**Correlations between transversal discrepancies of the upper maxilla and oral breathing**


**Abstract.** The aim of the study was to evaluate the relationship between malocclusion with cross-bite and permeability of the upper airways, and to observe the cephalometric changes of the rhinopharyngeal space after rapid palatal expansion therapy. **Materials and methods.** The sample consisted of 17 patients (age 9-12) of which 10 were males, followed up for a period of 1 year at the Department of Paediatric Dentistry of the Dental Clinic of the University of Pisa. Clinical, radiographical and otolaryngological examinations were carried out before treatment with palatal expander. After expander activation, each patient underwent an otolaryngological and orthodontic evaluation followed by rhinomanometry, and, in the cooperating children, endoscopy was also performed. After 6 and 12 months from the beginning of the treatment, each patient was examined again and the radiographic examination was repeated. **Results and conclusion.** The cephalometric analysis exhibited an increase of the rhinopharyngeal space in 16 children. Furthermore all the 17 patients showed, after therapy, an increase of the transverse dimension of the upper jaw, measured on the postero-anterior teleradiography. On the other hand, the otolaryngological examination, and in particular rhinomanometry, exhibited an improvement of the flow and of right and left nasal resistance only in 3 children, while in 6 children the graph remained unchanged, and in 8 children it worsened. The results show that the rapid palatal expansion produces an improvement of the transversal skeletal discrepancy, and an improvement of the permeability of the upper airways. To make a correct diagnosis lateral and postero-anterior teleradiography, and a cephalometric analysis are needed; instead the otolaryngological examination in our opinion it is not an essential diagnostic examination for this kind of pathology.

**Key words:** Palatal expansion; Rhinomanometry; Oral breathing.

**Introduction**

Breathing is a vital function of our organism, through which we take in oxygen and dispose of the carbon dioxide that is formed by organic combustion. At birth, the mandible moves downwards, and the tongue downwards and onwards, to let the air pass through the nose, pharynx and reach the lungs. Breathing is an automatic action that can also be performed voluntarily and that involves three functions: ventilation, diffusion and perfusion. Ventilation enables oxygen to reach the alveoli and carbon dioxide to be pushed out. Pulmonary ventilation may occur two ways, depending on the needs of the organism: through the nose (preferred and constant when at rest) and through the mouth (during physical exertion that requires more oxygen intake). Through diffusion the oxygen passes from the lungs to the bloodstream, and through perfusion it is carried to the organs [Casella and Taglietti, 1996].

Physiological breathing at rest occurs through the nose, with effortlessly closed lips, the mandible in the resting position, the front area of the back of the tongue leaning against the palate. The lips touch each other or stay at most two or three millimetres apart (labial competence). The facial muscles should never be involved in the respiratory function. The oral cavity instead is designed to accommodate other functions, such as phonation, mastication and deglutition; only in abnormal conditions does the mouth become an additional respiratory way [Caprioglio et al., 2000; Kluemper et al., 1995; Mc Namara, 1981].

Oral breathing is an abnormal condition in which the air passes solely through the oral cavity; there are some combined forms where breathing only partly occurs through the mouth, or in alternation with the nose [Lanteri and Caprioglio, 2002; Caprioglio et al., 1988; Caprioglio and Falconi, 1992].

There are many possible reasons for oral breathing and they can be divided into local and general ones.
Most local causes are morbid forms that result in several degrees of obstructions of the upper airways [Galiffa et al., 1992; Cozza et al., 1991]. Oral breathing significantly affects the development of the cranio-maxillo-facial complex of the child. Ricketts’s “Syndrome of respiratory obstruction” or “facies adenoidea” defines the group of facial features that are related to a major obstruction of the nasal ways for a given period of growth [Bresolin et al., 1984; Limme, 1993; Tourneluc, 1990].

Typical alterations can include the following.
- Poorly developed and retruded maxillae.
- Increased front facial height (especially the lower one).
- Increased gonial angle.
- Increased inter-maxillary angle.
- Increased craniomandibular angle.
- Increased occlusopatalatal angle.
- Ectomorphic or asthenic longlineal biotype.
- Poorly-developed ribcage, flattened or depressed thorax, depressed sternum, winged and forward-bent shoulder-blades and notes of rickets.
- Head posture prone to extension.
- Dark skin halo due to the venous stasis caused by the congestion of the nasal mucosae.
- Narrow nostrils.
- Incompetent lips.
- Short, hypotonic upper lip.
- Lowered mandible.
- Low posture of the tongue.
- Poor sagittal depth of the rhinopharynx due to retroposition of the maxilla.

