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Research Article

Effects of Swimming on Stomatognathic System

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Abstract

The work purpose to evaluate how the swimming could affect the skeletrical e dental structure of athlete due to the link of form and function. The athletes evacuate were 204, referred to nine Italian societies and 12 swimming pools. The athletes trained on average 7,7 + 3,5 times every week. A complete pathological analysis and one of hard and soft tissues of oral cavity followed by an intraoral examination. In the clinical analysis were evaluated: the occlusal state; the global conditions of the teeth; the presence or absence of dental erosions, discolorations and abrasions; the functionality of the tongue; the presence of disfunctions e problems of the Temporomandibular Joint (TMJ). The frontal breathing it's associated to the specialists of frog swimming style, while the mono or bilateral breathing is noticed into the specialists of freestyle swimming (into the swimmers of dolphin style the 78% has frontal breathing and the 22% bilateral). The 69,6% of the swimmers keeps a low postural position of the tongue, that increases of percentage in athletes more evolved. A major symmetry is present in the symmetrical style (frog and dolphin style). A major asymmetry is present in monolateral breather. The swimming and the presence of malocclusion are directly related, especially in frequency and intensity with the passage of competition category. Breathing and style of swimming have an impact on mandibular shift and rotations.

ABBREVIATIONS

TMJ: Temporomandibular Joint

INTRODUCTION

In the literature, the correlation existing between form and function was studied and recognized from many authors during the years [1-3]. In fact, the position of the teeth is influenced by the pression exercised by the surrounding tissues in equilibrium between intra and extra oral muscles: tongue, lips and cheeks [4,5]. That pression carried on by these tissues, reversed on teeth, changes due to the position of the head, and is affected by the posture that, for this reason, it is necessary to be taken into account in the studying facial morphology and into the analyzing dental balances [6]. Ferguson et al. demonstrated that a protruded posture of the mandible and of the tongue increase the Cross Sectional Area (CSA) of upper airways changing and altering the shape of these [7]. These balances could vary, in particular during the growth of the child but even in the adults, causing the shift more or less evident of the teeth and of the structure related to them, because of the action of activities or habits that act on structures for a long time, and in this case six hours recognized as threshold for the human [5]. None experimental prove neither clinical suggests that mandibular growth could be altered by occlusal pre-contacts (although it should be remembered that the dental eruption, and then the final position of the teeth could instead be) [8]. Considering that the respiratory needs influence the spatial position of bony bases and of the tongue, an altered pattern of breathing it is able to lead a change in the position of bony bases and tongue's. This wrong model of respiration will alter the balances of pressions exercised on teeth and bones, influencing the position and the growth of bony bases [3]. Some studies carried on mouses demonstrated that a forced oral breathing caused by a total obstruction of nasal airways lead to a modification and remodeling of the skull base and craniofacial structures [9]. The sport activity in general and the swimming in particular drive to a better and complete development in the three dimensions of the skeleton and of facial massive [10]. The stomatognathic system is influenced, in its structure, both from the posture and that to the breathing. In the swimming it's reported and confirmed an alteration of body posture, because of the Archimedes principle that reduces the perception of the weight in the water, associated to the abandon of upright posture in favor of an attitude of the body that is constantly in changing to permit the correct execution of the various swimming style (breaststroke, frog, backstroke, butterfly stroke). In the swimming the body is an a varied position lying horizontal [11], with different lays in a liquid substance (water), that gives different stimulations and references rather than the habitual posture out of water. During the swim, furthermore, the nasal breathing is left in favour of an oronasal respiration, in which deep inspiratory acts are followed by respiratory acts controlled mainly by lips and that involve less or more important mandibulary movements, with a variation of supra and infrahyoid muscles and of cervicobrachial muscles [12]. These variations that can be seen as alterations of the position of teeth and bone bases, without considering that these alterations may develop even in subjects that, independently by the agonistic act, had a correct maxillary bone baseline (1st class dental and / or skeletal) or a dental malocclusion and / or skeletal (2nd or 3rd class) or with a dysfunction borne by the temporomandibular joint of intra or extra capsular type.

The purpose of this study was to perform an assessment of epidemiological incidence and of the type of malocclusion in swimmers and the variability of this according to the swim specialty predominantly practiced and, finally, of a broader assessment about the possible changes made by swimming activity in competitive "evolved" athletes.

