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The Effect of Diet Consistency on the Craniofacial Morphology: A review Article.

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Mastication is a chewing route, that implicates a group of muscles that are responsible for moving the mandible condyle in the temporomandibular joint (TMJ) to chore food between the teeth in the maxillary and mandibular arches [(1)] .
Regarding the growth of the craniofacial system (CFS),there are an agreement which is strongminded via genetic and ecological aspects [(2)] . Masticatory forces considered as one of the chief environmental incentives that produce craniofacial difference amongst modern humans. New researeches on a broad variety of creatures, counting those having retro-gnathic post canine teeth, expect that retorts to the force of mastication that determined the superior in the occlusal plane [(3)] . The effect of masticatory stroke induced by the muscles of the mastication on the development of the morphology of craniofacial portion, has established significant attention in the recent oral invistigations [(4)] . Meanwhile the skeletal of the CFS adapts to the applied loads by bone remodeling in order to get the optimum formula to resist loads according to Wolff 's law [(5)] . CFS has been assumed that it formula is mainly resolute by loading induced by mucsles of mastication. This has been reinforced by numerous clinical and experimental readings [(6-9)] . Investigational studies displayed that the reduced stresses induced by function on the animals mandibles, whose nourished a lenient diet outcomes in organizational variations in their masticatory systems [(10)] , in addition to morphological modifications of the lower jaw, like diminished of the alveolar bone size [(11, 12)] .
Diet could be considered as a element of masticatory magnitude. Recent humans in developed countries eat an additional treated and softer diet rather than old humans. The change from hard to soft nourishment has been join by reduce in mandibular dimension and the growth of the alveolar bone, along with enlarged occurrence of malocclusion [(1,5,7)].

Also, It has been experiential that several educated human inhabitants have settled extra-severe malocclusions likened to peoples below embryonic circumstances of lifespan. Throughout that era, a brilliant occupation of both jaws and the masticatory system are important to masticate uncooked or incompletely prepared meat to endure. Also, a minor occurrence of malocclusions in inhabitants alive in rustic communities likened with those existing in municipal industrialized cultures has been distinguished [13]. The reasonable clarification for these differences could be related to the alteration in diet constancy of recent urban foods. Therefore, separately from the probable genetic and provocative tendencies and other factors, ecological circumstances also can play a important role. It was reported that the consequence of diet constancy has been intentional in many animal classes, like mice, pigs, rats, ferrets, primates, bats, and snakes [14, 15, 16, 17, 18] .

Numerous researches have been carried out over the years that sustenance the believed that nutritional constancy disturbs craniofacial development. Numerous of these researches were beginning in an effort to conclude why peoples lived in the western area had such high percentage of malocclusion likened to easteren societies. The hypothesis of strong chewing was essential for correct growing became single path of examination [14, 16, 17, 18] .

The following effects were noted on the effects of diet types:

Effects on the bone

Bone is an active tissue, that infinitely endures continous re-modelling, represented by bone resorption and apposition, in order to encounter the necessities of its efficient situation. The re-modelling frequency is a chief factor of the amount of the bone mineralization (DMB) [19]. In general, extra seriously overloaded bone has an advanced re-modelling degree and is consequently has a reduced amount of mineralization and stiffness than poorly overloaded bone [20]. The muscles therefore deliver a significant mechanical incentive for bone re-modelling by encouraging straining in the skeletal structure [21]. The import of muscle produced loading over underneath bone is exemplified by the result on the bony skeleton underneath situations of augmented and\or diminished the actions of the muscle. Kiliaridis *et al*. in 1996 [22], confirmed that the masticatory hypo-function produced the discount in radiographic bone frame in the dento-alveolar bone, as well as the condylar process and costa. Also, in the lower anterior margin of ramus part of growing mandible of mice. Bresin *et al*. [23] establish that bone form was greater in the firm nourishment set in totally zones excluding incisors to lateral. Additionally they found that the cortical bone is greater in the firm nourishment sets group in the cortical bone that is positioned in the ares underneath the incisor, ans also head-to-head to the mental foramen and additionally it is extended to the first molar, and ramus area overhead the condylar costa, the lateral cortical bone on the dento-alveolar process, pterygoid fossa as well as to the horizontal cortical plate of the pterygoid edge in the ramus. Also, the amount of bone compactness is advanced for the firm nourishment group individual median to the cortical bone on dento-alveolar process of tooth number six and extended to the pterygoid fossa. Utmost of the ordinary occlusal problem perhaps occurs since of the variation in the mid-palatal suture growth and because the maxillary are not properly associated with the lower teeth. Further cranial sutures are also affecting by nutritional constancy [24] .

