Human Chewing Pattern: Prosthodontic Overview

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ABSTRACT

Biting is the initial step of processing and prepare the food for swallowing so that it can be further processed in the digestive system. Chewing reduces the food bolus or food particles size, saliva moistens the nourishment and flavors are discharged. Taste and texture of the nourishment are seen and produce their effect on the chewing process. There are so many factors determining the chewing pattern. The teeth play an important role in the chewing system. They determine occlusal contact area where the food particles are ground. This fragmentation depends on the total occlusal contact area and the number of teeth present. The bite force depends on different chewing muscle volume and their co-ordination and muscle activity. The jaw movement and thus the neuromuscular control of chewing , plays an important role in the fragmentation of the food. The tongue and cheeks manipulation the food particles between the teeth is also important.Large differences in oral function exist among various groups of subjects, like dentulous subjects, partial and complete denture wearers, and subjects with implant-retained overdentures. Both most extreme bite force and masticatory execution are essentially lessened, when artificial teeth replace natural teeth and in patients with a neuromuscular disease .

KEYWORDS: Human chewing pattern, chewing pattern, chewing cycle, neuromuscular control of chewing, jaw movement

INTRODUCTION

Mastication is an essential function that has long been a subject of study in the dental literature. Knowledge of mandibular movement during mastication has great influence in the procedures in clinical dentistry. This article gives an overview and basic description of the classical studies of the physiology, function and neural control principles of the mastication. Hiiemae characterized it as "a key element of mammalian nourishing that includes the coordination of complex developments and exact dental impediment amid an unmistakable power stroke of the biting cycle"in the year of 2000. The length of time and powers created in the power stroke differ inside,between individuals and for the type of the food chewed. Lund and Kolta allude to mastication as the time "during which the food is mechanically separated and blended with salivation to make a slurry of little particles or bolus that can be effectively gulped".Understanding mastication is of utmost importance for us, Dentists. Some disorders of the stomatognathic complex system need observation of masticatory system for correct diagnosis. The activity of masticatory muscles during biting shifts between subjects in abundancy, onset timing, and term of the biting cycle.

General Characteristics:

1. Biting includes mandibular development in every one of the three headings: vertical, horizontal, and foremost back.
2. Recurrence
   a. extend from 0.5-1.5/second
   b. slower frequencies related with bigger sustenance molecule or potentially harder nourishment

3. Consistency
   a. adequacy changes from cycle to cycle
   b. adequacy depends to some degree on food being bitten

4. Biting is for the mostly one-sided (stand out from beginning tearing by front teeth)

(Note: despite the fact that biting is by and large one-sided, the contralateral muscle are dynamic in biting and help accomplish parallel jaw development)

5. Start of biting is by and large oblivious; starts naturally when sustenance is put in the mouth

Two strategies for biting have been recognized relying on the surface of the nourishment:

1. Puncture/pulverizing: hard nourishment is first pounded and punctured between the teeth without guide tooth-to-tooth contact. This outcomes in wear of the teeth, particularly at the tips of the cusps.
2. Shearing stroke: This strategy includes tooth contacts that happen simply after the sustenance has been decreased. This sort of development produces whittling down feature with trademark directional scratch lines on the characteristics of the cusps.

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The mean of the vertical measurement of the biting cycle are in the vicinity of 16 and 20 mm and in the vicinity of 3 and 5 for horizontal developments.

The length of the cycle differs in the vicinity of 0.6 and 1second relying upon the kind of sustenance.

The speed of masticatory development differs inside each cycle as per sorts of sustenance and among people. Speed, span and type of the biting cycle differ with the sort of impediment , sort of sustenance and nearness of brokenness. The connection between biting cycle kinematics and masticatory performance remains poorly understood .Wilding and Lewin performed one study that directly evaluated the effects of chewing cycle kinematics on masticatory performance and wide bilateral chewing cycles with lateral paths of closure were found to provide better chewing performances.

PHASES OF CHEWING CYCLE

Biting cycle includes 3 essential periods of the mandible in connection to the maxilla:

a. From a position in which the jaw is open , the end stroke brings about the teeth being carried into introductory contact with the food; the work is done in this stage is truly against gravity.
b. This is trailed by Power Stroke. At the point when the food experiences reduction. The movement of the mandible in this stage is slower than in the end stroke due to the resistance caused by the nourishment, despite the fact that there might be boundlessly more prominent masseter and temporalis muscle movemen this time.
c. Finally , there is the opening stroke, when the mandible is brought down, with an underlying slower stage taken after by a quicker stage.