MATERIALS AND METHODS

204 athletes were visited (111 Female and 93 Male), with a mean age of 15,3 years (range: 12-27 years old), whose characteristics are described in Table 1, all referred to Italian sport societies (nine different societies and 12 swimming pools) that train in mean 7,7±3,5 times/week (plus 2-3 training gym sessions every week). The subjects choosen for this study took part voluntarily e with a previous release of written authorization by the sport society, by the athletes themselves or by parents for the under 18 years old. At the same time they signed the Consent to Treatment of Personal Data (Privacy Law DL 196/2003). In this study, the approval from the Ethical Committee it's not reported because that's not required for works that are based on research protocol on medical devices already used in the clinical protocols approved from the Department for the medical use. A dental visit was performed with the use of sterile mirror and stylet. The data obtained during visits to the athletes were later collected in the appropriate medical records. The personal data and completed a history of pathologic complete and also a history of hard and soft tissues of the oral cavity were also collected. Immediately after, an intraoral examination of mucous membranes and hard tissue was done then evaluating the occlusion (over jet, overbite, dental Angle's class, crowding, midline, presence/absence of precontacts); the state of the teeth; the presence of erosions, discoloration and abrasion; the functionality of the tongue; the presence of dysfunctions and problems of the temporomandibular joint. Extra and intraoral photos of the swimmers followed by dental impressions to create the gypsum study models completed the visit.

RESULTS AND DISCUSSION

The 204 competitive athletes (93 males and 111 females) were visited directly during the sport activity in the swimming pools. They were swimmers-athletes of nine sport societies present on twelve different swimming pools, located in different Italian cities (Table 1).

In the evaluation of the type of prevalent respiration pattern was observed that the frontal respiration is associated to frog stroke specialist, while the mono or bilateral breathing is present in the swimmers that use a free style of swimming. About the specialist of dolphin stroke, the 78% of them presented a frontal respiration while the 22% a bilateral respiration (Data not shown).

The 69,6% of the visited athletes kept a low position of the tongue that remains even out of the swimming pool (Table 2). It increases on percentage in the athletes more evolved, where it goes up to 100%.

Present study suggest that a correlation between the habitual posture of tongue and the level of the swimmer is possible, in fact: from the athletes analyzed, with the increasing of the hours of training and of the years of training it is possible to find a low position of the tongue even out of the water (Figure 1).

By the examination of the "occlusal" data, the dental class according to Angle, both molar that canine, it is symmetrical in little more than 50% of the cases (Table 2); linking it with the specialties practiced there is a greater symmetry in symmetrical styles, such as the frog and dolphin. Putting it, instead, in correlation with the breathing there is greater asymmetry in who breathes unilaterally (Figure 2). 55% of athletes (Table 2) have a midline deviation. There is an increase in athletes superior

Table 1: Frequency and percentage of characteristics of studied sample.

Variables	N athletes	%
Category		
Cadetti	32	15,7
Junior	56	27,5
Ragazzi	100	49,0
Senior	16	7,8
Level		
International	12	5,8
National	55	27,0
Regional/Provincial	137	67,2
Days of training/week		
≤4 days	18	8,8
5-7days	175	85,8
≥8 days	11	5,4
Style		
Butterfly	30	14,6
Backstroke	28	13,7
Mix	16	7,8
Frog	35	17,1
Free Style	82	40,5
Not Specialized	13	6,3
Breathing		
Bilateral	44	21,6
Right	73	35,8
Frontal	58	28,4
Left	19	9,3
N/A	10	4,9
Ortodonthic treatment		
No	69	33,9
Yes	108	52,9
In progress	27	13,2

Table 2: Frequence and percentage of stomatognathic characteristics of studied sample [Type or copy/paste here a brief descriptive title of the table DO NOT use full-stop after table heading].

Variables	N Athletes	%
Tongue Position		
Low	142	69,6
Normal	62	30,4
Right Canine Class		
1	99	48,5
2	71	34,8
3	28	13,7
N/A	6	29,0
Left Canine Class		
1	98	48,1
2	75	36,8
3	25	12,2
N/A	6	29,0
Symmetry in Canine Class		
No	65	31,9
Yes	139	68,1
Right Molar Class		
1	98	48,0
2	74	36,3
3	30	14,7
N/A	2	10,0
Left Molar Class		
1	98	48,0
2	77	37,8
3	27	13,2
N/A	2	10,0
Symmetry of Molar Class		
No	88	43,1
Yes	116	56,9
Total Symmetry		
asymmetric	97	47,5
symmetric	107	52,5
OJ		
lower	30	14,7
increased	70	34,3
normal	98	48,0
N/A	6	29,0
OB		
lower	39	19,1
increased	74	36,3
normal	86	42,2
N/A	5	25,0
Median Line		
DX	64	31,4
SX	47	23,0
CENTERED	90	44,1
N/A	3	15,0
Facial Asymmetry		
No	70	34,3
Si	134	65,7
Crowding		
Not present	107	52,5
Diastema	18	88,0
Crowding	79	38,7

