Management of Craniomandibular Disorders. Part 1: A Craniocervical Dysfunction Index

A craniocervical dysfunction index has been developed (based on the Helkimo Dysfunction Index) to comprehensively assess craniocervical dysfunction and to objectively monitor the management of patients who present with these clinical problems. The close functional interrelationship of temporomandibular joints, jaw muscles, and cervical joints and muscles is reviewed, and a mechanism is proposed to explain dysfunctional relationships between these structures. This is the first of three papers stemming from a clinical study that investigated craniomandibular disorders and assessed the effect of routine dental management on craniomandibular and craniocervical dysfunction.

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Functional relationships exist between jaw and cervical muscles involved in head, neck, and jaw movements. Posterior cervical muscles of special importance include the trapezius and dorsal neck muscles, which support the head anteroposteriorly, and the sternocleidomastoid muscles, which control head rotation. Anterior neck muscles, both suprahyoid and infrahyoid groups, have an important role: the suprahyoid muscles (mylohyoid, hyoglossus, geniohyoid, and digastric) are closely associated with tongue function, while the infrahyoid group essentially supports the hyoid bone. As a result of these functions, close and complex integration of these muscle groups is essential for fluent neck, jaw, and tongue function.

Sherrington[1] showed that a clearly defined neurophysiologic relationship exists between dorsal neck and jaw muscle function. More recent neurophysiologic studies[2-4] have described an expanded role for the trigeminal system in the control of head and shoulder movement, additional to its primary role of subserving nociception from orofacial tissues.[5,6]

Abrahams and Richmond[4] proposed that the cervical spinal cord and its associations with the trigeminal system represent a specialized receptor system. Clinically, damage to neck structures (often as a result of whiplash trauma) causes a variety of symptoms, including disturbances of gait and vision, and dizziness. Cervical nerves C1 to C4 are primarily associated with head posture,[7] and afferents from C1 to C4 relay in nucleus caudalis, the most caudal region of the trigeminal sensory nucleus and the primary region for transmission of trigeminal nociceptive afferents. Non-nociceptive afferents may project to deeper portions of nucleus caudalis[8] as well as to more rostral areas of nucleus oralis and interpolaris.[9,10]

This neurologic infrastructure provides a basis for the intimate association between craniocervical and jaw posture. This association has also been acknowledged from clinical studies, and Brodie[11] emphasized that integrated head and cervical muscle function was required for maintaining head posture. Clinical observation of patients presenting with temporomandibular dysfunction (TMD) has indicated that cervical pain is a commonly occurring feature,[12-22] and occlusal relationships have been proposed as a possible etiologic factor.[23-26]

The varied symptoms that may be associated with cervical dysfunction (noted by Abrahams and Richmond[4]) in association with TMD were investigated by Norris and Eakin.[16] These authors found a predominance of female patients with symptoms including cervical pain, pain in and around the ear and down the neck, aching and tightness in the submandibular area, and sometimes a burning sensation in the neck and pain in the ipsilateral shoulder.

Reider[17] examined a population of "apparently healthy" subjects and found a high incidence of occlusal habits, headache, and neck ache. The prevalence of headache and neck ache occurring one or more times each month in this population was 43% with headache, 17% with neck ache, and 11% with both headache and neck ache.

Hellsing[23] and Hellsing et al[24] examined head and body posture in children and found that lumbar and thoracic spinal curvature increased with age and that cervical lordosis was related directly to head posture and mode of breathing (ie, nose or mouth). Mode of breathing influenced resting lip pressure and anterior tooth arrangement. There were also marked changes in posterior cervical muscle electromyographs (EMG), where flexion (head forward) increased EMG and extension (head backward) decreased EMG in these muscles, but increased sternocleidomastoid EMG. Both extension and flexion increased infrahyoid muscle activity, presumably to maintain hyoid bone position in association with a patent airway.

Posture

Postural or "orthostatic" stability of the cranium to the cervical spine is an important diagnostic consideration of craniomandibular pain and dysfunction. However, this is not always acknowledged in diagnosis and management of such patients, even when there is obvious cervical pain and dysfunction. Management strategies for craniomandibular pain have been directed toward malocclusion and/or abnormal temporomandibular joint (TMJ) mechanics and although this form of treatment often helped the patient initially, improvement was usually not maintained long-term. Abnormal head, neck, shoulder, and mandibular posture may have been responsible for the relapse following treatment directed solely at the TMJ. This suggested the need for upper-body biomechanical evaluation for all patients with craniomandibular pain and dysfunction.

