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Myofunctional therapy. Part 1: Culture, industrialisation and the shrinking human face

K. Boyd[1], S. Saccomanno[2], C.J. Lewis[3],
L. Coceani Paskay[4], V. Quinzi[2], G. Marzo[2]

[1]Department of Pediatric Dentistry, Lurie Children's Hospital of Chicago, Chicago, IL, USA
[2]Department of Health, Life and Environmental Science, University of L'Aquila, L'Aquila, Italy
[3]Department of Dental Anthropology, University of Arkansas, Fayettville, AR, USA
[4]Academy of Orofacial Myofunctional Therapy (AOMT), Pacific Palisades, CA, USA.

E-mail: sabinasaccomanno@hotmail.it

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Abstract

Culture, industrialisation and the shrinking human face: Why is it important?

Over the past 300,000 years, not only has the way we consume food from birth through our lifetime changed, there have also been changes related to the methods of food preparation, availability, processing, and storage. These diet-related factors, along with other epigenetic factors, have led to a widespread increase in orofacial myofunctional disorders (OMDs) and resultant human malocclusion phenotypes (HMPs) worldwide. Currently there is an increasing need for resolution of HMPs in early childhood and associated OMDs. This review will include reports of cases and describe the nature of the problem and strategies for effective solutions.

KEYWORDS Diet, Weaning, Malocclusion, Prevention, Orofacial myofunctional disorders, Early orthodontic treatment, Darwinian dentistry, Craniofacial complex, Breathing.

Introduction

The hard and soft tissue components of the mammalian craniofacial complex (e.g., bones, teeth, muscles and other soft tissues) dedicated to food processing such as chewing, grinding, tearing, and swallowing are also intimately connected to the hard and soft tissues of the upper respiratory complex through the nose, the sinuses, and pharynx and the larynx. Collectively these two survival apparatuses comprise the Cranio-Facial-Respiratory Complex (CFRC).

Charles Darwin described a theoretical process by which one species could gradually change into another as transmutation. Darwin eventually came to describe this transmutation of species process as 'Evolution by Natural Selection' (NS). There are several processes by which these traits evolve, however, the main process of NS requires genotypic diversity such that the various phenotypes present in the population are then subject to ever-changing and challenging environmental conditions. Over time, this process of epigenetic modulation of phenotypic expression can be incorporated into the species' genome. For instance, the suite of genes responsible for coding various skin-colour phenotypes are thought to be under the influence of NS [Crawford, 2017].

An example of how NS operates on a micro-evolutionary and short-term scale can be made from observations collected during and long after the Dutch Famine or Dutch Hunger Winter, during World War II [Heijmans et al., 2008]. Immediately at the end of WW II the liberated starving Dutch were inundated with massive amounts of highly caloric rescue rations from the Allied Forces. Pregnant women who had survived starvation during this period gave birth to infants who were plagued in adulthood with chronic diseases including obesity, cardiovascular disease, hypertension and type 2 diabetes, collectively termed Metabolic Syndrome. Barker [2007] called this phenomenon the Thrifty Phenotype or Barker's hypothesis, which suggests that an epigenetic adjustment to fetal 'energy-substrate utilisation' genes during famine, conveyed from the environment to the fetus via the placenta, would ultimately confer post-natal survival advantage through promoting excessive storage of energy (fat).

Dentofacial volumetric decreases and industrialisation

Human skeletal malocclusion (HSM) is a nearly ubiquitous finding in populations exposed to environmental factors and cultural practices associated with industrialisation [Saccomanno, 2020]. These HSM phenotypes are a relatively recent phenomenon and only show up rarely in the human fossil and ancient skeletal records [Gilbert , 2001]. Coinciding with women beginning to enter the industrialized workforce during the 18th and 19th centuries there has been an increased prevalence of marked changes in HSM phenotypes, going from hundreds of generations practicing ancestral regimens of infant and early childhood breastfeeding and weaning with minimally processed firm foods, to more modern eating patterns (i.e., bottle feeding and weaning with highly processed 'baby foods').

Studies evaluating the consistency of foods in human development and animal models indicate that dietary toughness has a direct impact on the size, shape, and alignment of the masticatory craniofacial bones and teeth [Beecher and Corruccini, 1981; Corruccini and Beecher, 1982; Ciochon et al., 1997; Liu et al., 1998; Lieberman et al., 2004].

The overall cranial length was shorter and the facial prognathism truncated with decreased size in the maxilla and mandible as well, as smaller muscle attachment areas for the temporalis and masseter muscles [Ciochon et al., 1997]. Furthermore, the development of the muscles and masticatory function including suckling was inhibited by weaning onto a liquid diet [Liu et al., 1998], showing that a significantly soft diet can have cascading effects of decreased functionality and growth of the masticatory apparatus. A tougher diet can enable increased ability and efficiency in the chewing motion and bite force, whereas a softer diet does not promote this training of the functional capabilities of the masticatory apparatus [Le Reverend et al., 2014]. Finally, with increased strains from chewing tougher foods, there is a stronger covariation between the dental arch and the temporalis and masseter muscles, whereas a lower strain shows no significant covariation relationship [Noback and Harvati, 2015]. Thus, tougher diets promote growth and development of the masticatory apparatus, a tighter relationship between the functional elements, and an increased efficiency and training of the mouth functions (Fig. 1).

