

MECHANICAL PRESSURE AS GENERATOR OF GROWTH, DEVELOPMENT AND FORMATION OF THE DENTOFACIAL SYSTEM

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Abstract: In this article, the role of mechanical load in growth, development and formation of the dentofacial system is discussed.

Key words: mechanical pressure, dentofacial system, masticatory apparatus

Masticatory apparatus is a complicated complex of tissues and organs developing in walls of the anterior part of the digestive tube. The functions performed by the masticatory apparatus are very various and time-dependent.

Of special interest both for theory and practice is the masticatory apparatus since it is easily accessible for visual noninvasive investigations and therefore many anomalies, diseases and defects of elements of the masticatory apparatus and even other systems located inside the oral cavity may be early found.

Furthermore, the organs of the masticatory apparatus confirm their functional adaptation to the environment and used food. As Dovgyalo [2] wrote, the structure of the face bones is dictated by the state of the dental arches. Anichkin pointed to the influence of function on the development of the temporomandibular joints [1]. Many other evidences show that mechanical pressure is one of the physiologic stimulus of the growth as bone as soft tissues [4]. For example, Wolf [6] noted that bone structure varies with mechanical load.

Modern stage of medical development is characterised by extended possibilities of the exact sciences, i.e. mathematics, mechanics, chemistry, physics, computer sciences. Building mathematical models of complex biologic objects enables one to analyse changes occurring in living tissues both in norm and pathologies, to chose individual optimal treatment techniques, to quantitatively estimate states of bone and muscle tissues and different disorders in dynamics.

The masticatory apparatus is composed of structures having various anatomical form, degree of morphologic maturity, and hence it may be in states of ripening, growth, development and involution. From this standpoint the biomechanical study of living tissues behaviour with consideration of growth deformations and the *in vivo* determination of necessary mechanical parameters present new and scantily known problem.

The masticatory apparatus of a modern man is a result of the prolonged process of the phylogenesis. This system participates at an initial stage of receiving and treatment of food, forming of a food lump. It takes an active part in voice and speech formations, respiration,

