Chapter 6.1

Dynamic Neuromuscular Stabilization: assessment methods

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CHAPTER CONTENTS

The assessment of a breathing pattern is a significant and 'insightful' entranceway into the assessment of postural functions. It allows for an assessment of the respiratory-stabilization function of the diaphragm and its collaboration with other muscles of the trunk (Kolar 2006). The examination can be performed in various positions, such as supine, sitting or standing. Further, we can describe from the clinical assessment the quality of the respiratory-stabilization pattern based on observation and palpation. Dynamic Neuromuscular Stabilization (DNS) is an approach based on developmental kinesiology. See Chapter 2.1 for more detail of developmental kinesiology.

An infant does not need to be taught to breathe or stabilize the spine correctly because genetically determined programmes occur automatically as a result of maturation of the central nervous system (CNS). Starting at 5 months of age, any healthy infant demonstrates an ideal pattern of dual respiratory-stabilization function. In any position (supine, prone, sitting, quadruped or standing), ideal postural and movement stereotypes occur (Kolar & Kobesova 2010). In DNS, we compare a patient's breathing, posture and movement patterns with those of a healthy 5-month-old or older infant. The assessment and treatment procedures described below can be utilized in patients suffering from various painful syndromes of the locomotor system as well as in patients with primary breathing problems. Postural-respiratory function is indivisible in that the muscles of the torso play a simultaneous role in stabilization and breathing (Kolar et al 2012, McGill et al 1995). An impaired breathing pattern goes hand in hand with impaired postural stabilization (Kolar et al 2012, Smith et al 2006). Therefore, the treatment addresses both functions simultaneously. Without a normal breathing pattern, no other movement pattern can be normal. An altered respiratory-postural pattern is a matter of intra- and inter-muscular coordination controlled by the CNS, which is hardly measurable. If indicated, the clinical assessment (observation and palpation) is combined with pulmonary function tests, instrumental balance assessment, electromyography, dynamic MRI imaging or other tests to support the diagnosis and to objectivize treatment results.

DNS: CLINICAL EXAMINATION OF DUAL RESPIRATORY-POSTURAL FUNCTION

Standing posture assessment

First, the patient's primary stance should be observed. The initial alignment of the chest and the pelvis is critical for both the quality of the breathing pattern and the postural-stabilization function. As previously mentioned (see

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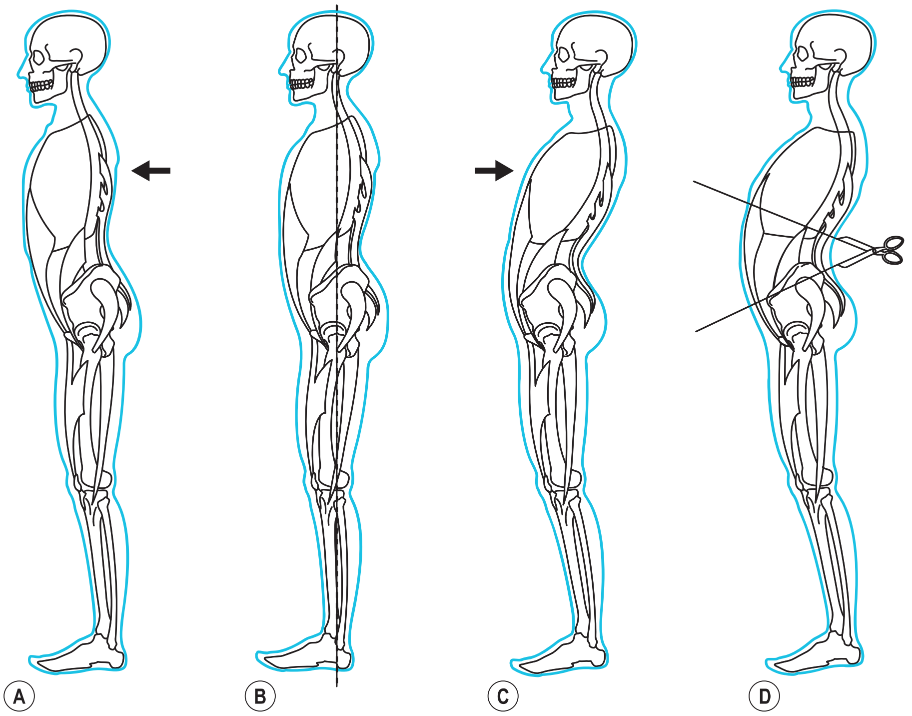

Figure 6.1.1 Chest-spine-pelvis alignment. **A** Forward-drawn chest position. Chest is positioned in front of the pelvis. **B** Optimal alignment, chest positioned above the pelvis, normal spinal curvatures, optimal balance between the anterior and posterior musculature. **C** Thorax positioned behind the lumbosacral junction. **D** 'Open scissors' syndrome: 'inspiratory' (cranial) chest position and an anterior pelvic tilt. Abnormal chest–pelvis relationship results in **A**,**C**,**D** situations in patients with abnormal spinal curvatures in the sagittal plane and hyperactivity of the paraspinal muscles.

