Relationship between mandibular deviation and ocular convergence

A. Monaco* / O. Streni** / M.C. Marci*** / L. Sabetti**** / G. Marzo***** / M. Giannoni******

Recent studies have confirmed the relationship between head posture, mandibular position and visual focusing. A case-controlled study was conducted to assess the occurrence of ocular convergence defects between subjects with functional mandibular latero-deviation and healthy subjects in pediatric age. Sixty subjects (the study group) presented mandibular latero-deviation classified as functional according to the use of a clinical examination and frontal and basal tele-radiography. Sixty subjects without functional mandibular laterodeviation (control group) were selected randomly from all subjects seeking pediatric dental care and matched by gender and age to study group. All one hundred and twenty subjects were submitted to orthoptic tests performed by the same operator. These results seemed to confirm that in mandibular latero-deviation subjects ocular convergence defects occurred in greater frequency than in controls underlining the importance of role of pediatric dentistry among interdisciplinary cooperation.

J Clin Pediatr Dent 28(2): 135-138, 2004

INTRODUCTION

The occlusion had to be considered in the general context of the global physiological balance of the individual, it is the visible and tangible expression of the muscular, articular, neurological and psychological behaviour of the patient[1].

Thus dysfunction of one component of this complex system frequently affects other components of the craniomandibular system as well as adjacent systems.[2,3] Recent works assessed the influence of dental occlusion on the masticatory muscle system,[4,5] on the head posture[6,7] and on human body functions.[8-10]

Recently some Authors showed the relationship between visual focusing and dental occlusion, others between visual eye dominance and mandibular deviation associated with head posture.[11,12]

* A. Monaco, DDS, Department of Odontostomatological Clinic, School of Dentistry, University of L'Aquila, Italy.
** O. Streni, DDS, Department of Odontostomatological Clinic, School of Dentistry, University of L'Aquila, Italy.
*** M.C. Marci, MD, DDS, Department of Odontostomatological Clinic, School of Dentistry, University of L'Aquila, Italy.
**** L. Sabetti, MD, Department of Eye Clinic.
***** G. Marzo, DDS, Department of Periodontology, School of Dentistry, University of L'Aquila, Italy.
****** M. Giannoni, MD, DDS, Department of Odontostomatological Clinic, School of Dentistry, University of L'Aquila, Italy.

Send all correspondence to Dr. Monaco Annalisa, Prosthetic Department, University of L'Aquila-67100 Italy.

E-mail: annalisamonaco@yahoo.it

The ocular receptor and the stomatognatic one, particularly, are connected in an anatomic and physiologic way. Vision plays a major role in the multisensory process of postural stabilization and ophthalmologic causes can be related to abnormal head posture.[13]

The eye position in the orbit was controlled by ocular nuclei. They receive afferences from vestibular nuclei and send fibres to nuclei which control neck and head movements. The ocular proprioceptive afferences have the same sub cortical stations in which vestibular stimuli arrive. These centres correspond to the main site of tonic-postural regulation: cerebellum,[14-16] midbrain reticular formation, superior colliculus,[17-19] oculomotor nuclei,[20] vestibular nuclei.[21]

Ocular proprioceptive receptores[22-24] moreover, send afferences to trigeminal and cuneate nuclei,[25] in the same sites arrive stomatognatic proprioceptions and deep and superficial neck muscle proprioceptions.[26,27] Some important encephalic nuclei (oculomotor nuclei, vestibular nuclei, trigeminal nuclei, accessorial nerve nucleus), are connected to each other through the medial longitudinal fasciculus. This is an association fasciculus that should give an anatomic support to the ocular-cephalic-gyro reflexes and to collic-vestibular-visual interactions.

Other studies showed the relation between mandibular posture and visual focusing modification.[28,29] Head and neck postures also depend on muscle tonic state and they are connected to extraocular muscles. Many authors believed in the irrefutable role of the head and neck posture in the mandibular position.[12,30-35]

The head posture appears to have the most significant and immediate effect on mandibular postural rest position.[36] Thompson[37] and Brodie[31] stated that the pattern of the head of the individual is laid down before the third month of post-natal life and the mandible assumed its pre-ordained relation with the rest of face and head, long before any teeth have erupted.

The purpose of this study was to attempt to objectively show, the link between mandibular deviation and the general muscle structure, particularly the muscles responsible for ocular motility.