Craniomandibular disorders (CMD) may result in symptoms of referred pain as well as local musculoskeletal pain. Local symptoms include decreased range of mobility, muscular stiffness and pain, and degenerative or osteoarthritic changes in spinal joints. These symptoms may arise as a result of sustained muscular contraction, poor posture, and subsequent mechanical compression of neurovascular elements, cervical vertebral joints, and cervical nerve roots. Other local symptoms attributed to craniocervical problems are complaints of soreness and/or tightness in the throat and when swallowing, which may be due to a change in cervical curvature, and is characterized by a forward head posture with increased tension of anterior neck structures.

Considering the multiplicity of signs and symptoms that may arise from altered head posture, it is evident that there is a direct relationship between craniovertebral abnormalities and CMD. Ideal head posture places its center of gravity slightly anterior to the cervical spine. For this reason, when the subject is sitting or standing, the head falls anteriorly if the cervical muscles are totally relaxed. To maintain this orthostatic or postural position, strong posterior cervical muscle activity is needed to balance these forces. The anterior cervical muscles are small, thin muscles that stretch from the clavicle, sternum, and rib cage to the hyoid bone (infrahyoid muscles) and from the hyoid bone to the mandible (suprahyoid muscles). Three-dimensional stability of the hyoid bone is maintained by complex reflex-muscle influences in relation to airway maintenance. Two other important muscles that influence the position and stability of the head and neck are the sternocleidomastoid muscle anteriorly and the levator scapulae muscles posteriorly. Mandibular movement is controlled by jaw muscles and relates to the cranium through the articulation of the teeth and TMJs. This complex relationship is important because the mandible is attached in this way to both the cranium and the shoulder girdle, and positional changes of either will result in postural changes of the mandible.

Rocabado et al[25] reported a correlation between Class II malocclusion and forward head posture of 70%, providing strong evidence for a close interrelationship of head posture and malocclusion. In their study a typical adult patient with TMD presents with a deep overbite or Class II malocclusion and forward head posture. Such patients may develop facial pain, abnormal TMJ mechanics, and compression of upper cervical facet joints, which result in suboccipital headache or headache referred to the craniofacial region from cervical muscles. Abnormal head posture may also predispose to fatigue of cervical muscles and compression of facet joints of the cervical spine, and this may cause neck pain and referred pain into the arm and the intercapsular area. The forward head posture favors abduction and protraction of the scapula, which over long periods may create shoulder girdle symptoms and encourage further changes in spinal curvature. Thus, TMD may be associated not only with the relationship between the mandible and the cranium, but also the cervical spine, suprahyoid and infrahyoid structures, the shoulder girdle, the thoracic spine, and ultimately the lumbosacral spine. These structures function as an interrelated biomechanical unit. Dysfunction in any part of the unit may lead to dysfunction of the unit as a whole. For example, internal derangement within the TMJs may lead to inflammation of joint tissues and reflex changes in jaw musculature, ultimately causing pain, muscle fatigue or spasm, and postural changes within the upper spine.[26]

Table 1 Craniocervical Dysfunction Index

Criteria	Score
A Impaired range of movement/mobility index	
Normal range of movement	0
Slightly impaired movement	1
Severely impaired movement	5
B Impaired cervical joint function	
Smooth movement without cervical joint sounds or pain on movement	0
Cervical joint sounds—clicking, popping or grating noises with head movement	1
Locking—head or neck becoming momentarily fixed	5
C Muscle pain	
No tenderness to palpation in the cervical muscles	0
Tenderness to palpation in 1 to 3 palpation sites	1
Tenderness to palpation in 4 or more palpation sites	5
D Pain on cervical movement	
No pain on movement	0
Pain during one movement	1
Pain on 2 or more movements	5
E Craniocervical posture	
> 6 ± 0.5 cm	0
4-5 ± 0.5 cm	1
< 3.0 cm	5
F Dysfunction score	
(0-25 points) = A + B + C + D + E	
No dysfunction	0 (Index 0)
Mild dysfunction	1-4 (Index 1)
Moderate dysfunction	5–9 (Index 2)
Severe dysfunction	10–13 (Index 3)
Severe dysfunction	15–17 (Index 4)
Severe dysfunction	20–25 (Index 5)

Background of the Dysfunction Index

Helkimo[27-32] studied symptoms of dysfunction of the masticatory system in two Lapp populations in northern Finland and found anamnestically and clinically that the prevalence of masticatory dysfunction symptoms was high: 43% had symptoms associated with jaw movements, 35% reported TMJ sounds, 29% reported fatigue or jaw stiffness, and 15% had face or jaw pain. Approximately half could state the time of onset and whether it was sudden or insidious. Parafunction was reported by 42%, and 21% reported headaches that occurred at least twice a week.