From a vacant position , the mandible is moved upwards and outwards, bringing the buccal cusps of the maxillary and mandibular teeth on the working (left) side in contact.(BUCCAL PHASE)

In power stroke , the mandibular teeth at that point slide upwards and medially against the maxillary teeth to immediately achieve the intercuspal position.(INTERCUSPAL PHASE).

The mandibular teeth proceed downwards and inwards against the maxillary teeth (LINGUAL PHASE).

(Note: while the teeth on the working side are traveling through the buccal stage those on the adjusting (right) side are in the lingual Phase yet in the turn around course.)

Many investigators like Lund & Enomoto, 1988 further divide chewing cycles into four moderate opening (MO), quick opening (QO), quick shutting (QC) and moderate shutting (MC).

NEURAL PATHWAYS

Teeth are closely linked with periodontal sensitivity suggesting an integrated role of the pulp-dentine-enamel complex.[1] There is the immense significance of teeth in the sensorimotor control of jaw work. The neural premise of the pulpal affectability adds to the wonderful tangible separation component of teeth. Somatosensory data from orofacial mechanoreceptors, for example, periodontal, mucosal, muscle axle, thermoreceptor, and gustatory and olfactory receptor, assumes a basic part in the era and control of jaw developments amid mastication.[1,2,3]

These are the group of proprioceptors that give data with respect to the position of parts of body in space and the receptors of stance and developments .They comprise of the terminal dendrites of tactile neurons and are exemplified in structures of connective tissue or free and react to pressure or development included by related structures.

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Proprioceptors for Mastication:

- TMJ and jaw
- Muscles of mastication
- Dentition and Periodontal membrane- An unmistakable relationship exists between dental status and masticatory execution as controlled by various investigations related biting test.[4,5]

TMJ Propioceptors: Propioeptor endings are situated in capsule and ligaments. while teeth are not in contact these receptors play an important role in determining the mandibular position in space. Wyke stated that these receptors provide the greater afferent activity regarding perceptual awareness of joint position and movement [6]. Kuwahara et al[7] showed that specific chewing patterns appeared to be associated with specific TMJ disorders.

Muscles Of Mastication: Matthew stated that their primary function was subconscious rather than conscious nervous control of contraction. More than twenty muscles are involved in the procedure of rumination. Masseter muscle is the essential chomp constrain generator for chewing and swallowing[6].Tthe mandible crosses the midline and articulates with the temporo-mandibular joints (TMJ), each of which possesses six degrees of freedom in humans. The jaw is driven by no less than 18 muscle gatherings, and the masticatory developments, which these muscles create, are usually asymmetrical.

Dentition: A definite relationship exists between dental status and masticatory performance as determined by different studies related chewing test.[8,9-15]

Central Pattern Generator: Chewing is a vital orofacial function controlled by central pattern generator in brain stem. Sensory afferents modulate CPG circuitry directly or ascend to synapse within the ventral posterior medial thalamic nuclei and subsequently pass information to suprabulbar areas.[16] Basal ganglion[17], Red nucleus[18], other cortical or cerebellar region[17,19]are also involved in chewing and other orofacial movements.

CENTRAL PATTERN GENERATOR

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CHEWING CYCLE EVALUATION METHODS

1. Video sequences of rhythmic chewing
2. Electromyographic recording of the jaw muscles- 2 bipolar electrodes placed on middle masseter, anterior and posterior temporalis parallal to muscle fibre with common electrode over middle of forehead. Isotonic contraction denotes reflects jaw movements and Isometric contraction denotes bite force.
3. Jaw tracking device with optoelectronic sensors-linearly measures the full range of mandibular movement to acuracy of 150 um at any jaw position. A couple of metal grips was connected to the labial surfaces of Upper and lower incisors to position the sensors.
4. Cinematography with mechanical tracing and electrical analysis, although by Murphy.
5. Functional connectivity magnetic resonance imaging (fcMRI) to understand nerurobiological mechanisms.

FACTORS INFLUENCING MASTICATORY CAPACITY

Occlusal figure: An extensive variety in the masticatory execution is discovered, which might be identified with various components, for example, the aggregate occlusal surface, the occlusal contact territory, the quantity of teeth show, the quantity of impeding sets of teeth, tooth shape, the favored side and the activity of the delicate tissues A considerably more critical element controlling the masticatory execution of individuals with regular teeth ended up being the measure of occlusal contact region of molar and premolar teeth, which is by and large one fifth of the aggregate occlusal surface. The quantity of postcanine teeth gave off an impression of being less vital than the quantity of occlusal contacts of these teeth.[14,20,21] In these investigations, the quantity of impeding back teeth was communicated in occlusal units. A blocking molar combine was considered two occlusal units, though a premolar match was considered one occlusal unit.[8] This end point might be subject to occlusal morphology in dentulous subjects.