MATERIALS AND METHODS

Four hundred and seventy-six patients referred consecutively for pediatric dental care (interceptive orthodontic and/or dental routine care) at the Paediatric Centre of University of L'Aquila, over period of four years were assessed. One hundred and seventy presented clinical characteristics of mandibular deviation. Among them sixty (the study group) presented functional mandibular deviation diagnosed according to the use of a clinical examination, with frontal and basal tele-radiographs. These sixty children (36 males and 24 females) aged from 4 to 11 years (mean age 7 years) had no cross-bite and had mandibular functional deviation.

Ethnic group of these subjects could be identified as Italian and the social economic state were the same. In fact by the demographic information of the subjects of the study the middle monthly family income in EURO were 1000.00 to 2000.00.

Subjects with functional mandibular deviation were chosen according to the following features: at **clinical examination** deviated chin from mid-sagittal plane (recognized by perpendicular line to horizontal bipupillary and bicommissural lines); at **intraoral examination** the lack of alignment of upper and lower labial frena, interincisive lines and molars/canine classes asymmetries; at **functional examination** the presence of deviation of incisor midline in maximal intercuspation, in centric relation and in rest position, deviation during mandibular opening and noise and tenderness referred to TMJ.

At-frontal tele-radiograph taken with the mouth open, the mandibular deviation at rest is confirmed as the symmetry of maxillary and mandibular structures; -at basal tele-radiograph it was confirmed the maxillary and mandibular incisor midlines deviation; it also studied mandibular and maxillary symmetry relative to the cranial base.

The sixty children, chosen for the control group, were selected through the pair matching procedures among subjects attending pediatric dental care and without mandibular deviation, so that each child of study group had a matching gender and age case control.

Subjects of both study and control groups were submitted to ophtalmologist for evaluation by the same operator, who tested ocular convergence with two convergences tests. The first one evaluated the distances (centimetres) of the convergence near point. This test uses a luminous stick,[38] which is slowly approximated, on both eye's plane, until the base of the nose. In normal subjects the convergence of both eyes could be harmonious, symmetric and simultaneous until this point. A convergence between 3-4 cm has been considered as normal, between 5-7 cm as sufficient and (7 as insufficient. The second test assessed the fusional convergence by Berens' prisms. For this test a punctual light source produced with a calibrated torch lamp and Berens' prismatic bars is used. The Berens' prismatic bars appeared as a series of prisms of growing strength joined side by side. The incident ray, issued from the object, is deviated towards the base of the prism, so that the image of the object is exteriorized towards the top of the prism. The diagnostic examination consisted of measuring the angle of deviation and then finding the angle formed by the two visual axes or the objective angle.[39]

The ocular convergence was estimated if greater than 25 diottries as normal, if between 18-25 as sufficient and if below 18 diottries as insufficient.

The data have been computerized and SPSS/PC packages have been used for statistical analysis. The chi-square test has been used to check the correlation between mandibular deviation and convergence defects. A <0.05 significance level was assumed for each comparison.

RESULTS

Among sixty children with positional mandibular deviation thirty-eight subjects (63.0 %) showed a compromised convergence.

They were tested by two examinations. The convergence test (Table 1) showed 14 patients (23.0%) grouped in the category "5-7 cm" grade and 24 (40.0%) in ">7 cm" grade. The Berens prismatic test (Table 2) showed 10 subjects (16.4%) graded in the category "<18 diottries" grade and 28 (46.6%) in the "18-25 diottries" grade.

In the sixty subjects of control-group the same tests gave a different percentages; only eleven subjects in fact (18.0%) showed a compromised convergence: 3 (8.0%) grouped in the category "5-7 cm" grade and 8 (10.0%) in the ">7cm" grade.

These results appeared very interesting and a highly significant association ($p<0.0001$) was found between mandibular deviation and visual focusing compromise measured by the tests.

DISCUSSION

In our experimental study, among sixty patients showing positional mandibular deviation, thirty-eight (63.0%) of them showed ocular convergence defects (OCD) and only twenty-two (27.0%) had a normal ocular convergence .

Table 1. Number (percentage) of subjects with convergence defects in the two groups.

	Study group subjects (with subjects positional deviation)	Control group	P<
	N° =60 N(%)	N°=60 N(%)	
Convergence's defects cases (Test della convergenza)	38(63.0)	10(20.8)	0.0001
5-7cm	14(23.0)		
>7cm	24(40.0)		

Table 2. Number (percentage) of patients with convergence defects in the two groups.