Clinical examination indicated TMJ tenderness in 45% and jaw muscle tenderness in 66%. Deviations and irregularities of jaw movement were found in 63%, and 48% had palpable TMJ sounds. One in three individuals reported pain in the TMJ region on maximum jaw movement. With few exceptions, the recorded symptoms of dysfunction were equally common among men and women and varied slightly with age (Helkimo[28]).

These findings allowed Helkimo to develop the Clinical Dysfunction Index, an Anamnestic Index, and an Occlusal Dysfunction Index.

The Clinical Dysfunction Index was based on five symptoms: impaired range of jaw movement, impaired TMJ function, pain on jaw movement, muscle pain, and TMJ pain. Each symptom was graded by using a three-grade severity scale 0, 1, or 5 for none, mild, and severe, respectively.[33] The scores for the five symptoms were added and the dysfunction score varied from 0 to 25 points. The higher the score was, the more severe was the disorder.

The Anamnestic Index[34,35] was based on the patient's report of dysfunction symptoms and was similarly assessed on a three-grade scale. The Occlusal Index was based on number of teeth, number of occluding teeth, presence of occlusal interferences, and articulation interferences. It also was assessed on a three-grade scale. Helkimo[31-33] did not include cervical muscles and joints, although he reported that more than one third of the Lapps examined had neck and shoulder pain and discomfort.

Craniocervical Dysfunction Index

As part of a detailed investigation of craniocervical dysfunction, an index was developed based on the Helkimo Dysfunction Index. The index was prepared from a craniocervical questionnaire that was developed to assess:

1. Pain in the cervical region
2. Cervical muscle tension
3. Clicking, grating, or popping noises on moving the head
4. Pain on turning or bending the head or neck
5. Sleep disturbed by pain in the head or neck
6. Daily activities disturbed by pain in the head or neck region
7. A comprehensive craniocervical examination

The Craniocervical Dysfunction Index (Table 1) graded the severity of the functional disorder numerically, providing a standardized means of assessment. Pain was assessed in relation to specific neck movements, cervical joint sounds, cervical muscle tenderness, craniocervical posture, and range of cervical mobility. Each clinical symptom was evaluated and given a score of 0 (no dysfunction), 1 (mild dysfunction), or 5 (severe dysfunction).

The index for neck mobility (Table 2) was based on measurements of five parameters: flexion, extension, rotation, and lateral flexion to the right and left. Each movement was given a score of 0 (normal range of head movement), 1 (mild restriction), or 5 (severe restriction). The scores for these five parameters were combined, and the total score (F) was graded to give a final value of 0, 1, or 5. The Mobility Index indicated the range of movement and graded severity as follows: 0 = normal range of head movement, index value 0; 1 to 4 = reduced range of head movement, index value 1; 5 to 25 = severely impaired range of head movement, index value 5. The index values (0, 1, or 5) were then included in the Craniocervical Dysfunction Index.

Table 2 Cervical Mobility Index

Movement	Degrees of mobility	Score
A Flexion	>45	0
	10–44	1
	<9	5
B Extension	>55	0
	13–54	1
	<12	5
C Rotation	>70	0
	16–69	1
	<15	5
D Lateral flexion to the right	>40	0
	10–39	1
	<9	5
E Lateral flexion to the left	>40	0
	10–39	1
	<9	5
Sum A + B + C + D + E		

Index for range of movements based on numerical score:
0 = Index value 0 (optimum cervical movement).
1–4 = Index value 1 (reduced cervical movement).
5–25 = Index value 5 (severely impaired cervical movement).

The Craniocervical Dysfunction Index (Table 1) was based on the Cervical Mobility Index and four clinical signs:

A. Cervical Mobility Index: the values 0, 1, and 5 were obtained as previously described.
B. Cervical joint function was assessed by scoring 0, 1, or 5 depending on the quality of neck movements: 0 = no joint sounds; 1 = joint sounds present; 5 = locking present.
C. Muscle pain was assessed as 0, 1, or 5, depending on the number of sites that were tender to palpation.
D. Pain on cervical movement was assessed as 0, 1, or 5, depending on the number of cervical movements that were painful.
E. Craniocervical posture was assessed as 0, 1, or 5 as described by Rocabado[25] and related to the horizontal measurement of the concavity of the neck to a vertical line from the thoracic spine to the occipital curve of the head.