Effects on the muscles

The human masticatory coordination is a multifaceted Musculo skeletal system wherever stimulation the masticatory muscles, jaw movements, and function and distortions in the TMJ and jaw are strictly interconnected [25- 27]. Any single of these aspects deviations by means of intrinsic and\or extrinsic source, as a result it will disturb totally the others. This clearly distresses the stimulation designs of the masticatory muscles acclimating to an original situation and it arises as a significance of cranio-facial growing and development [26]. Litretures that are dealing with growing rodents have revealed that condensed masticatory task reasons morphological mandible deviations. Also, current studies disclose that myostatin lacking mice with enlarged muscle mass and physiological cross section, beside contractile muscle forces display larger bone mineral compactness than typical mice in the spine and TMJ [28, 29]. So, the craniofacial mandibular construction and the grade of mineralizing may possibly reflected to remain strictly linked with the performance of the masticatory muscle. The technique that used to modify the masticatory task is nourishing early animals a lenient nourishment. Varying the constancy of the nutrition in this manner has been revealed to source complete size modifications in mandubular ramus area [2].

In another hand, the masticatory muscles enzyme action is exaggerated by diet stiffness owing to alterations in muscles mechanical tension. It has been revealed that variations in nourishment firmness disturb muscular fiber phenotype and enzyme action determined by genome of mitochondria and nuclear. Furthermore, modifications in mRNA expression stages of the myosin heavy chain isoform genes MYH one and two were discovered in rats nourished by hard and soft food [30].

Ciochon *et al*. [26] look at the muscles weight intricate in mastication. As the bulks for the deep masseter, superficial masseter and temporalis muscles were altogether considerably superior in the hard food group. Additionally, the anterior cranium profiles is too different among the two tested groups; the firm food group show more vertical profile, although the lenient food group display a totally extra horizontally profile.

Effects on the jaw shape

Morphological dissimilarity in the shape of the mandible had been noticed due to diet effects. The palate was noted to have relatively longer in the lenient diet collection. Beecher and Corruccini [31] stated that in the rats which nourished a lenient food get a finer maxillary arch span likened to the groups nourished by the firm type food. Also modifications were distinguished in the incisors teeth of the upper and lower jaws. In the soft diet group, the upper incisors demonstrate a more proclination concerning occlusal and palatal planes, whereas the mandible gonial angle displayed a reduced appositional rate [32]. The mature system of complex phenotypes, like cranio-facial shape and size, gain with numerous, complicated developmental processes which are overstated by genetic and epigenetic incentives [33] . However, there are confirmations behind genetic determinism on craniofacial form [34] , there is a universal agreement that epigenetic provocations have a main part in regulator overall skull outline together from connections within the human being (prototype of transferring neural crests cells because they move toward interaction with mesoderm) in addition to ecological stimuli. Amongst the various environmental features that could have subjective the development of the highly derivative in human face and masticatory forces as a reaction to differences in their stiffness and hardiness beside the subdivision extent in food was believed to be mainly significant [35, 36].

Effects on the Mandible

In 2008 Odman et al. [27] create that a seven months period with squat masticatory loads in the hypo-functional group during adolescence and early maturity had a important outcome on the final outline of the mandible of rat as associated to control groups. As the part of the mandible was lesser in hypo-functional linked to control set. Fascinatingly, alveolar process was smaller in the control group. The morphometric investigation discovered important alterations such as the part of the angular process and the inclination of the condylar process.