Fig. 2.1.3, Ch. 2.1), the thorax should be positioned so that the anterior-posterior axis between the insertion of the diaphragm's pars sternalis and the posterior costophrenic angle is almost horizontal. The axis of the lower thoracic aperture and the pelvic axis are parallel to the chest, which is 'positioned' above the pelvis (Fig. 6.1.1B). Only such an alignment allows for ideal respiratory-postural coordination between the diaphragm, pelvic floor and the abdominal muscles. In healthy individuals, the parallel cranio-caudal movement of the diaphragm and the pelvic floor and the synchronous changes in the diameter of the abdominal wall occur during breathing. Therefore, posture may affect the recruitment of these muscles (Talasz et al 2011). Based on an ideal (physiological) standing posture derived from developmental kinesiology, the above-described alignment between the thorax and pelvis and the coordinated muscle activity can be observed in a 14- to 16-month-old healthy infant (Fig. 6.1.2).

An inspiratory position of the thorax known as the 'inspiratory alignment of the thorax' is usually accompanied by an anterior pelvic tilt. Clinically, this abnormal posture is known as 'open scissors' syndrome (Fig. 6.1.1D). A forward shift of the thorax presents another common deficit (Fig. 6.1.1A), as well as a thorax positioned behind the lumbosacral junction, which is the result of an incorrect spinal curvature in the sagittal plane (Fig. 6.1.1C). This malalignment is often observed in individuals with spinal stenosis or ankylosing spondylitis and it is typically accompanied by a kyphotic or semi-flexed posture.

The increased activity of the upper portion of the abdominal musculature together with a drawing-in of the abdominal wall are considered typical deficits. This is referred to as an 'hour-glass syndrome' (Fig. 6.1.3). Constant isometric activation of the upper sections of the abdominal wall and the inability to relax the abdominals prevents the diaphragm from sufficient caudal descent during inspiration and during postural strain. Abdominal movement closely correlates with diaphragmatic movement, in other words, abdominal movement increases diaphragmatic excursions (Wang et al 2009). Shoulder alignment should also be noted. Their protraction often suggests dominance and shortening of the pectoral muscles. The rib cage elevates when shoulder retraction is attempted and there is a muscle imbalance between the upper and lower trunk stabilizers (the pectoral and abdominal muscles).

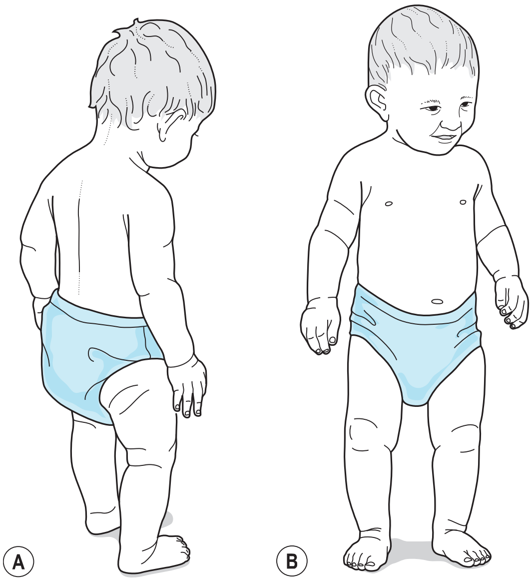

Figure 6.1.2 Physiological stabilization of the spine, chest and pelvis, i.e. optimal, genetically determined posture. Neutral position of the thorax and the scapulae; upper chest and shoulder blade fixators are relaxed and in balance with lower fixators; optimal balance between the anterior and posterior core musculature; upright spine and a neutral position of the pelvis. Such muscle coordination and optimal alignment between the chest and the pelvis and proper spinal stabilization are maintained during all the movements and in any posture – supine, prone, quadruped, sitting, etc. Neutral chest position is maintained through the entire respiratory cycle, during inspiration and expiration.