Industrialisation did not affect all countries equally, as food availability, production and consumption depend on cultural norms and traditions. Moreover, industrialisation contributed heavily in the softening of the diet from weaning to old age, in some countries more than others.

Several studies worldwide have shown this relationship between softer diets and phenotypic changes, and that phenotypic changes to the masticatory apparatus can occur within one generation due to a dramatic transition in the diet and food processing strategies where there was a transition from traditional meals prepared with basic processing and cooking methods to the modern diet denoted by mechanized processing [Corruccini, 1999; Little et al., 2006; Defraia et al., 2006]. However, morpho-functional patterns established during development can be modified more easily prior to complete ossification, suggesting that the ideal treatment time for dysfunctions of the masticatory apparatus - due to environmental changes from bottle-feeding, weaning onto soft foods, and a dietary regimen of 'Westernised' foods - ought to be prior to the completion of dental and skeletal development [Corruccini, 1999; Cornette et al., 2015].

Human skeletal malocclusion (HSM) can be/become comorbid with many systemic health conditions, such as habitual mouth breathing, sleep-related breathing disorders (SRBD) or obstructive sleep apnoea (OSA) [Boyd, 2020] and is often associated with neurological deficits like Attention Deficit/Hyperactivity Disorder (ADHD), appetite dysregulation and impaired cardio-respiratory fitness (CRF). Therefore, identifying and treating HSM in early childhood takes on additional significance [Paglia, 2019].

Case reports

Here are described the following case reports.

1. A single case study of a 4-year-old child born and being raised in a large urban area of the United States.
2. A single case study of an 8-year-old Italian boy, born and raised in a large city.

Both children presented with suboptimal development of the CFRC in early childhood and therefore both the diagnostic phase and therapeutic approaches were collaborative and multidisciplinary.

FIG. 1 How the palate changed from prehistory to mid 1900s (modified from Brian Palmer).

FIG. 2 Pretreatment profile and lateral teleradiography of a 5- year-old girl with Class II mandibular retrognathia, anterior open-bite and habitual oral breathing.

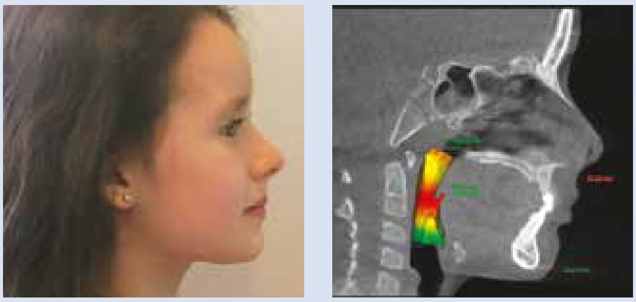

FIG. 3 Posttreatment profile and lateral teleradiography at 8-years of age showing complete resolution of mandibular retognathia, anterior open-bite and habitual mouth-breathing.

Case 1 (by K. Boyd)

The initial images of this 5-year-old girl demonstrate Class II mandibular retrognathia, anterior open-bite and habitual mouth breathing (Fig. 2). After treatment, at 8 years of age, the images demonstrate complete resolution of mandibular retognathia, anterior open-bite and habitual mouth-breathing (Fig. 3).

Case 2 (by S. Saccomanno)

This case is that of an 8-year-old Italian boy with mouth breathing, palatal contraction, atypical swallowing, anterior open bite, and a finger sucking habit.

The three phases of therapy included palate expansion and myofunctional therapy to correct oral breathing, myofunctional

FIG. 4 Phase 1: Rapid expansion and myofunctional therapy to restore nasal breathing.

FIG. 5 Phase 2: Myofunctional therapy to restore chewing and correct swallowing.

FIG. 6 Phase 3: Orthodontic therapy to align and coordinate arches and optimise occlusion.

therapy to correct chewing and atypical swallowing [Saccomanno et al., 2014; Saccomanno et al., 2019], and orthodontic treatment (Fig. 4, 5, 6) [Rosa et al., 2019; Paolantonio et al., 2019).

Conclusion

Our current environment is still affecting our growth and development both genetically and epigenetically. However, the dental community can educate the public and the patients on the importance of preventing the involution of our face and its life-long impact. Even the use of telemedicine which is increasingly widespread offers another opportunity to focus on prevention of OMDs by helping patients recovering their basic orofacial functions especially nasal breathing and chewing [Saccomanno et al., 2020].

