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Is there a hierarchy of survival reflexes?

Kieran Macphail *

Bowskill Clinic, 4 Duke Street, London W1U 3EL, United Kingdom

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ABSTRACT

A hierarchy of survival reflexes for prioritising assessment and treatment in patients with pain of insidious onset is hypothesised. The hierarchy asserts that some systems are more vital than others and that the central nervous system (CNS) prioritises systems based on their significance to survival. The hypothesis suggests that dysfunction in more important systems will cause compensation in less important systems. This paper presents studies examining these effects for each system, arguing that each section of the hierarchy may have effects on other systems within the hierarchy. This concept is untested empirically, highly speculative and substantial research is required to validate the suggested hierarchical prioritisation by the CNS. Nonetheless, the hierarchy does provide a theoretical framework to use to exclude contributing systems in patients with pain of insidious onset.

Introduction

Chek [1] has hypothesised the hierarchy shown in Fig. 1. The model asserts that the central nervous system prioritises the function of systems that are more important for survival whilst sacrificing the function of less important systems. It is proposed that this model can be used as a clinical reasoning tool in the management of chronic pain patients.

From top to bottom the segments are; breathing, the stomatognathic system, vision, the vestibular system and hearing, the upper cervical spine and then the organs with the emotions of the limbic system embedded within them. The emotions are considered as a floating system and they may move to the top of the hierarchy in certain circumstances. Penultimate is the pelvic complex. All vertebra from C4 down and the limbs are placed at the bottom.

The value of this model is best appreciated practically. For example, mouth breathing can lead to cervical protraction [2]. The cervical spine's influence on the kinetic chain may cause lumbar spine compensation, most commonly an anteriorly rotated pelvis (Lima et al., 2004). Anterior rotation of an innominate during motor control tasks is associated with low back pain [3].

Respiration

The importance of respiration can be viewed in the context of the integrated model of joint function. It illustrates the interplay between the active, passive, neural and emotional components in joint function. Respiratory alkalosis may cause increased contraction of smooth muscle cells [4]. Smooth muscle cells are located in collagen within intervertebral discs, ligaments, fascia and menisci. Thus alterations in breathing mechanics may affect the function of the passive system. Furthermore, respiratory alkalosis alters neuronal excitability, muscle function and emotional state. Through these mechanisms respiratory rate may at times affect the function of the entire musculoskeletal system.

Breathing mechanics may affect dentofacial and craniorofacial structure. Harari et al. [5] retrospectively analysed the changes in 116 pediatric patients, 55 of which showed signs and symptoms of mouth breathing and 61 controls that were normal nasal breathers. Mouth breathing was assessed using subjective history and physical exam. These findings were confirmed with a mouth-breathing questionnaire. Mouth breathers demonstrated considerable backwards and downward rotation of the mandible, increased over-jet, increased mandible plane angle, a higher palatal plane and narrowing of both the upper and lower arches compared to nasal breathers. Furthermore, a posterior cross bite was more prevalent in the mouth breathers at 49% compared with 26% in controls. As was an abnormal lip to tongue seal, 56% in mouth breathers as opposed to 30% in controls. This could be viewed as the CNS prioritising respiration over the stomatognathic system.

Mouth breathing is also associated with compensatory changes throughout the kinetic chain. In children, mouth breathers have been found to have significant increases in cervical protraction and thoracic curvature in the sagittal plane measured with biophotogrammetry [2]. These changes lead to measureable reductions in thoracic rotation and winging scapula. At the lumbar spine sub-

* Tel.: +44 20 7486 6523.
E-mail address: kieran@kieranmacphail.com

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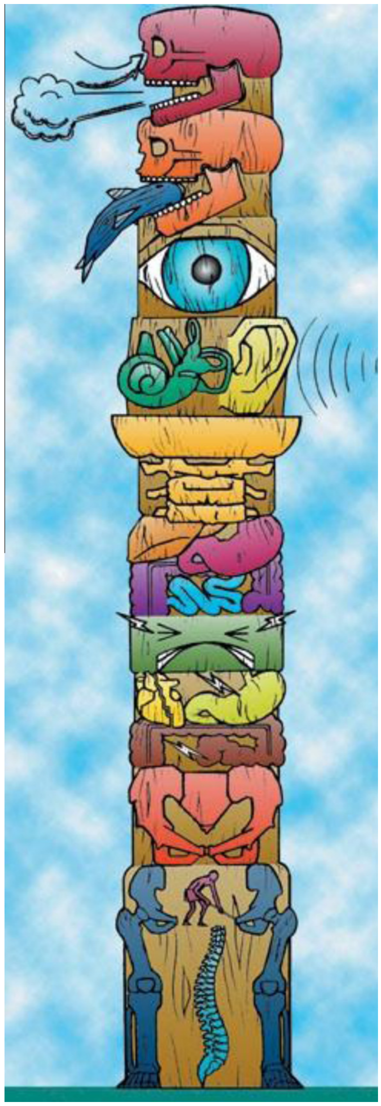

