutral T/L junction at shoulder flexion		
Umbilicus remains in neutral position			**8. Trunk Extension Test: Prone**	**Left**	**Right**
Proportional activation of the rectus			Head and cervical spine remain in neutral position		
Chest in caudal position			Spinal extension is proportional involving all spinal segments and the spinal curve is smooth		
3. Diaphragm Test: Seated	**Left**	**Right**	Scapulae remain in neutral position		
Activation of latero-dorsal abdominal wall			Pelvis remains in neutral position		
Lower ribs expand laterally			Adequate activation of ischiocrural muscles		
Shoulders remain in caudal position			**9: Quadruped Position Test: Hands and knees support**	**Left**	**Right**
Maintain upright position of spine			Head remains in neutral position		
4. Hip Flexion Test: Seated	**Left hip flexion**	**Right hip flexion**	Proportional loading of the palms		
Trunk stable in frontal plane			Neutral position of scapulae		
Spine stable in sagittal plane			Thoracic spine stays stable in a sagittal plane		
Pelvis stable			Pelvis remains in neutral position		
5. Supine Test with Legs Raised Up	**Left**	**Right**	**10. Bear Position Test: Hands and feet support**	**Left**	**Right**
Cervical spine upright			Neutral position of head		
T/L junction stability (low back adheres to the table)			Upright and elongated thoracic spine in sagittal plane		
Proportional activation of entire abdominal wall			Neutral position at knees		
Balanced activation of rectus abdominis without diastasis			Proportional loading of the feet		
6. Trunk and Neck Flexion Test: Supine	**Left**	**Right**	**11. Squat Test**	**Left**	**Right**
Head in neutral position			Head maintains neutral position		
Thorax kept in caudal position			Shoulders and spine remain in neutral position, with shoulders aligned over the great toes		
Lower ribs fixed in caudal position			Knees remain in line, with hips and feet position over the great toes		
Balanced activation of rectus abdominis without diastasis			Neutral ankle and foot centration		

Trunk stability tests in frontal plane: If lateral shift occurs, describe to which side the trunk shifts
Spine stability tests in sagittal plane: Indicate if increased kyphosis or lordosis occurs
Pelvis stability tests: Indicate if anterior or posterior tilt occurs

Fig. 34. Functional DNS tests sheet.

2.7. Arm lifting test

See Figs. 19-21

2.8. Trunk extension test

See Figs. 22-24

2.9. Quadruped position test

See Figs. 25-27

2.10. Bear position test

See Figs. 28-30

2.11. Squat test

See Figs. 31-33

3. Conclusion

DNS assessment is based on the comparison of the patient's stabilizing pattern with the stabilizing pattern of a healthy infant.

This paper presents a functional diagnostic set comprising eleven DNS tests that analyze the quality of postural stabilization which helps to define the key links of dysfunction. It proposes an evaluation sheet (Fig. 34) that every clinician can use in practice for quick assessment of an individual's postural-stabilization patterns. It may also serve for re-evaluation after a DNS therapeutic trial.

In clinical practice, any position can be compared with a developmental position and any clinical sign can be evaluated in each position. Based on clinical experience we described the most frequently used tests and the signs that are best monitored in the particular test positions. For clarity and shortness this paper presents mainly visual assessment for most tests, while in clinical practice palpation is as important as visual assessment. In each described position palpation assessment can be applied to evaluate the intra-abdominal pressure regulation (as described in tests 2 and 3) and muscle tone distribution. The aim of this paper is to present clinically useful protocol to evaluate an individual's stabilization pattern.

4. Clinical relevance

- This paper provides a practical approach to the postural assessment component of the physical examination.
- Despite the common utility of postural assessment, challenges remain in determining valid and reliable methodologies to establish baseline and later comparison measures. This paper presents a logical model of assessment based upon well established developmental kinesiological standards.
- A practical evaluation form is presented that allows clinicians to efficiently document their findings.

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