

Paediatric Orthodontics

Part 3: Masticatory function during development

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Abstract

The importance of masticatory function during development, the aim of early therapies

Hypoplasia of the upper maxilla is a widespread condition which orthodontists often need to face during early treatment. Mechanical maxillary expansion (both rapid and slow) produce undiagnosed effects on the palatal suture and unwanted side-effects on the periodontium and alveolar process, as well as anchorage-teeth displacement, root resorption, bone fenestration. It is clear that early therapies need a non-mechanical and non-traumatic approach in the respect of the physiology and biology of one of the most important systems for the future health of the developing patient.

KEYWORDS Chewing pattern; Crossbite; Electromyographic activity; Maxillary expansion.

Introduction

The study of malocclusions and their relationship with masticatory function, especially during the first years of development, is of interest for the medical dentistry and the medical field in general. If one considers that malocclusions appear during growth (i.e. during the psycho-physical development of a child), the complexity and importance of the matter is clear. Owing to the difficulty even today of acquiring reliable studies and tools, the orthodontic field is full of technical therapies and technological innovations all focusing on the dental movement "tout court" never or rarely considering the functional effects.

Masticatory function is one of the oldest and most important phylogenetic functions in humans, both during childhood development and in adulthood, right through to old age. The best-known factors are the teeth that may no longer be a vital organ of survival for humans, as they are for animals. But they still show very precise neural connections

[Piancino et al., 2017; Bracco et al., 2010] and are essential in terms of optimal physiological functioning. The influence of mastication on the cranial sutures activity and the temporomandibular joint development is well known [Hinton, 2014; Jing et al., 2014; Abed et al., 2007; Deshayes et al., 2006; Fuentes et al., 2003; Hilton et al., 1988; Kiliaridis et al., 1985; Engström et al., 1986; Ingervall et al., 1976; Duterloo, 1970; Moss et al., 1969; Enlow et al., 1965]. In other words, balanced dental occlusion and healthy masticatory function play an important part in enhancing our quality of life.

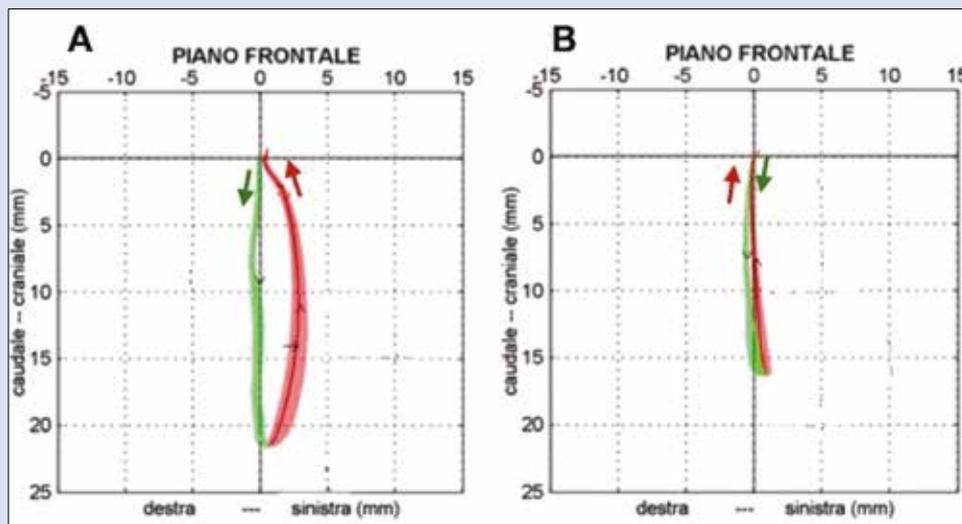
One of the malocclusions which most undoubtedly affects mastication during the early stages of development even in condition of deciduous dentition, with irreversible consequences once childhood development is complete, is that of crossbite [Ferro et al., 2016; Grippaudo et al., 2013; Thilander et al., 2012; Piancino et al., 2006; Pinto et al., 2001; Ben-Bassat et al., 1993].

Alterations to masticatory function

The physiological and biological knowledge of the masticatory function based on reliable scientific results is necessary for a coherent path from diagnosis through the therapy during development. In fact, nowadays, it is of clinical relevance, for a successful orthognathodontic therapy, to consider not only the repositioning of teeth within the dental arches, but the effects of the therapy on function [Quinzi et al., 2018]. This is true especially for early therapies in developing children [Piancino et al., 2013; Piancino et al., 2017].

It is known that the chewing pattern and electromyographic activity during chewing on the crossbite side are severely altered [Brin et al., 1996; Piancino et al., 2008; Piancino et al., 2009]. From the kinematic point of view the main difference with respect to the physiological chewing is the reverse direction of the pattern of closure that has been shown with a high significance [Piancino et al., 2006; Throckmorton et al., 2001]. The altered patterns are called "Reverse Chewing Patterns" and show reduced height, reduced width, reduced area and reduced angle of closure (Fig. 1) [Wilding et al., 1994; Lewin, 1985]. Moreover, very important, the muscular activation is affected, being the masseter of the crossbite side significantly less activated with respect to the normal side [Ciavarella et al., 2012; Piancino et al., 2009].