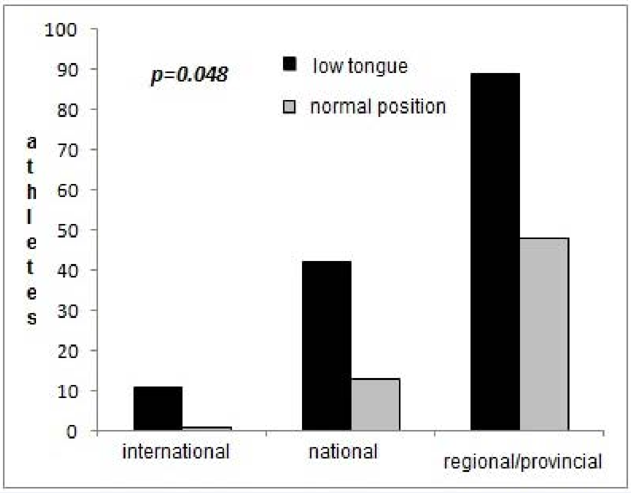

Figure 1 Association between level of the athlete and tongue position.

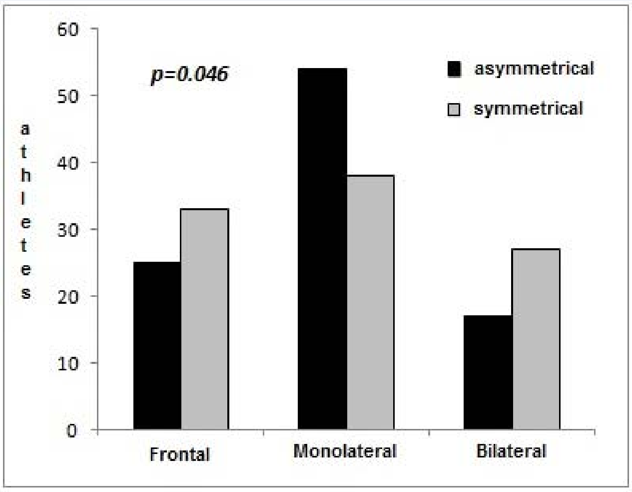

Figure 2 Association between type of breathing and dental symmetry.

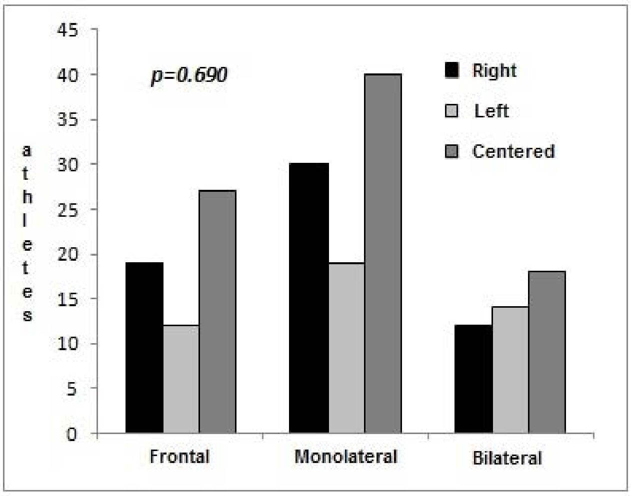

Figure 3 Relation between type of breathing and median line shift.

category compared to boys (who have recently started important session of training) (category 53% boys; 56% higher classes) (Data not shown).

Results

From these data collected it's possible to notice that the great part of butterfly's specialist is forced to use this type of breathing from their position in the water. At the same time the athletes performing other specialties don't allow us to create a link between their breathing in the water and the act done during the swimming. The analysis of breathing in breaststroke was impossible due to the reasons given in the previous sentences.

By correlating the midline deviation with breathing we not found a match between the deviation of the center line and side breathing, but there was an increase in the deviation in athletes who breathe unilaterally (Figure 3). Evaluating, however, the specialty of athletes with deviations of the median line 44% (43 athletes) of them is a specialist in Freestyle, Backstroke 15%, 20% specialists in frog, 16% in the butterfly, Mixed 9%, 16% have no specialization (category Boys) (Data not shown). With regard to the space in the dental arch, in 38.7% of cases there was a crowding (Table 2), which is associated to the specialty predominantly practiced.

The presence of significant facial asymmetries was in the 65.7% of the athletes. Perfect occlusion (1st class according to Angle, over jet and overbite normal, no crowding) was present in only four athletes, with 2 in orthodontic treatment. Symptoms and dysfunctions of temporomandibular joint were present very few athletes (17% of athletes) (Data not shown).

Therefore, there is a prevalence of mandibular rotation which leads to an asymmetry, in particular in those who breathes unilaterally. In advanced athletes, there were changes that tend to skeletal and dental asymmetry.