Fig. 1. Survival Totem Pole (Chek, 2008). From top down; respiration, stomatognathic system, vision, hearing and vestibular system, upper cervical spine, viscera, limbic system, pelvis, spine and limbs.

jects compensated most frequently with an anteriorly rotated pelvis, although others used a posterior pelvic tilt strategy [2]. In the lower limb the knees hyperextend and the ankles dorsiflex. These findings suggest a possible link between posture and mouth breathing.

The respiratory function of muscles is prioritised over their stabilization function. The postural and respiratory function of the diaphragm is coordinated with the respiratory and postural inputs summated at the phrenic motorneurons [6]. Further integration of respiratory and postural roles has been demonstrated for the transversus abdominis and the intercostals. Hodges et al. [6] assessed the effects of increasing respiratory demand on the postural function of the diaphragm. Six participants had to oscillate an arm whilst breathing through a tube, which increased dead space in the lungs for 4 min. As participants reached the final minutes, their respiratory rates increased and CO_2 levels had decreased. Their results showed that as respiratory demand increased, the postural function of the diaphragm declined. They concluded:

"To maintain homeostasis, the CNS must prioritise respiratory drive over other functions of the respiratory muscles, such as postural control" [6, p.1006].

The clinical application of this statement is clear. Patients need to be cleared for respiratory dysfunctions, such as breathing pattern disorder or mouth breathing.

Stomatognathic system

Chek [1] placed the stomatognathic system second on his hierarchy as nutrition is acutely important to survival. The stomatognathic system consists of the mouth, teeth, jaws, pharynx and related structures. This system is co-dependant on the function of inferior structures. The hierarchy promotes that the function of lower systems will be compromised to optimise the function of the stomatognathic system, for example to optimise occlusion.

Temporomandibular dysfunction can directly impact posture through its communication with the vestibular system. Unilateral truncular anaesthesia to the mandibular nerve has been shown to cause a decrease in postural stability [7]. This effect may occur as the trigeminal nerve communicates through the medial longitudinal fasciculus with cranial nerves III, IV, VI and XI. The medial longitudinal fasciculus is a key brainstem association path and links the different oculo cephalogyr synergetic centres. These inter-relations intimate that the trigeminal nerve could be involved with other afferent inputs involved in postural control.

Experimental evidence suggests that the impact on posture of alterations in occlusion is measurable and, possibly correctable. D'Attilio et al. [8] examined the effects of giving rats a cross bite for 1 week with an occlusal pad on the right first molar. The occlusal pad was then switched to the left first molar for another week. The rats underwent whole body radiographs before the experiment, at 1 week and at 2 weeks. They found that after 1 week all rats developed scoliotic curves and 83% were fully corrected after the second week. The obvious limitation in the transferability of this study is that rats are quadrupedal. Nonetheless, the study illustrates the ease with which occlusion can affect the spine in vertebrates.

Rothbart [9] examined the correlations between foot alignment and vertical face dimensions in 22 Mexican children. Patients were selected if they had a foot posture index greater than two, a foot index posture asymmetry greater than two, asymmetry in posterior superior iliac spines and vertical face dimension asymmetry greater than 3 mm. Vertical face dimensions were measured by calculating the distance from the outer corner of the eye to the outer corner of the lip. There was a statistically significant correlation between foot pronation and ipsilateral anterior rotation of the pelvis, anterior rotation of the pelvis and ipsilateral loss of vertical face dimension, as well as loss of vertical face dimension and ipsilateral foot pronation. Rothbart [9] explained these findings with an ascending adaptation model. However, these results could equally be attributed to a descending adaptation model, illustrating the effects alterations in the stomatognathic system can have on the pelvis and the lower limb. These results were not evident in every patient but the selection criteria singled out those patients most likely to show the results.

Vision

"Quite simply, as a developmental being, if you couldn't see, you wouldn't know what was going to try and eat you, and you wouldn't be able to see what you were going to eat. The result of this is obvious!" [1].

Morningstar et al. [10] examined the relative importance of the visual system in hierarchical control of the spine and compared it with the vestibular system and upper cervical spine. They performed a review of studies examining the functional interactions of the postural and somatosensory reflexes. Their findings sug-