	Study group subjects (with positional deviation)	Patients of control group	P<
	N°=60 N°=60	N°(%) N°(%)	
Convergence's defects cases (Berens prism test)	38(63.0)	11(18.0)	0.0001
<18 diottrie	10(16.4)	3(8.0)	
18-25 diottrie	28(46.6)	8(10.0)	

In order to explain why patients have either convergence defects or positional deviation with compromise of head and shoulder posture, we have to consider ocular-vestibular reflexes and proprioceptors of the muscles of the neck.

Proprioception messages coming from the muscles of the neck are integrated in the central nervous system and they contribute to control the balance and body orientation in the space-time surrounding it.[39]

All these inputs come from a high number of muscular spindles, which have a main role in the neck proprioception, related to articular cervical receptors.[40]

The relation between the vestibular system and the proprioceptive cervical systems which help to control postural and eye movements, is well known.[41]

Several anatomic studies [42] confirm how the afferent proprioception from the neck controls the posture, the head position and the ocular movements. In fact we have seen that centripetal impulses from the muscles of the neck proprioceptors cooperate with the labyrinthal impulses to promote the oculomotor muscular activity through the cervical-vestibular-ocular reflex.[43] The latter consists of generating ocular reflexes movements provoked through the cervical proprioceptors stimulation.

Furthermore, neck and extraocular muscles proprioceptions related to the cuneate nucleus, determine the gaze direction. The latter controls the balance of the tonic postural system.

Our research shows a high percentage of convergence alteration among patients with positional mandibular deviation. These studies show how the eyes influence on the head, neck and shoulders posture (vestibular-ocular interactions) can be associated with the occlusion modification. This suggests a neuro-muscular approach to analyse those subjects.

CONCLUSION

The results of this study seem to show that patients with functional mandibular deviation suffer ocular convergence defects more than normal individuals.

REFERENCES

1 Bricot B. La riprogrammazione posturale globale. 1st ed. Montpellier: Sauramps Medical, 1996.
2. Bell WE. Clinical management of temporomandibular disorders. Year Book Medical Publishers, Inc. Chicago 1983.
3. Little EH. Basic neuroscience for the health professions. Slack Inc. New Jersey, 1990.
4. Clark GT, et al. Co-activation of sternocleidomastoid muscles during maximum clenching. J Dent Res 72: 1499-1502, 1993.
5. Kiliaridis S. et al. Effect of masticatory muscle fatigue on cranio-vertical head posture and rest position of the mandible. Eur J Oral Sci 103: 127-132, 1995.
6. Lee W. et al. The relationship between forward head posture and temporo-mandibular disorders. J Orofac Pain 9: 161-167, 1995.
7. Sandikcioglu M. et al. Atlas morphology in relation to cranio-facial and head posture. Eur J Orthod 16: 96-103, 1994.
8. Aloi A. Effects of mandibular appliances on athletic performance. Cranio Clin Int 1: 99-105, 1991.
9. Bakker M. Mandibular elevator muscles: physiology, action and effect of dental occlusion. Scand J Dent Res 101: 314-331, 1993.
10. Tripodakis A. et al. Clinical study of location and reproducibility of three mandibular positions in relation to body posture and muscle function. J Prosthet Dent 73: 190-198, 1995.
11. Pradham NS et al. Mandibular deviations in TMD and non-TMD groups related to eye dominance and head posture. J Clin Pediatr Dent 25(2):147-155, 2000.
12. Lin SY, White GE. Mandibular position and head posture as a function of eye dominance. J Clin Pediatr Dent 20: 133-140, 1996.
13. Barber HO, Sharpe JA. Vestibular disorder. Year Book Medical Publishers Inc, Chicago, 1988.
14. Fuchs AF, Kornhuber HH. Extraocular muscle afferents to the cerebellum of the cat. J Physiol 200:713-22, 1969.
15. Baker R, Precht W, et al. Mossy and climbing fiber projections of extraocular muscle afferents to the cerebellum. Brain Res 38: 440-445, 1972.
16. Schwarz DWF, Tomlinson RD. Neuronal responses to eye muscle stretch in cerebellar lobule IV of the cat. Exp Brain Res 27: 101-111, 1977.
17. Abrahams VC, Rose PK. Projections of extraocular, neck muscle, and retinal afferents to superior colliculus in the cat: their connection to cells of origin of tectospinal tract. J Neurophysiol 38: 10-8, 1975.
18. Rose PV, Abrahams VC. The effect of passive eye movement on unit discharge in the superior colliculus of the cat. Brain Res 97: 95-106, 1975.
19. Donaldson IML, Long AC. Interactions between extraocular proprioceptive and visual signals in the superior colliculus of the cat. J Physiol 298: 85-110, 1980.