Tanaka *et al*. in 2007 [37] deliberate the role of diet constancy on the mineralization of the rat mandible. As the mineralization percnetages were inferior in the trabecular rather than cortical bone and in the anterior portion of body of the mandibular which displayed high advanced percentage of mineralization than the latter area. Soft food collection had a pointedly advanced grade of mineralization than the firm food group. Additionally, the condyle trabecular bone in the firm nourishment group presented a significantly advanced rate of mineralization than the lenient food group. These outcomes specified the significance of the appropriate role of the masticatory muscle for cranio-facial growing and development.

Grunheid *et al*. [38] four years subsequently, had identical theory, consuming rabbits as models, nevertheless, their outcome recommended a decrease in masticatory functional has not significantly disturb re-modelling degree as the amount of mineralizing areas of loaded mandible during chewing but might persuade an extra varied mineral circulation. Further precisely, the grade of bone mineralization did not vary among the experimental and control groups all through the evaluated sites. Though, rabbits nourished lenient diets, the cortical bone at sites of attachment of temporalis and digastric muscles and cortical bone in alveolar process had a considerably advanced degree of mineralization than cortical bone at the site of attachment of masseter muscle, however there was no significant alterations among mentioned locations in the control animals.

Sella-Tunis et al. 2018 [39] litreture displays that the shape of the mandibular differs to a definite level. the task of applied load to the mandible via the temporalis and masseter muscles. it is expected built on previous studies; "…the size and shape …of the jaws should reflect muscle size and activity" [40] .

This argument is mainly centered on incidental proof, specifically, the relations amongst the morphology of the mandibular and dental abrasion (which representative widespread job of muscles of mastication) and the morphology of the mandibular and maintenance economy. Thus, soft diet necessitates less mastication load). Such as, numerous anthropological reportes have stated an connotation between extreme attrition and wide mandibles [41, 42] .

In regards to diet, people with hard diet presented with longer, narrower mandible and up righted ramus and coronoid process than those with soft diet who showed ramus and coronoid process with angular shape [43].

New studies also showed a broad mandible with low mandibular plane angle in those people who have strong bite and bruxism where as those with light biting force showed high mandibular plane angle with narrower mandible [44- 48].

Human Clinical researches improved the relation between the shape of lower jaw and muscles of mastications. For example, those presented with myotonic dystrophy of these muscles showed a large angle with increasing vertical growth of the mandible [9] . Also larger coronoid process was noticed in people with hyperactive temporalis muscle [49] .

In regards to animal, like rats and pigs, some studies insist on the facts that decrease masticatory function due to normal or soft diet will leads to many changes in the jaw and or arch shape, cross section also in length and width of alveolar process [26, 11, 31] .

In 2022 Karamani *et al*, [13] experiment systematically the common fact which related to the influence of diet texture on the structural anatomy of the rat's mandibular basal bone. Their review stated that with hard diets consumption, there were higher increase in mandibular plane and condylar base inclination, bigonial width, height and length of angular process. In addition to more increases in corpus height, height of the body of mandible, depth of ante gonial notch, development rate in the gonial angle , angular process convexity and of condylar process height.

On another hands, It was also revealed that when rats fed a hard diet, there was a considerable decrease in the height and depth of the mandible. Other decreases were noted in the angle between plane of mandible and angular process, lastly a decrease in the angle of mandibular ramus [11, 13] .

It has been clearly obvious that there was a conflict in the results of many studies about mandibular growth in width and length. In addition to condylar length and width, corpus length, body of mandible length, height of ramus and process of coronoid [26, 31] .

The results of the previously mentioned studies on rats and others were suggested that the consistency of diet may influence the shape of anatomical structures in addition to the growth and developmental pattern of mandibles in different ways. However a great attention should be considered in regards to these results of the studies done on animal since there is a considerable differences between humans and animals in function and craniofacial morphology [13] .

Effects on Mandibular Condyle

The aim of any orthopedics work in dental field is to get the desire effects in dento-facial structures especially in the growth of mandible. The most important part is the main target cartilage of mandibular condyle. A wide range of controversy was observed in regards to the possibility to obtain this goal. Many studies on animal were examine the tissue of cartilage of condyle and insist on the fact that TMJ was respond in a favorable way to mechanical forces since these studies on cartilage tissue suggests that there was more growth whenever the mandible was still under function [50] .