The dysfunction score was based on the sum of these individual assessments (ie, A + B + C + D + E):

1. A total score of 0 indicated no dysfunction; index value 0.

2. A score of 1 to 4 indicated mild dysfunction; index value 1.
3. A score of 5 to 9 indicated moderate dysfunction; index value 2.
4. Scores of 10 to 13, 15 to 17, and 20 to 25 indicated severe dysfunction; index values 3, 4, and 5, respectively.

In this way, a comprehensive assessment of craniocervical dysfunction may be made in relation to these five clinical signs. The dysfunction index enabled clinical evaluation to be made independent of the patient's opinion of the severity of their symptoms or need for treatment.

To accurately grade the severity of symptoms, the Anamnestic Index was designed on the basis of each patient's report of their cervical dysfunction symptoms. Special attention was given to clicking, grating, pain and difficulty with head movement, the presence of cervical pain, and systemic disease capable of interfering with cervical function. This index related directly to the cervical region and did not include headache pain in the orofacial area. This index was graded 0, 1, or 2. Patients with severe symptoms of cervical dysfunction were rated A2. These individuals reported one or more of the following symptoms: difficulties in moving the neck, locking of the neck, pain on movement of the neck, pain in the cervical muscles, daily activities disturbed by pain in the head or neck, and sleep disturbed by pain in the head or neck. Patients with mild symptoms of dysfunction were rated A1. They reported one or more of the following: cervical joints sounds, neck tenderness on waking or with movement, and muscle tightness or symptoms given under A2. Patients classified as A0 were free of symptoms of cervical dysfunctional, ie, did not report any of the symptoms listed in A1 and A2.

A scoring method of 0, 1, 5 similar to that of Helkimo[30] was used. An index of 5 indicated either a single severe symptom or five mild symptoms. However, it was considered unlikely for a patient to present with a single isolated severe symptom. An alternative scoring method with 10 as the maximum was considered, but it was decided that a maximum value of 5 would allow differentiation of signs and symptoms.

As with the Helkimo Index[30] the numbers should not be interpreted in a linear mathematical sense, ie, an index of 5 is not five times more severe than is an index of 1. A score of 5 represents severe impairment of a range of clinical criteria. It was also important to ensure that the sum of the scores for moderate impairment in four movements did not exceed the score of severe impairment in a single movement.

Conclusion

The Craniocervical Dysfunction Index was developed to enable objective assessment of patients with craniocervical disharmony. It has provided a numerical means for assessing the degree of dysfunction and to allow differential diagnosis. It also suggests management priorities and allows monitoring of treatment progress. In addition, it provides an objective means for long-term reassessment of these problems.

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Resumen

El manejo de los desórdenes craneomandibulares: I[a] parte. Indice de discunción craneocervical

Se desarrolló un índice de disfunción craneocervical (basados en el indice de Disfunción de Helkimo), para determinar comprensivamente la disfunción craneocervical; y para revisar objetivamente el manejo de pacientes que se presenten con estos problemas clínicos. Se revisa la estrecha correlación funcional entre las articulaciones temporomandibulares, los músculos de la mandíbula, y las articulaciones y músculos cervicales; y se propone un mecanismo para explicar las relaciones disfuncionales entre estas estructuras. Este es el primero de los tres artículos que se obtuvieron de un estudio clínico que investigó los desórdenes craneomandibulares y que determinó el efecto del manejo dental rutinario sobre la disfunción craneomandibular y craneocervical.

Zusammenfassung

Behandlung der kraniomandibularen Störungen: 1. Teil: Ein Kraniozervikaler Dysfunktionsindex

Ein Kraniozervikaler Dysfunktionsindex (auf den Helkimo Dysfunktions Index begründet) wurde entwickelt, um kraniozervikale Dysfunktionen umfassend abschätzen zu können und um die Behandlung von Patienten, die solche klinische Probleme aufweisen, objektiv überwachen zu können. Die enge, funktionelle Wechselbeziehung zwischen temporomandibularen Gelenken, Kiefermuskeln, und zervikalen Gelenken und Muskeln wird hier uberprüft, und ein Mechanismus wird vorgeschlagen, um die dysfunktionalen Beziehungen zwischen diesen Strukturen zu erläutern. Dieser Text ist der erste von drei Artikeln, die von einer klinischen Untersuchung abgeleitet sind, welche die kraniomandibularen Störungen erforscht und den Einfluss von routinemässigen Zahnbehandlungen in kraniomandobularen und kraniozervikalen Dysfunktionen beurteilt haben.