To obtain a correct development of the arches and the complex oromaxillo facial, it is fundamental the presence of the correct neuromuscular function, of proper breathing, a correct activity of the tongue, either during the function that in the resting phase [13,14]. It is observed that the asymmetries of class and the deviation of the midline are more common in athletes who have never undergone orthodontic treatment." It can hardly be expected something different. It has been scientifically noticed as swimming has positive influences on growth in young people by stimulating the production of hormones that promote the development and physical stature, skeletal and muscular [15]. Swimming is a sport in which are carried out rhythmic movements, which are repeated for a large number of times. This involves the recruitment of cyclic multiple motor units, carrying in addition to an increase in muscle mass, even an increase in bone density, affecting the mechanisms of apposition and bone resorption [16]. In this regard, even Yamada et al. have shown that swimming activity in rats promotes the formation of cartilage and bone remodeling [17]. From the data collected could be observed that all those involved in the study maintained a low position of the tongue throughout the day, even outside of the sport. A different position of the tongue can influence the onset of malocclusions, dental and skeletal, during the growth, in particular during the active phases of expansion of the jaw.

This view is supported by several studies such as by Archer [6], which showed us that the position of the tongue and the pressure exerted on hard and soft tissue were substantially different considering the natural head position and a displaced position twenty degrees in extension and bending. Professional athletes during training and competition tend to change the position of the head while maintaining a low tongue. This could be a causal factor of orthodontic problems during the development of young swimmers. And it is well known that the lingual posture is closely associated with breathing and adopted the posture of the head [18]. A low-lingual is evident in fact much more frequently in the mouth breathing, compared to the normal population [19]. The mandibular advancement and lowering lingual are functional when respiratory reflexes during the execution of the athletic action, allow a reduction of the time required to breathe preventing the ingestion of water. Even the extension of the head, typical in front breathing of dolphin specialist and breaststrokers, obtained by a contraction of the cervical muscles, favors the acquisition of a low posture of the tongue [20]. Although swimmers are not mouth breathing due to adenoid tonsil diseases or intranasal, oronasal breathing practiced during exercise, associated to the acquisition of a horizontal posture of the body in weightlessness and gravitational pull, with the simultaneous and repeated extension and rotation of the head. This could explain the high frequency of athletes that tend to maintain the low position of the tongue once they are found to be clear of the water, in an upright position with the gravitational attraction and with a nasal breathing with closed lips. The position of the mandible and tongue is influenced by the force of gravity [18] and in swimmers, while they are in the water, due to the buoyancy and Archimedes' principle, this is extremely reduced. The breathing pattern, linked to the position of the tongue, can affect the development of the cross-ratio (i.e. normal arch or lateral cross-bite) as shown by Melsen et al. [3]. According to these authors, the simple lingual push in the swallowing was associated with sagittal discrepancies, mesial and distal occlusion and an increased anterior over jet. The possibility of observing a malocclusion was higher in these individuals, rather than in those where the dental contact takes place during swallowing. This observation may also be referred to swimmers because they are forced to breathe through the mouth during their sports performance. On the analysis of the occlusion, skeletal and dental, there was an evident tendency to relapse in the initial malocclusion, in cases of athletes treated for dental malocclusion, also in association with a shift of the midline, the latter linked to breathing habits (unilateral or bilateral respiration).

Solow has shown that altering the posture craniocervical is largely associated with the presence of a specific malocclusion, given by an alteration of the growth pattern [21]: this is due to the fact that the muscular pressures vary with the position of the head [22]. In swimmer postural alteration is induced by the need to proceed in the medium in which he moves, namely water, which entails a significant reduction of the force of gravity and a greater friction. As regards to the skeletal appearance, the analysis showed a prevalence of facial asymmetry. All these modifications and variations were directly proportional to the age and the amount of training (time and frequency of training) [23-29]. Nevertheless, it was still considered the symmetry class and midline deviation between athletes who are undergoing ortognatodontic treatment and who have never been treated orthodontically. It is observed that the asymmetries of class and the deviation of the midline are more common in athletes who have never undergone orthodontic treatment. It can be concluded, therefore, that orthodontic treatment has definitely affected the analysis of the symmetry of occlusal class athletes, through a reduction in the amount of asymmetries that have been detected.

From this work it is possible to confirm as swimming may contribute to a proper three-dimensional development of the facial bones in harmony during the development phase. A work of Silvestrini-Biavati [10] demonstrates how the professional swimmer had a higher prevalence of Class I molar ratio and a low frequency of severe overcrowding, perhaps because of greater transverse dimension of the arches. Similarly, the dental arches are properly complied in the sagittal and vertical plane. Swimmers, when viewed at the right time have a growth pattern that tends to the first class of Angle.

CONCLUSION

This study confirms that a particular function, represented by swimming, can affect the shape of the stomatognathic system. It is also necessary to implement preventive measures, such as education and information for athletes of any competitive level. Despite the results, it must certainly give up the activity swim, the most effective and complete from the point of view of aerobic, morphological and skeletal, the benefits of which are evident regardless of age and health of each individual.

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