20. Donaldson IM, Knox PC. Afferent signals from pigeon extraocular muscles modify the vestibular responses of units in the abducens nucleus. Proc R Soc Lond B Biol Sci 244: 233-9, 1991.
21. Buisseret-Delmas C, Epelbaum M, et al. The vestibular nuclei of the cat receive a primary afferent projection from receptors in extraocular muscles. Exp Brain Res 81: 654-658, 1990.
22. Rose PK, MacDonald J, Abrahams VC. Projections of the tecto-spinal tract to the upper cervical spinal cord of the cat: a study with the anterograde tracer PHA-L. J Comp Neurol 314: 91-105, 1991.
23. Lukas JR, Aigner M. et al. Number and distribution of neuro-muscular spindles in human extraocular muscles. Invest Ophthalmol Vis Sci 35: 4317-27, 1994.
24. Rose PV, Abrahams VC. The effect of passive eye movement on unit discharge in the superior colliculus of the cat. Brain Res 97: 95-106, 1975.
25. Porter JD. Brainstem terminations of extraocular muscle primary afferent neurons in the monkey. J Comp Neurol 247: 133-43, 1986.
26. Abrahams VC, Richmond FJ. et al. Projections from C2 and C3 nerves supplying muscles and skin of the cat neck: A study using transgamaglionic transport of horseradish peroxidase. J Comp Neurol 230: 142-154, 1984.
27. Nyberg G, Blomquist A. The control projection of muscle afferent fibres to the lower medulla and upper spinal cord: An anatomical study in the cat with the transganglionic transport method. J Comp Neurol 230: 99-109, 1984.
28. Meyer J, Baron JB. Participation of trigeminal afferences in tonic postural regulation. Static and dynamic aspects. Aggressiologie 17A: 33-40, 1976.
29. Sharifi Milani R, et al. Relationship between dental occlusion and visual focusing. Cranio 16: 109-118, 1998.
30. Pradham NS. The effect of eye dominance on head posture and mandibular position. Master Thesis, Tufts University, 1994.
31. Brodie AG. Anatomy and physiology of head and neck muscle. Am J Ortho 36: 831, 1950.
32. Darling DW, Kraus S, Glasheen-Wary MB. Relationship of head posture and rest position of the mandible. J Prosth Dent 52: 111, 1984.
33. Funakoshi M. Effects of the tonic neck reflex on the jaw muscles of the rat. J Dent Res 52: 668, 1973.
34. Rieder C. The incidence of some occlusal habits and headaches and neckaches in an initial survey population. J Prosth Dent 35: 445-451, 1976.
35. Wyke B. Neurology of the cervical spine joints. Phisiotherapy 65: 72, 1979.
36. Mohl ND. Head posture and its role in occlusion. NY State Dent J 42: 17-23, 1976.
37. Thompson JR. Concepts regarding function of the stomatognathic system. J Am Dent Assoc 48: 626-637, 1954.
38. Deodato F, et al.Caso clinico di correlazione tra deglutizione atipica e convergenza oculare. Approccio diagnostico e terapeutico.Ortodontia Italiana. 10: 295-300, 2001.
39. Kavououdias et al. From balance regulation to body orientation: two goals for muscle proprioceptive information processing? Exp Brain Res 1124: 80-88, 1999.
40. Kogler A, et al. Postural stability using different neck positions in normal subjects and patients with neck trauma. Acta Otolaryngol 120: 151-155, 2000.
41 Yagi T, Hatano G, Morizono T. Role of dorsal neck proprioceptive inputs to vestibular compensation in humans. Nippon Ika Zasshi 65: 291-297, 1998.
42. Neuhuber WL, Zenker W. Central distribution of cervical primary arrerents in the rat, with emphasis on proprioceptive projections to vestibular, perihypoglossal and upper thoracic spinal nuclei. J Comp Neurol 280: 231-253, 1989.
43. Shinsuke et al. Effects of tonic neck reflex on optokinetic nystagmus in rabbits. Acta Otolaryngol (Stockh) 115: 134-136, 1995.