It has been suggested that according to the texture of diet and the active states of muscles of mastication, the loads exert on the bones of maxilla can differs. Stimulation of the mechanisms of resorption or apposition of bones will leads to alteration in the quality of the bone in certain positions especially at the area of attachments [51, 52, 53] . According to these evidences, the texture of diet will affect physically on the strength of loads which exerts on the condyle of mandible and maxilla, hence there will be a biological effect on the bone [54, 55] .

The condyle of mandible represents a fundamental growth center for the lower jaw since the bone will deposit along endo-chondral ossification [56] . The mechanical load creates by masticatory process significantly affects the cartilage of condyle of the lower arch, since these loads will alter the pattern of developmental growth of mandible [57] . As evidence on this, many studies showed that animals with hard food had a big condyle, ramus with more heights and long mandible in regards to animal with soft food [57, 58] .

Another experiment which was done in 1999 revealed that rats fed softer diet had condyle which significantly smaller in length and width. The cartilage was thin in anterior part of all portions where as in the posterior part of the condyle was thick. These findings were related to the decrease in the function of mastication that affects the cartilage thickness and reduce growth of condyle (59).

Another examination Chen J. *et al* [60] tests the efficient loading changes on genes expression that present in different regions of condylar cartilage in the mandible of female mice. They found that 2-6 weeks of alteration of functional loading leads to significant reduction in condylar cartilage thickness. While an important decrease in trabecular thickness and volume of bone fraction of subchondral bone was occur at 4 weeks .

Current knowledge insists on the fact that an elevation in the activity of muscles of mastication caused by hard diet texture leads to best bone quality [51, 61, 62] . The volume of bone is a assumed volume of attention which filled by mineralized bone, this volume in a soft diet animal, was reduced [57] . Additional studies were stated that a firm diet significantly creates a advanced level of trabecular bone mineralization in the condyle, in compares to animals nourished with a lenient nutrition [37] .

During 2017 another study tried to analyze the effects of diet`s physical consistency on the bone feature of mandibular condyle. These study suggest that the constancy of the food doesn’t restrict physically with the typical development and growth of mandible in the animal samples. The final results of the study cleared that rats nourished a softer nutrition were significantly had a diminution in mineral density of bone the postero-superior area of the condyle of mandible, especially along the periods of active growth stge. So, this study insist on the idea that whenever the diet is soft, there is an undesirable effect on the feature of bone of mandible [63] .

These results were similar to other results suggested by other investigators. It has been establish that trabecular bone of the condylar mandible in group with firm nutrition showed advanced mineralization degree in comparison to group of softer diet [37] . Resemble to this results, additional study stated that animals nourished with a softer nourishment were significantly had a decrease mineral density of bone associating with a firm nutrition group [61] .

There is also a controversy in these results, another study found reverse results. Grunheid *et al*. stated that no changes were significantly found in the amount of mineralization among the animals nourished with dissimilar constancies of diet [64]. This differences in the results between the studies can caused by examining the anterior part of the mandibular condyle. Dissimilar loaded could be exerted to veraes areas in the condyle. so, there were dissimilar results. As detailed former, this study examined posterosuperior area of the condyle of mandible, where deposition of bone and endochondral ossification arises higly dynamically in the mandibular condyle [65- 68] .

Effects on the TMJ

The system of mastication represents neuro-musculoskeletal complex structure composed of different parts, with a corpus mandible that supports the process of alveolar bone which holds teeth and PDL around. The muscles of mastication and TMJ connected mandible to the to the rest of skull. Since the TMJ consists of cartilage and condylar process and since these parts were greatly adaptive and respondent to the mechanical stress, the TMJ represent an important item of research interest [69] .

It has been found that during mastication of hard food, a greater force was applied on the TMJ, so, a change in the consistency of diet will affect the structures of craniofacial system. Scheidegger *et al*. examined the influence of diet texture on TMJ condyle, alveolar bone, PDL and condylar cartilage in healthy rodents [70].