The shape of the thorax is also important for the physiological stabilization of the spine. Common deviations in the shape of the thorax are especially associated with rib tilting. A long (asthenic) thorax is flat in the anterior-posterior direction and the ribs are markedly hanging with narrow intercostal spaces. An asthenic thorax demonstrates a significant difference in the size of the perimeter of the thorax during inspiration and expiration or with significant breathing excursions and results in quite good ventilation ability. A barrel-chest is the opposite of an asthenic thorax, in which the ribs run horizontally and the intercostal spaces are wide. The anteroposterior diameter of the thorax is increased, the chest is in a permanent inspiratory alignment and has a low ventilation capacity (van Schayck et al 1995). The barrel chest configuration is typical but not specific to chronic obstructive pulmonary disease and it is often associated with an abnormal postural development. A newborn's chest is barrel-shaped and the rib cage geometry changes during early childhood development (Openshaw et al 1984). An abnormal postural development can result in anatomical changes, including the thoracic area (Park et al 2006). A barrel-shaped chest is anatomically disadvantageous for stabilization function. As far as shape deviations, the position of the posterior angles of the lower ribs in relation to the spine is the most significant. If aligned too far ventrally (in front of the spine), the function between the spinal extensors and the intra-abdominal pressure cannot be balanced. In this situation, paravertebral muscle overactivity is observed leading to a greater tendency toward spinal problems in these individuals. Non-physiological postural development usually leads to this deviation in shape. We often observe a barrel-shaped chest in patients with chronic back pain and after failed back surgery syndromes. In many of these patients, an abnormal postural development is considered to be the primary etiology of their chronic pain syndromes. Also, a barrel-shaped chest is a mere consequence of the ageing effect (Maitre at al 1995). Ageing is related to changes in the CNS, including neuronal loss, reduction in the components of myelin and intracellular enzymes, decreased receptor concentration, etc. At the same time, changes in the peripheral nervous system occur (Wickremaratchi & Llewelyn 2006) and one can assume that such processes have an influence on sensory-motor postural control, as well as having an anatomical consequence. The ageing process can be viewed as a reverse process of postural-locomotion development. In many aspects, the posture of ageing individuals resembles a newborn's posture (spinal kyphosis, barrel-shaped chest, decrease range of motion, semi-flexed posture).

However, a distinction has to be made between a developmental thoracic deformity and congenital thoracic malformations. Pes excavatus presents as a depression of the sternum with an anterior protrusion of the ribs. Pes carinatum is a reverse deformity with the sternum protruding anteriorly (Maitre at al 1995). Usually, such deformities result in rather esthetic issues (Jaroszewski et al 2010, Kelly et al 2008), however, sometimes they may influence ventilatory parameters (Jaroszewski et al 2010) and they do not automatically result in abnormal postural stabilization (Schoenmakers et al 2000) or an abnormal respiratory pattern. This type of chest malformation may be inconvenient with respect to stabilization and respiratory stereotype, especially when associated with scoliosis (Schoenmakers et al 2000) or with a connective tissue disorder (Kelly et al 2005). It is our experience that, unlike developmental chest deformities, physical therapy and other rehabilitation interventions do not usually result in changes of the anatomical parameters in congenital types of malformations. Only a few studies show benefits of conservative treatment on chest wall geometry (Haecker 2011, Moreno et al 2011). If necessary, the deformity needs to be surgically corrected (Jaroszewski et al 2010). All clinicians should be aware that chest pain, dyspnoea, decreased endurance, decreased exercise tolerance and increased fatigue may occur in patients with a severe form of pectus excavatum (Jaroszewski et al 2010).