The type of problem most often associated with the facies adenoidea is Angle Class II, Division I (but there are oral breathers in I and III Class). Therefore, the local clinical pictures are:

- increased vertical skeletal dimension (hyper-divergence of several skeletal planes);
- tendency to grow in mandibular post-rotation;
- increased facial length, especially in the median and lower third (assessment of soft tissues);
- skeletal tendency to retragnathia;
- decreased upper transversal diameters with labioversion of the front teeth;
- the position of the tongue at rest may change.

The clockwise postural rotation of the mandible results in an increased upper facial height (hyper-divergence). The change in the resting position also results in an increased inter-occlusal gap, which in turn accelerates the vertical posterior dentoalveolar growth (compensatory growth). Such changes in the cephalic, lingual and mandibular posture occur so as to increase the pharyngo-oral patency [Fields et al., 1991; Sfondrini et al., 1997; Solow, et al., 1984].

Skeletal problems associated with a respiratory condition can be summed up as follows.
- Vertical problems: hyper-divergence.
- Sagittal problems: class II and class III.
- Transversal problems: unilateral cross bite and bilateral cross bite.

Transversal problems present an inconsistency between the transversal diameters of the upper maxillary and the mandibular ones; this can be due to a reduction in the transverse diameter and to an increase in the mandibular transverse diameter, or both conditions together (Fig. 1-2):
- unilateral cross bite;
- bilateral cross bite.

A rapid palatal expansion (Fig. 3) is the only non-surgical maxillary expansion method that offers a veritable transversal gain of bone substance in the upper maxillary, and therefore a real extension of the skeletal base [Ekstrom et al., 1977; Germane et al., 1976].

It is commonly recognised that the orthopaedic expansion of the maxillary, through an increase in the transverse diameter of the nasal cavities, may positively improve the respiratory function, since a correct respiratory function is closely related to the resistance of the upper airways to the passage of the airflow.

**FIG. 1-2 - Images of monolateral cross-bite.**

**FIG. 3 - Image during palatal expansion.**
The aim of this study is to assess the relation existing between cross-bite malocclusions and the patency of the upper airways, and to observe any clinical-instrumental change in the respiratory parameters and any cephalometric change in the rhinopharyngeal air space, after application of the palatal expansor.

Materials and methods

After Ethical committee approval, 17 children (10 males) aged between 6 and 12, with unilateral or bilateral cross bite, who were oral or combined breathers were selected at the Department of Paediatric Dentistry of the Dental Clinic of the University of Pisa. We excluded from the study any allergic patient, patients with inflammations of the initial airways, or patients having major skeletal abnormalities.

Their parents were preliminarily informed and questioned about the treatment and purpose of the study, and they gave their consent.

The therapeutic protocol involved the following.
- A paedodontic preliminary examination, an orthodontic and otorhinolaryngological examination, Opt X-rays, latero-lateral teleradiographies of the skull and a posteroanterior radiography.
- Application of the palatal expansor.
- Orthodontic and oral check-up at the end of the active period of the expansor.
- Orthodontic and oral check-up at 12 months, including a tele- and posteroanterior radiography.

The otorhinolaryngological examination included a clinical and an instrumental examination. A flexible nasopharyngoscope was used for the semi-quantitative assessment of the residual postnarial space, so as to detect any hypertrophy of the lymphatic structures, any deviation of the osteo-cartilaginous structures or any phlogistic component. In addition, we performed an active anterior and posterior rhinomanometry, i.e. with the patient freely breathing, using a facial mask, to measure the nasal resistance to the passage of the air. The rhinomanometry provides accurate indications about the degree of patency of the nasal fossae [Dalton et al., 1991; Sorensen et al., 1980] by measuring the following parameters: right-side and left-side respiratory flow, sum of respiratory flows, right-side and left-side inspiratory and expiratory resistance, and total inspiratory and expiratory resistance. It is a method that records the airflow through the nostrils and, by correlating this measurement to the pressure gradient between the nostril and the rhinopharynx, can be used to quantify the nasal resistance to the passage of the air. For the cephalometric assessment of the rhinopharyngeal air space on the laterolateral teleradiographies, we used the Ricketts and Woodside, Linder-Aronson, Lundstrom methods (Fig. 4), with the following measurements: ADI-Snp, AD2-Snp, PtV-AD. The teleradiographies on a postero-anterior projection measured the transversal dimension of the upper maxillary (JL-JR) and of the mandible (AG-GA) and maxillomandibular width differential (Fig. 5).