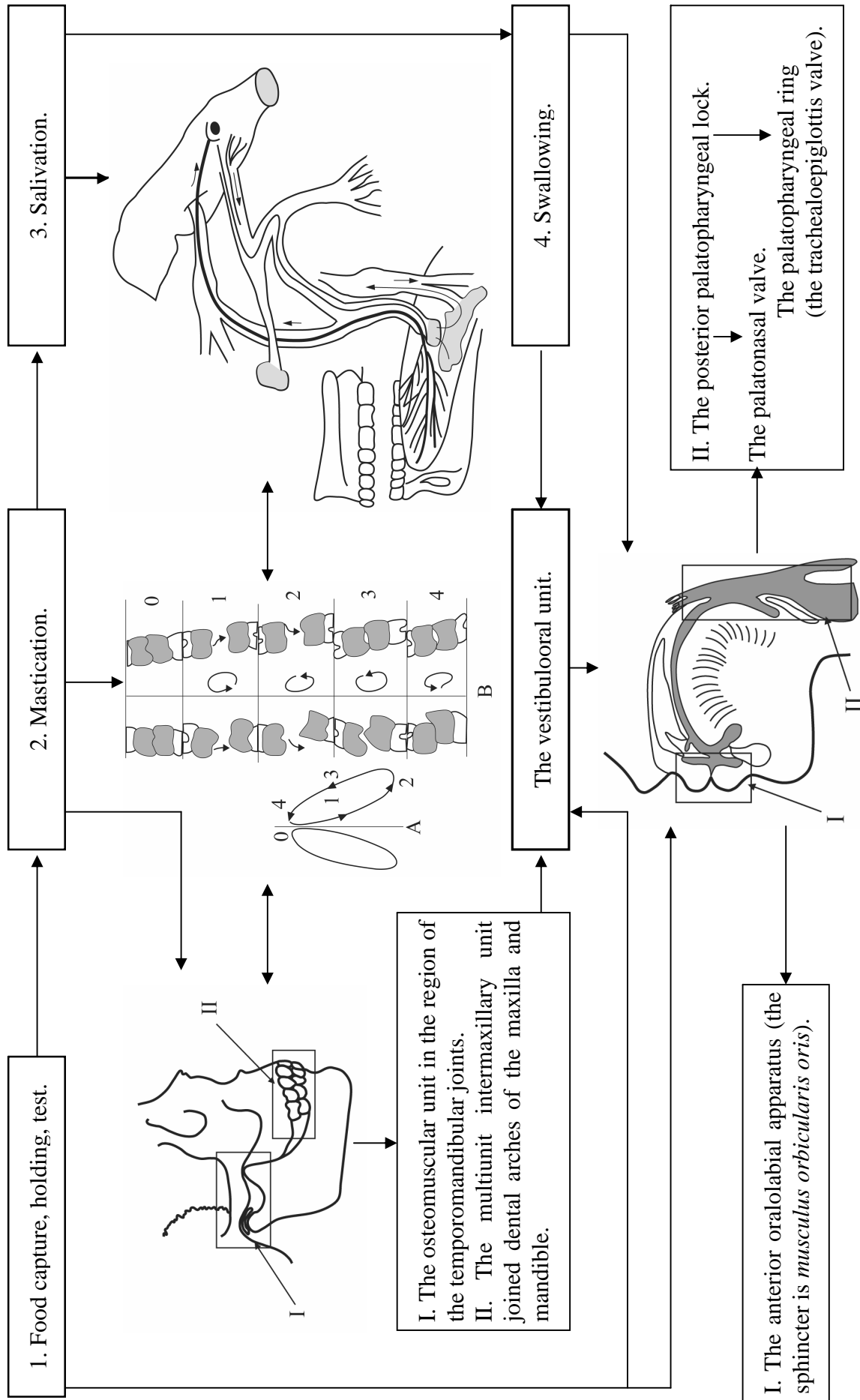


Fig. 1. Biomechanical aspects of the algorithm of food capture and treatment by the masticatory apparatus.

swallowing, facial expression, etc. The masticatory apparatus shows relationship between anatomical form of its organs and their functions in all the age periods of a human lifetime, this relationship being determined by functional load from the fertilisation moment to senility.

This biomechanical system has functionally-oriented multiunit character and its activity is mainly implemented by two main frame units: the osteomuscular unit in the region of the temporomandibular joint and the intermaxillary unit formed by the dental arches of the maxilla and mandible [5].

It should be noted that there is one more unit, namely the vestibulooral unit which is formed by the oral cavity and contains a strong muscle organ (the tongue). The entrance into this unit is controlled by the anterior vestibular lock which operates as a sphincter. The posterior pharyngopalatine lock is analogue of the vestibular lock, but has a more complex structure and has two additional valves to transport a food lump from the oral cavity to the esophagus. The algorithm of such food movement is shown in Fig. 1.

One of the key points of biomechanical description of both bone and soft tissues of the masticatory apparatus is the consideration of growth processes and role of mechanical pressure not only in stimulation of increase of the organ's sizes but also in organ's formation. Pressure is also very essential on the cell level [3]. The generating function is carried by reproducing cell elements and intercellular pressure which is intensified due to physiologic compression by amniotic fluid at the embryogenic stage. It is known that at the third month of the embryogenic stage there takes place progeny of the mandible, whereas the mutual arrangement of jawbones is prognathic after formation of the palate [4]. At intrauterine stage, lips and tongue of a fetus are observed to move due to pressure of amniotic fluids acting on these organs and mobility of a fetus.

In act of sucking which occurs in the postnatal period, large mechanical forces are produced by musculature of not only the tongue but also the vestibulooral unit providing negative pressure in the oral cavity to absorb milk.

As deciduous teeth erupt, masticatory pressure becomes the main factor of growth of tissues and organs and increases with rise of number of antagonised teeth. Of prime importance for the processes of growth and forming of the jawbones is the increase of the occlusion height of deciduous and then permanent molars.

In summary, we can say that biomechanical pressure essentially accompanies the processes of the growth and formation of the masticatory apparatus. Note that the character, origin, intensity of pressure are in close association with age periods of physiologic organism development.

So, pressure acting on cell, tissue, organ structures may be considered as integral characteristic which varies with age, i.e. at 1) reproductive stage; 2) placental stage; 3) stage of sucking pressure; 4) stage of mastication pressure.

This clearly demonstrated the necessity of care to health of a child well before his birth. Prophylactic actions must include thorough attention to health of future parents, obligatory observance of dietary regimen rules.

The following age anatomical features are the decisive evidences of influence of mechanical load on the processes of growth, development and forming of the masticatory apparatus:

- primary and secondary dentitions;
- existence of tremas and diastemata;
- formation of the *tuberculum articulare* by 6-7 years as support for the mandible;
- formation of the counterforts;
- change of form and angle of the mandible, enlargement of its sizes;
- formation of spiral-like twisting enamel prisms and collagen fibers in the periodontal ligament;

- in cases of adentia a decreased masticatory pressure causes atrophy of the alveolar process.

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МЕХАНИЧЕСКОЕ ДАВЛЕНИЕ КАК ОДИН ИЗ ГЕНЕРАТОРОВ РОСТА И ДЕФОРМИРОВАНИЯ ЖЕВАТЕЛЬНОГО АППАРАТА

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Жевательный аппарат – сложный комплекс тканевых и органных образований, развивающихся в стенках переднего отдела пищеварительной трубки. Наряду с тем, что выполняемые этим аппаратом функции чрезвычайно разнообразны, они во многом зависят от возраста. В статье рассматривается роль механической нагрузки в процессах роста, развития и формообразования жевательного аппарата на различных стадиях развития плода и ребенка. Библ. 6.

Ключевые слова: механическое давление, зубочелюстная система, жевательный аппарат

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