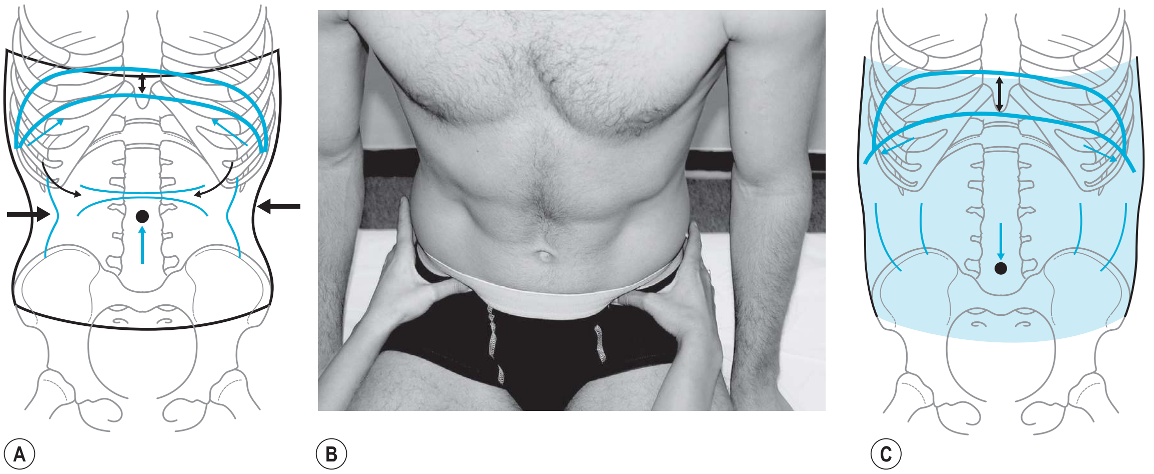

Figure 6.1.3 'Hour-glass syndrome'. **A** Constant concentric activation of the abdominal wall, especially in its upper section, with the umbilicus in a cranial and a 'drawn-in' position. Such muscle coordination results in a cranial position of the diaphragm and limits diaphragmatic descent during postural tasks, thus altering postural stabilization. During postural activity, the diaphragmatic excursion is small and the direction of activation is toward the centrum tendineum (blue arrows) because the diaphragmatic attachments on the lower ribs are not stabilized via an eccentric abdominal contraction. **B** Clinical picture of an 'hour-glass syndrome'. The activity of the upper abdominal wall predominates; the patient cannot eccentrically activate the lower section of the abdominal wall (pushing clinician's thumbs outwards and caudally). **C** Correct model of stabilization. Balanced function of all the abdominal wall sections, the diaphragm descends during postural tasks and its costal attachments are stabilized. Note opposite direction of the blue arrows and greater diaphragmatic excursion when compared to **A.** The umbilicus moves caudally as a result of increased intra-abdominal pressure and diaphragmatic descent. The abdominal wall expands proportionally in all the directions.

Assessment of the breathing pattern and the diaphragm's respiratory function

Movement of the ribs (thorax) and the abdominal cavity are observed. During diaphragmatic breathing, the diaphragm descends caudally, flattens and compresses the internal organs caudally. With inspiration, for example, the kidney shifts several centimetres caudally while during expiration it migrates cranially (Xi et al 2009). The thoracic and abdominal cavities symmetrically expand. It is important that during physiological diaphragmatic breathing, the lower aperture of the thorax also expands in addition to the abdominal cavity. The sternum moves ventrally. During rib palpation, it is observed that the intercostal spaces expand and the lower thorax expands proportionately in the lateral, ventral and dorsal directions (Fig. 6.1.4B). Simultaneously, both thumbs then palpate the dorsolateral aspect of the abdominal wall below the 12th rib and observe whether the palpated area expands during inspiration. 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 (Fig. 6.1.4A). The sternum does not change its position in the transverse plane. The accessory breathing muscles (scalenes, pectorales, upper trapezius, etc.) are physiologically relaxed during resting breathing.

In a pathological scenario, the sternum moves cranio-caudally and the thorax expands only minimally while the intercostal spaces do not expand. The accessory muscles are activated during inspiration. A patient's inability to perform diaphragmatic breathing suggests an insufficient or impaired synchronization between the diaphragm and the abdominal muscles. This is often caused by an inability to relax the abdominal wall (especially the upper portion). The nature of the breathing pattern and its control usually correlate with the results of clinical tests focused on the stabilizing function of the spine.

If the upper chest stabilizers (pectoralis, upper trapezius, scalenes, SCM) dominate and pull the thorax into an 'inspiratory position', the thoracic position is commonly accompanied by impaired costovertebral joint mobility. This dysfunction is compensated for by movement in the thoracolumbar junction even during breathing (see Fig. 6.1.1D). The spine moves into extension during inspiration while during expiration it moves into flexion. With thoracic spine straightening, the entire thorax moves cranially; however, physiologically, it should remain in a neutral position during inspiration and expiration (see Fig. 6.1.2).