Condylar cartilage which also called secondary cartilage, is an identical varied tissue that contain cells at a different stage of chondrogenic maturation. The method of classification and the term used, varied among the detectives, since it mainly be contingent on animal classes in addition to stage of growth of the tissue [71] .

Many authors found an influence of diet whether hard or soft on individual cartilage layers [70] . Finally there are suggestions to improve a significant influence of soft nourishment in reduction of condylar measurements in rodents; so, further experimental studies are needed to test the existing data on condylar cartilage, alveolar bone and PDL results.

Effects on craniofacial growth

The craniofacial morphology and development were greatly affected by environmental and genetic factors [13] .

It is widely accepted that a decrease in muscle mass and their interrelated structures is due to reduction of mechanical loading of the cranio-facial skeleton as a result of decreased action of masticatory muscles. It is well accepted that mechanical strains persuade the growth of bone, specifically before skeletal maturity and since mastication firmer diets creates advanced tensions in the inferior portion of the face. Uncooked foods might lead to additional craniofacial growth in the inferior maxilla, mandible as well as in certain areas subjected to higher functional rate [72].

Several investigational studies on nonhuman mammals suggested that extremely dietary progression can leads to reduction in the craniofacial growth rates in the lower face and this will cause malocclusions and dysmorphologies [73] . Utmost of these studies assessed the development in animals fed laboratory nutrients. However, normal people were focused on different number of special environmental stimuli that acts together in the same time and in an included style on cranial growth.

Effects on face development

Earlier studies were agreed with the idea that firm, hard and natural foods generally can lead to a rise in the general skull size [74] , in addition to increase in facial size in regards to overall size, an increase in the area of temporal muscle [35, 74] , TMJ size increase and cranial vault width enhancement.

Although the significant effect of mechanical loading on the growth of the face is well valued but it is not completely understood how the face is overloaded during the mastication. This is very resulting to other primates in many respects such as reorientation and facial growth in coronal plane and attendance of a retrognathic face [12] . Several dependable inferences were suggested as a result of many tests on a varied selection of nonhuman primates and further mammals. this could be included in:

a) Mastication produces an incline of strains in face with maximum straining qualified near the occlusal plane, restrained straining in the middle face, and precise little straining in the upper face [75] .

b) muscle attachment areas and insertion like process of coronoid and zygomatic arch could be locally high strains [12] .

c) During one side mastication, the retrognathic facial type is susceptible to bend in coronal plane, twisted and sheared in the anteroposterior plane [12, 76].

The universal model mentioned above concerning the influence of changing in diet on gracilization of the face, the new derived outlook regarding response to variation in the texture of food are incompletely established to the natural newly human models. Indeed , the results recommend that the influence of diet softening on cranio-facial shape is intense in regards to relation to lessening of temporal fossa and in the suspected location of temporal muscle attachments and could be joining to muscle attachment and TM [12,75, 77] .

Conclusions:

Changed the masticatory function has encourage a change in muscles of mastication and definite effect on growing craniofacial complex. These modify compact function of mastication and leads to fibers in the elevators and transverse skull measurements. The special effects are most probably related to the variation in craniofacial anatomy and growth outline. Restricted studies evaluating hard with soft nourishment in several species have maintain the finding that the jaws of animals fed a softer nourishment were typically narrower and have a low bone density. There have been different litretures searching the diet constancy and how this influences the morphology of condyle and mandible. The relation between diet consistency and the growth of the head has a great medical significance as it admits an reaction to the human`s growth and development evolution so, one can comprehend the growth of the human and get a more efficient treatment strategies for orthodontic abnormalities and condylar complaints .

It has been approved from many researches that occlusal loading certainly influences the bone amount, mass of it, and density of mandibular bone, in addition to length and width of mandible .

It is also accepted that muscular loading has an effect on the mineralization rate, the collagen immunoreaction. Beside the genetic expression and the chondrocytes action on the cartilage. However, further studies are needed to assess the longstanding properties of changing diet consistency of animals.

Conflict of interest:

There are no financial conflicts of interest to disclose.

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