Statistical analysis was performed by the School of Dental Medicine of University of L’Aquila, with SPSS 15.0 software for Windows. In addition to standard description statistical calculation (mean and standard deviation), the non-parametric Wilcoxon signed rank test was utilized for the comparison of pre- and post-treatment changes. The results were evaluated with a 95 per cent confidence interval. The statistical significance level was established at p < 0.05.
Results

At the end of the palatal expander therapy, all patients presented an appropriate transversal diameter of the upper maxillary, thus solving all the cases of cross bites. The occlusal situation remained unchanged on the 12-months check-up, after the end of the active treatment. The otorhinolaryngological examination just after the expansor treatment showed no particular change in the original clinical condition; the 12-months check-up and in particular the rhinomanometric test showed an improvement in terms of flow and of right-side and left-side nasal resistance in only 3 of the 17 monitored patients (17.65%); in 6 cases, the tracing remained virtually unchanged (35.3%), and in 8 children resistance increased (47.05%) (Fig. 6). The 6 and 12-months measurements made on the posteroanterior tele radiographies (Fig. 7, 8) showed an increased maxillary width (JL-JR) and a decreasing of the maxillomandibular width differential (Table 1, 2) in all patients, evidence of the effectiveness of the palatal expander; the mandibular width remained virtually unchanged or increased by 1 mm at most.

The 6 and 12-months Ricketts and Woodside, Linder-Aronson, Lundstrom cephalometric test of the rhinopharynx (Fig. 9, 10) showed an increase in the three linear parameters in 3 cases: the AD1-Snp increased by 2 mm on average, the AD2-Snp and Ptv-AD by 1 mm. Values remained unchanged in one case only (5.88%) (Table 1, 2).

Discussion

The aim of this study was to assess the relationship between malocclusions with a transversal discrepancy of the upper maxilla and the patency of the upper airways, and to observe any change in the cephalometric and rhinomanometric values after treatment with a palatal expander.

In agreement with the scientific literature, we noticed that patients suffering from respiratory conditions showed alterations in the dentoskeletal apparatus [Bushey, 1979; Smith and Gonzales, 1994; Pollard and Emamandra, 1995]. In particular, we observed transversal discrepancies of the upper maxilla, increased over-jet, skeletal Class II, dentoalveolar open bite.

We carried out a follow-up study of the skeletal...
alterations through a cephalometric examination of the rhinopharyngeal air space on laterolateral teleradiographies after treatment with a palatal expander in oral and combination breathers with cross bite. Measurements taken before and after palatal expansion showed an actual increase in the diameters of the upper airways; while the rhinomanometric examinations found no actual clinical improvement, i.e. the resistance of the airways did not decrease.

Therefore, the resolution of respiratory conditions rests with a clinical examination by the otorhinolaryngologist, as well as by the dentist, but an actual improvement of the skeletal structures (resolution of the cross bite) must not necessarily mean the clinical success of such conditions in the surgical area (persistence of oral breathing). Therefore, the application of a targeted myofunctional treatment is also advisable, which may be combined with orthopaedic-orthodontic or surgical devices (ORL) to enable the young patient to electively breath again through his/her nose. These exercises may be started as soon as the child is able to cooperate and may be continued until the child is 12 years old [Levrini, 1997], and include: exercises for respiratory training, for the posture of the tongue, to strengthen the orbicularis and the masticatory muscles (especially in cases of skeletal open bites).

**Conclusions**

We can conclude that, to obtain a correct diagnosis and therefore an appropriate treatment plan, in paediatric patients suffering from transversal failure of the upper maxilla associated with respiratory conditions, a close cooperation between the dentist and the otorhinolaryngologist is essential. It is important to perform an objective surgical and dental examination as well as an orthopaedic-orthodontic treatment, which may be associated with medical-surgical therapies. The palatal expander treatment improves the transversal dimension of the upper maxilla and increases the cephalometric dimensions of the upper airways. However, an increase in such measurements does not mean an improvement in the resistance of the airways and therefore a direct relation between the X-ray examinations and the clinical/rhinomanometric examinations.

We believe, therefore, that the increased transversal dimension of the upper maxilla in oral breathers is only part of the treatment, which is certainly more complex and which falls under the province of several specialists, but however it still turns out to be effective in increasing the dimensions of the upper airways. In our opinion, the rhinomanometric examination turned out to be unhelpful in showing the improvement of the patency of the upper airways. Finally, in the assessment of the rhinomanometric results [Gross et al., 1993], one must consider the relative cooperation of the young patients and the alterations that may result from any kind of anatomical discrepancy (such as septal deviations, valvular problems) or functional discrepancy (such as a hypertrophy of the turbinate bones) or pathological discrepancy (such as a cold).

**References**


Bushey RS. Adenoid obstruction of the nasopharynx. In Mc Namara, Jr. Nasorespiratory function and craniofacial growth. Monograph n.9, craniofacial growth series, center for human growth and
GIUCA M.R. ET AL.

development, Ann Arbor, MI: Univ. of Michigan; 1979. 199-232.