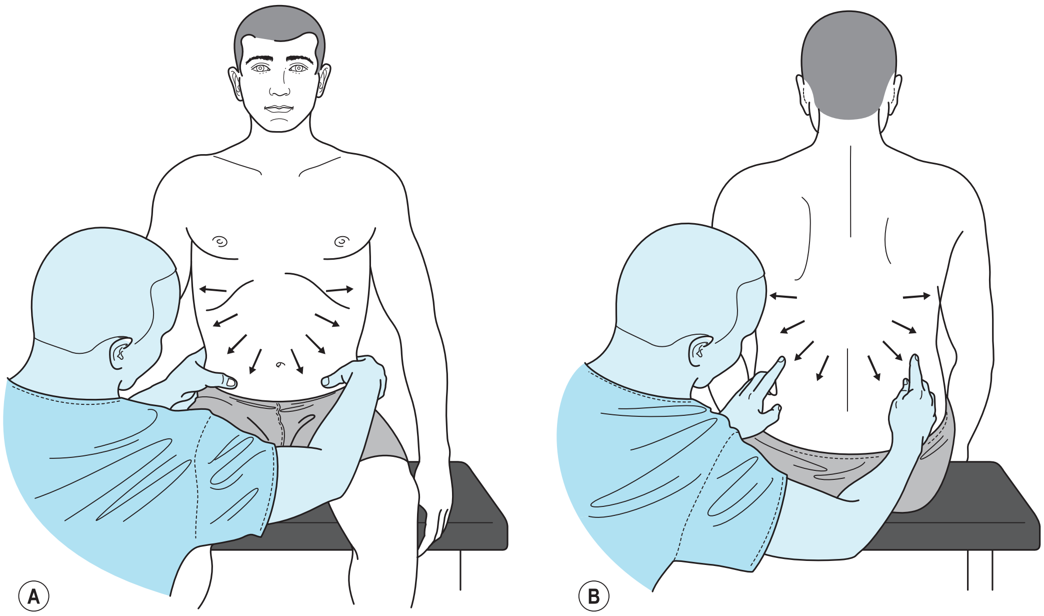

Figure 6.1.4 Assessment of the respiratory–postural function of the diaphragm. With inspiration, the individual should be able to expand all sections of the abdominal wall while maintaining an upright sitting position and relaxed shoulders. The clinician palpates the area above the groin from the front (**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.

When assessing the breathing pattern as described above, the patient's natural pattern is examined, i.e. without any specific instruction or corrections. The area between and below the lower ribs is observed and palpated. Most of the patients, including individuals with dysfunction as well as healthy individuals, do not demonstrate an ideal pattern as their default movement stereotype. However, it is the ability to modify the stereotype that matters. The second step of the assessment consists of patient instruction. The patient is instructed to relax the upper chest stabilizers, sit upright and breathe into the lower chest cavity and into the latero-dorsal aspects of the abdominal wall as well as into the lower abdominal wall above the groin. The examiner guides the patient verbally and manually. Most of the patients are 'locked' in their insufficient stereotype. They cannot follow the instruction and cannot modify their respiratory-postural stereotype. The overactivity of certain muscles or muscle sections (constantly substituting for the insufficient ones), overloading of certain spinal or joint segments and finally, pain syndromes are all results of the constant uniformity. From our experience, the ability to better modify the breathing and/or movement patterns and the ability to better follow the clinician's instructions indicate better prognosis – the treatment will be shorter and simpler and the results will last longer.

Assessment of the diaphragm's postural function

During the assessment, the patient sits at the edge of a treatment table, feet unsupported, arms relaxed along the trunk. The same rule as described above is utilized. First, the patient's natural pattern is observed and then, if necessary, the patient is instructed in how to correct it. The upper extremities are freely positioned without the patient leaning on them. Laterodorsal portions of the abdominal wall are palpated below the lower ribs from behind (see Fig. 6.1.4B) and the groin area is palpated from the front medially to the anterior superior iliac spines above the femoral heads (see Fig. 6.1.4A). The patient, while holding their breath, is asked to expand the laterodorsal sections of the abdominal wall posteriorly and laterally or to push their abdominal wall caudally and ventrolaterally against the pressure of the examiner's thumbs. In this test, the abdominal wall is assessed during increased abdominal pressure.

A symmetrical pressure of the abdominal wall against the examiner's thumbs is considered to be the correct pattern. Through activation of the diaphragm, an eccentric bowing out of the abdominal wall in all its sections occurs first. This is followed by an isometric contraction of the abdominal muscles. This principle is clearly apparent in a weightlifter when lifting a heavy load (see Fig. 2.1.7, Ch. 2.1).

The test is positive if the patient is not able to freely activate the palpated abdominal wall or if the pressure against the resistance from the examiner's thumbs is asymmetrical or bilaterally weak and the upper portion of the rectus abdominis and the external obliques dominate. The abdominal wall is drawn in at its upper half and the umbilicus migrates cranially (see Fig. 6.1.3A,B). The patient also substitutes the activation of the lower abdominal wall with a posterior pelvic tilt. Activation of muscles in the palpated area without symmetrical bowing out of the lower abdomen is also considered incorrect.

Additional assessment approaches are described in Chapters 6.2, osteopathy; 6.3, physiotherapy; 6.4, psychology; 6.5, questionnaires and manual methods and 6.6, capnography.

Treatment and rehabilitation methods, based on DNS methodology, are summarized in Chapter 7.1b.

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