These cases describe how orofacial myofunctional disorders (OMD) such as habitual mouth breathing, insufficient chewing and parafunctions contribute to the etiology and exacerbation of malocclusions, which may in turn impact the persistency and and worsening of the OMDs themselves. Through restoration of nasal breathing daytime and nighttime, and though promotion of optimal chewing and other orofacial functions, the CFRC will grow harmoniously, so that orthodontists can focus on providing perfect smiles.

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References

› Crawford NG. Loci associated with skin pigmentation identified in African populations. Science Nov 2017:358:6365
› Heijmans BT, Tobi EW, Stein AD, Putter H, Blauw GJ, Susser ES, Slagboom PE, Lumey LH. Persistent epigenetic differences associated with prenatal exposure to famine in humans. Proc Natl Acad Sci U S A 2008 Nov;105(44):17046-9. doi: 10.1073/pnas.0806560105. Epub 2008 Oct 27.
› Barker DJ. The origins of the developmental origins theory. J Intern Med 2007 May;261(5):412-7.
› Gilbert SF. Ecological developmental biology: developmental biology meets the real world. Dev Biol 2001;233:1–12.
› Beecher RM, Corruccini RS. Effects of dietary consistency on craniofacial and occlusal development in the rat. Angle Orthod 1981; 51(1):61-69.
› Corruccini RS, Beecher RM. Occlusal variation related to soft diet in a nonhuman primate. Science 1982; 218(4567):74-76.
› Ciochon RL, Nisbett RA, Corruccini RS. Dietary consistency and craniofacial development related to masticatory function in minipigs. J Craniofac Genet Dev Biol 1997; 17:96-102.
› Liu ZJ, Ikeda K, Harada S, Kasaharal Y. Functional properties of jaw and tongue muscles in rats fed a liquid diet after being weaned. J Dent Res 1998; 77(2):366-376.
› Lieberman DE, Krovitz GE, Yates FW, Devlin M, St. Claire M. et al. Effects of food processing on masticatory strain and craniofacial growth in a retrognathic face. J Human Evolution 2004; 46:655–677.
› Reverend BJD, Edelson LR, Loret C. Anatomical, functional, physiological and behavioural aspects of the development of mastication in early childhood. British J Nutrition 2014 ;111: 403–414.
› Noback NL, Harvati K. Covariation in the Human Masticatory Apparatus. Anatomical Record 2015; 298:64-84.
› Corruccini SR. How Antropology informs the orthodontic diagnosis of malocclusion's causes. The Edwin Mellen Press: Lewiston, New York; 1999.
› Little BB, Buschang PH, Peña Reyes ME, Tan SK, Malina RM. Craniofacial dimensions in children in rural Oaxaca, Southern Mexico: Secular Change, 1968–2000. Am J Physical Anthropology 2006; 131:127–136.
› Defraia E, Baroni G, Martinelli A. Dental arch dimensions in the mixed dentition: A study of Italian children born in the 1950s and the 1990s. Angle Orthod 2006; 76(3):446-451.
› Cornette R, Tresset A, Herrel A. The shrew tamed by Wolff's law: do functional constraints shape the skull through muscle and bone covariation? J Morphol 2015; 276(3):301-9.
› Boyd KL. A century of adenotonsillectomy's failure to fully resolve sleep-disordered breathing: mild malocclusions are maybe not so mild? J Clin Sleep Med 2020 Aug;16(8):1229-1230.
› Paglia L. Oral Prevention starts with the mother. Eur J Paediatr Dent. 2019 Sep; 20(3):173.
› Quinzi V, Saccomanno S, Jewel Manenti R, Giancaspro S, Coceani Paskay L, Marzo G. Efficacy of rapid maxillary expansion with or without previous adenotonsillectomy for pediatric Obstructive Sleep Apnea Syndrome based on polysomnographic data: A systematic review and meta-analysis. Appl Sci 2020; 10: 6485. doi:10.3390/app10186485.
› Saccomanno S, Antonini G, D'Alatri L, D'Angeloantonio M, Fiorita A, Deli R. Case report of patients treated with an orthodontic and myofunctional protocol. Eur J Paediatr Dent 2014 .Jul ;15(2suppl).
› Saccomanno S, Di Tullio A, D'Alatri L, Grippaudo C. Proposal for a myofunctional therapy protocol in case of altered lingual frenulum. A pilot study. Eur J Paediatr Dent 2019 Mar;20(1):67-72.
› Rosa M, Quinzi V, Marzo G. Paediatric Orthodontics Part 1: Anterior open bite in the mixed dentition. Eur J Paediatr Dent 2019 Mar;20(1): 80-82.
› Paolantonio EG, Ludovici N, Saccomanno S, La Torre G, Grippaudo C. Association between oral habits, mouth breathing and malocclusion in Italian preschooler. Eur J Paediatr Dent 2019 Sep; 20(3): 204-208.
› Saccomanno S, Quinzi V, Sarhan S, Laganà D, Marzo G. Perspectives of tele-orthodontics in the COVID-19 emergency and as a future tool in daily practice. Eur J Paediatr Dent 2020 Jun;21(2): 157-162.