Maximum Bite Force: Significant correlations are reported between masticatory performance and maximum bite force for subjects with natural dentition, shortened arch as well as complete arch.[22,23,24,25] This indicates that a higher bite force leads to a better fragmentation of the food. Greatest nibble constrain gave off an impression of being essentially bigger in a gathering of youthful dentate subjects when contrasted with old dentate subjects, no huge contrasts in masticatory efficiency were observed.[26]

Age: Masticatory execution does not modify essentially with age in people who have a total or practically total dentition. In any case, in these people, there is a critical increment with age in the quantity of strokes used to set up the test nourishment for gulping. The optimum volume for chewing by children should be less than 2.21 g and can be increased with development of the dental stage. The explanation for this finding is because of the smaller oral cavities of children. The other reason can be children's chewing pattern is under development. Although maximum bite force increases with age.

Body mass and Jaw estimate: All investigations on the interspecific scaling of biting beat have demonstrated that biting recurrence diminishes with increments in body size and jaw length. Little creatures gnaw at a higher recurrence and therefore have a shorter biting cycle span than bigger creatures.[55]

Salivation: Decrease of molecule estimate, lessening of resistance against sustenance twisting and the arrangement of a sound bolus that can be gulped are the principle objectives of the biting procedure. Salivation saturates the divided nourishment particles amid biting, so that the sustenance can be gulped.[27,28.]

Gulping thresholde: The gulping edge is affected by the masticatory execution. Subjects with a diminished biting execution, due to an inadequate dentition, needed more chewing cycles to prepare the food for swallowing than those with a good performance.[9,13,29] Furthermore, they swallowed larger food particles than those with good performance.[13,15,30,31] The swallowing process has been studied directly with videofluorography.[32] Nourishment developments amid finish encouraging arrangements on delicate and hard sustenances, covered with barium sulfate, were researched with this system. The developments of tongue, jaw, hyoid, and sustenance were recorded, so that the different phases of intra-oral transport, including gulping, could be measured.

Sustenance Texture and Taste: Sustenance surface has a vast impact on the chewing process, e.g..[32,33,34] A clear relationship between muscular activity and food properties has been reported.[35,36] The quantity of biting cycles going before the principal swallow relies on upon the surface of the food[27,32]. It is proposed that an impact of taste on the biting procedure runs by means of its connection with salivation stream rate. Flavor discharge from nourishment might be identified with the surface of the divided sustenance particles and in this way it will be related to masticatory performance.[37]

Chewing efficacy in different individuals:

Dentate subjects: The chewing path of mandible was first demonstrated by Hildebrand. At first mandible drops down towards balancing side maximum up to 2 cm crosses the midline towards the working side and then elevates to close in centric position. The width of the path is 1 cm. The dimension of this path and time period varies according to size and type of bolus of food. Typical biting cycles are by and large two-sided, while strange biting cycles are never reciprocal. Outskirt development remove does not vary in any predictable path amongst "slashing" and "pounding" biting cycle sorts.

In many examinations on the connection between dental state and masticatory work, subjects with a poor dental state were contrasted and subjects who have a complete dentition. The masticatory performance of partially edentulous patients has been studied before and after completion of prosthetic restoration.[21] The normal masticatory execution was found to approach the level of a control gathering of subjects with an entire dentition, if all occlusal units of the longest back side were supplanted. Subjects with a deficient dentition tended to bite transcendently along the edge of the longest posterior curve. Recovery of post-canine teeth reestablishes a portion of the target masticatory capacity and prompts an expanded appreciation of the masticatory function.

Deep bite cases: It was originally presumed that excessive Over bite would produce predominantly vertical chewing strokes.[56] This was initially supported by the cinefluorographic analysis[57] which showed deep bite subjects had cycles that were more irregular and vertically arranged. Deepbite subjects had altogether littler most extreme vertical speeds than subject with normal occlusion. A deep bite malocclusion alters the shape of chewing cycles and the consistency of chewing cycle kinematics.