FIG. 1 Normal masticatory pattern of a patient with normal occlusion (A) and Reverse Chewing Pattern of a patient with posterior cross-bite malocclusion (B), during chewing a hard bolus deliberately on the left side. The solid line, light gray (downward arrow): opening and dark gray (upward arrow): closing, represents the average chewing cycle of 3 trials lasting 10 s each; the light gray and dark gray areas represent the standard deviation over the average cycle. Observe the reduced height, reduced width, reduced area and reduced angle of closure of the reverse chewing pattern compared to the normal one.



This means that the asymmetry of the occlusion determines an asymmetry of the masticatory function both from a kinematic and neuromuscular point of view i.e. asymmetry of movements, of articular loads, of muscular activation and coordination leading to asymmetry of bones and structures when the crossbite is not early corrected [Slavicek, 2002; Simoes, 2013; Tecco et al., 2011].

The aim of early therapies

Indeed, it is only through balanced and harmonious function that a developing system may grow healthily and balanced from a neuromuscular perspective, avoiding impairment and maintaining the results throughout adulthood. Interestingly, the basic research recently showed the clear role of the masticatory function enhancing the number of neurons and synapses in the dentate gyrus of the hippocampus that is the seat of memory and cognition processes, both during development and ageing [Miyake et al., 2016; Kubo et al., 2007; Mori et al., 2013; Nose-Ishibashi et al., 2017; Fukushima-Nakayama et al., 2017]. Therefore, the final goal of early orthognathodontic treatment is to achieve (via the teeth) a rebalancing of function, especially that of mastication, respecting the known gnathological principles. This can easily be achieved using the functionalising appliance “Function Generating Bite (FGB)” for correcting not only the dental malocclusion but especially the anomalous chewing patterns with high significance [Piancino et al., 2006]. Also its capability of re-balancing the neuromuscular coordination between sides was shown [Piancino et al., 2016]. To this end, the dental mechanical therapies fixed to the teeth during the early stages of development should be used with great attention and limited to the cases really necessary, because they inevitably create mechanical strain and biological traumas in a complex developing system [Quinzi et al., 2018; Mummolo et al., 2014].

Why function generating bite corrects the malocclusion and the chewing patterns?

Here comes the question: why is it important to correct the masticatory function during development and why the Function Generating Bite has shown to correct the Reverse Chewing Patterns? The restoration of a physiological masticatory function is important to obtain a symmetric basal

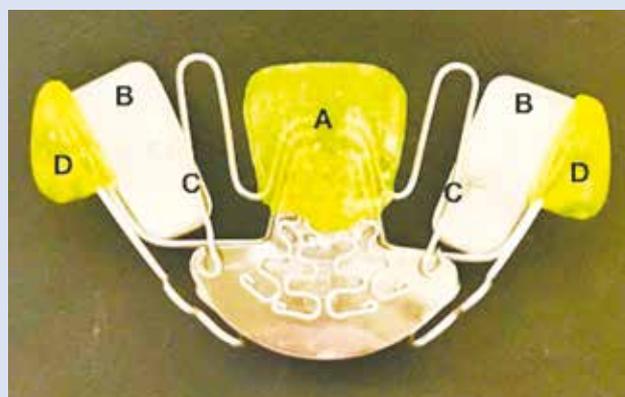


FIG. 2 The appliance Function Generating Bite (FGB). A palatal plate for restoring the physiological tongue thrusting; B: posterior bite plates to disengage the mandible and leveling the occlusal plane; C: expansion spring for the bodily movement of the teeth increasing the bone growth; D: buccal shields for muscular anchorage.

and sutural development and a stable result of therapies [Rosa et al., 2019; Quinzi et al., 2019]. Research on mastication shows that restoration of function after a malocclusion corrected with an FGB device is not a coincidence, and that it is worth exploring further the features of the device in order to understand the gnathological and clinical importance of the results [Piancino et al., 2008].

FGB (Fig. 2) is a functionalising device individually made of acrylic resin and resilient stainless steel bite planes and wires [Piancino et al., 2016; Bracco et al., 1979]. It allows the repositioning of teeth whilst fully respecting physiological condition of the temporo-mandibular joint and avoiding harmful misaligned cusp-to-cusp dental contacts. This is due to the resilient stainless steel bite planes located in the posterior regions of the occlusion that disengage the mandible and self-regulate the mandibular position in the three planes of the space during the orthodontic movements. One of the most important action due to the bite planes is the leveling of the occlusal plane and the alignment of the dental arches avoiding dental trauma.

From the orthodontic point of view the posterior bite planes

activates simultaneously with the expansion springs realising a couple of forces and a bodily movement of the teeth [Mummolo et al., 2014]. This is of importance to stimulate the bone growth avoiding the tilting movements, to obtain a stable orthodontic correction [Serrano et al., 2014; Rice, 2008; Opperman, 2000; Hinton, 1988; Persson et al., 1978].

The appliance has a muscular anchorage and activates during swallowing, so that the orthodontic forces moving the teeth are intermittent (swallowing) and self-regulated by the muscles of the patient. It fluctuates in the mouth (no dental anchorage) and is characterised by contact points to the teeth avoiding any dental upper or lower constriction.

FGB easily restores the masticatory function because it prevents cusp-to-cusp contacts during orthodontic movements; it is an orthognathodontic device acting in physiological way. To this end the book "Understanding Masticatory Function in Unilateral Crossbites" (Wiley), shows a new, coherent approach to the early "cure" (in medical terms) of one of the most important district of the human body contributing to the mental and physical wellbeing of the young patients along life.

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