Complete denture wearer: Nourishment pounding tests have demonstrated that entire denture wearers have a much lower biting productivity than people with regular dentitions. Finish denture wearers needed on average 4 times,[38,39,40], 6 times,13 and even 8 times78 the number of chewing strokes of dentate persons to achieve the same level of pounding. The denture wearers required by and large 3 to 5 times the quantity of biting cycles for a delicate, separately hard sustenance. As a result, full denture wearers select just a couple of nourishment particles at any given moment, level of pounding. The denture wearers required by and large 3 to 5 times the quantity of biting cycles for a delicate, separately hard sustenance. As a result, full denture wearers select just a couple of nourishment particles at any given moment, so the total force needed to crush the food is limited.[41] We may conclude that edentulous persons are handicapped in masticatory function and even clinically satisfactory complete dentures are poor substitutes for natural teeth. Though lingualised occlusal scheme provides better chewing efficacy. Koide[54] investigated the masticatory performance of edentulous patients wearing complete dentures arranged with lingualized occlusion and bilateral balanced occlusion. It was found that lingualized occlusion offered a higher ability of food crushing, showed higher masticatory efficiency, displayed faster as well as smoother masticatory movement, and showed chewing patterns that were closer to the chopper type compared with bilateral balanced occlusion.

Partial denture patients: In the absence of posterior occlusal support mandibular movement during mastication can be adapted to a premolar chewing pattern. The closing angle of the lower incisors is narrower during first premolar chewing compared to first molar chewing. The condylar movement is smaller and slower on both sides when the chewing region is changed from the first molar to the first premolar. These individuals should be instructed to use their jaw with minimal lateral deviation irrespective of the toughness of food being masticated.

Implant Supported Overdentures: The target oral capacity essentially enhances when the mandibular denture is held by oral inserts. The most extreme nibble drive of subjects with a mandibular denture supported by inserts is 60 to 200% higher than that of subjects with a conventional denture.[38,40-44] However, the average bite force after treatment was still only two thirds of the value obtained for dentate subjects.[38] The masticatory performance also significantly improved after implant treatment.[38,45] The number of chewing cycles needed to halve the initial size of the food diminished from 51 to 28.[38] The implant held mandibular overdentures may impact the maintenance and the dependability of the denture, and in this manner the oral capacity. In an inside subject hybrid clinical trial the impact of maintenance and soundness of the denture on the greatest chomp constrain and the comparing EMG, and on the masticatory performance was studies.[38] No significant differences in maximum bite force, muscle activity, and masticatory performance were found among the 3 connection types.[38]. The subjective oral function of subjects with an implant-retained overdenture has been recently reviewed.[48] Both chewing ability and satisfaction improved as a result of implant treatment.[45,46,47]

Orthognathic patients:A decreased biting execution has been accounted for patients with a mandibular prognathism, who were scheduled for orthognathic surgery.[48-52] Patients with a hypoplastic mandible also showed a reduced chewing performance before treatment.[53]

SIMULATED CHEWING EXPERIMENTS

Some studies showed that food resistance was produced by a computer controlled external load, connected on the mandible in a descending direction during closing. Loads were unexpectedly alternated with successions of cycle, even without a load. Jaw movements, and EMG of the masseter, temporalis, and digastric muscles were recorded. It was recorded that the external load needs additional muscle activity to counteract it, consists of two components: an anticipating component starts prior onset of application of food simulating load and a peripherally induced component starts after the onset of the load. The anticipating component works only if a counteracting resistance is expected. The anticipating muscle activity starts immediately after the jaw starts closing. Peripherally induced muscle activity is generated on average 23 ms after the onset of the load. About 85% of the muscle activity required to counteract the external load is peripherally induced, which concludes that the muscle activity is of sensory origin. However, when the rate of chewing strokes was doubled (fast chewing with 120 cycles per minute), the peripherally induced muscle activity decreased to only 40%. The masticatory system is mainly closed-loop controlled. Furthermore, food resistance varies largely from cycle to cycle. Thus, instant muscle response is necessary to maintain a constant chewing rhythm.

CONCLUSION

Functional ('normal') occlusion is necessary for a healthy stomatognathic system in the provision of dental aged care, orthodontic therapy, and quality prosthetic and restorative treatment.[58,59,60] However, as Clark and Evans[61] have indicated, the criteria that denote an 'ideal' functional occlusion have not been conclusively established. Extensive tooth wear might be a basic design principle in the human as a mechanism for functional adaptation, but this is reduced in the contemporary humans. Whether the changes of occlusal contact features related to this reduction in tooth wear lead to an increased frequency of musculo-skeletal problems in industrialised societies remains unanswered.[62] Balanced occlusion in people with natural dentitions is frequently found [63] and appears an acceptable outcome of orthodontic therapy.[64] Over one-third of bridge units were not in antagonistic contact[65], indicating that the clinicians are surmised to reduce the risk of the failure of restoration by over-prevention of 'heavy contact'. All these imply that there is a necessity to provide a standard of a functional occlusal contact relation.

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