Universidad Europea

TRABAJO DE FIN DE GRADO

Grado en Odontología

MASTICATION MUSCLES AND AGEING

Madrid, curso 2020/2021

Número identificativo	225

Agradecemientos

En primer sitio, me gustaría agradecer mi director(a) de Trabajo de Fin de Grado. Muchas gracias por sus consejos, su ayuda y su soporte durante todo este año.

A Kacem, mon père, merci pour avoir rendu cela possible. Merci pour être rester debout, rester fort, pour m’avoir épaulé et soutenu malgré la distance qui nous sépare.

To my Imano, ماما, your love knows no boundaries and your strength no limit.Thank you for teaching me these values, thank you for always being a call away and thank you for always understanding me. In short, thank you for being you. We made it mama!!

To my big sisters, Nour and Sarah, thank you for constantly pushing me higher and further. Your differences and similarities have shaped me into who I am today. Last but not least, thank you for always contributing to the ‘Dana Foundation’ and for always getting me out of trouble when needed. I am forever grateful to have you both my side, always.

To my big, beautiful family planted all around the world. Thank you for your constant love and support. I love you deeply.

À toi Yaëlle, pour avoir été mon binôme tout au long de ces années. A toutes les activités, la clinique, les cafes, les exams, les réveils et les revisions… On se disait souvent que la seule issue possible était la réussite et maintenant nous réussissons ensemble comme prévu… Merci merci merci.

Enfin, à toi Sosota, synonyme de Madrid, de soeur, d’amie, de coloc, de réconfort, mais surtout synonyme de ‘*home*’. Nous avons su recréer un ‘chez nous’ ou nous avons tout partagé. Nous avons appris l’une de l’autre, grandi et

muri ensemble pour devenir de *jeunes femmes cactus*. Madrid would have never been the same without you and its only just the beginning… Merci pour avoir été une partie intégrante de cette belle expérience Madrilène.

ABSTRACT

Introduction: With longer life expectancy, there is a need of maintaining essential basic functions of the human body such as mastication at an optimum quality, especially in the geriatric population. Generalised sarcopenia is a consequence of old age, and this phenome also impacts masticatory muscles.

Objective: Performing a literature review, the aim of this study was to revise the anatomy and physiology of a healthy mastication but also understand the consequences of age-related factors concerning the mastication system.

Material and methods: Using various databases such as Pubmed, Mendeley, Research Gate, Google Scholar, using key words related to our subject with diverse inclusion and exclusion criteria for article selection.

Results: A review of the different components of the mastication system and more specifically the muscles used while chewing yielded necessary information to understand the physiological effects of a healthy ageing masticatory system. It was important to differentiate between sub-types of the elderly population. A healthy old subject is defined as someone with no general pathologies and a good oral health. Healthy dentate patients of over 65 years of age present masticatory performances similar to that of younger patients. This differs widely from a patient presenting various systemic diseases, polymedicated, with a bad oral health usually missing large spans of teeth, suffering from dento-buccal pains.

Conclusion: There is a significant decrease of masticatory muscle performance observed exclusively in the geriatric un-healthy population. This can be explained by age-related factors resulting in mastication impairment:

tooth-loss being the chief key factor, followed by xerotomia and generalised diseases often observed in the elderly population such as Alzheimer’s, Parkinson’s and strokes. Dentate old patients present little mastication dysfunction. Anyhow, the mastication system is constantly finding adaptation methods to the consequences of its own ageing.

RESUMEN

Introducción: Con la prolongación de la esperanza de vida, existe la necesidad de mantener las funciones básicas esenciales del cuerpo humano, como la masticación, en una calidad óptima, especialmente en la población geriátrica. La sarcopenia generalizada es una consecuencia de la vejez, y este fenómeno también afecta a los músculos de la masticación.

Objetivo: Realizando una revisión bibliográfica, el objetivo de este estudio fue revisar la anatomía y fisiología de una masticación sana, pero también comprender las consecuencias de los factores relacionados con la edad en relación con el sistema de masticación.

Material y métodos: Utilizando diversas bases de datos como Pubmed, Mendeley, Research Gate, Google Scholar, utilizando palabras clave relacionadas con nuestro tema con diversos criterios de inclusión y exclusión para la selección de artículos.

Resultados: La revisión de los diferentes componentes del sistema de masticación y más concretamente de los músculos utilizados durante la masticación, aportó la información necesaria para comprender los efectos fisiológicos de un sistema masticatorio sano y envejecido. Era importante diferenciar entre los subtipos de la población anciana. Un sujeto anciano sano se define como alguien sin patologías generales y con una buena salud oral. Los pacientes sanos de más de 65 años presentan un rendimiento masticatorio similar al de los pacientes más jóvenes. Esto difiere mucho de un paciente que presenta varias enfermedades sistémicas, polimedicados, con una mala salud

bucal a los que les suelen faltar grandes tramos de dientes, y que sufren dolores dento-bucales.

Conclusiones: Existe una disminución significativa del rendimiento muscular masticatorio observada exclusivamente en la población geriátrica no sana. Esto puede explicarse por los factores relacionados con la edad que provocan un deterioro de la masticación: la pérdida de dientes es el principal factor clave, seguido de la xerostomía y de las enfermedades generalizadas que se observan con frecuencia en la población anciana, como el Alzheimer, el Parkinson y los accidentes cerebrovasculares. Los pacientes ancianos dentistas presentan pocas disfunciones de la masticación. En cualquier caso, el sistema de masticación encuentra constantemente métodos de adaptación a las consecuencias de su propio envejecimiento.

Introduction

As children, we learn to live by imitating other people's movement. This notion includes various basic and functional movements such as eating, masticating and proper phonation. The process manifests itself first when the teeth erupt followed by the development of the masticatory system as a whole. It is composed of bones (mainly mandible and maxilla), muscles (mastication and auxiliary muscles) and the temporomandibular joint (TMJ). It is innervated and irrigated and operates under neural control (1).

According to the Oxford Dictionary of Dentistry, the process of chewing food occurs in three phases: the first being incision of the food, the second corresponds to chewing of the bolus and final stage is swallowing (2). It involves several movements of the mandible controlled by the mastication muscles. It is a group of muscles which act together to produce coordinated movements of the mandible during function. They are innervated by the 3rd branch of the trigeminal nerve: the mandibular portion (1,2,3).

It is therefore wise to ask ourselves the following question: **To which extent does ageing affect the masticatory system?**

The elderly population is a very interesting epidemiological profile that is quickly increasing thanks to an increased life expectancy. For example, in Spain, the average life expectancy is valued at 83,0 years old being the best ranking in Europe (after Bulgary) (4). As people live longer, the challenge for maintaining an optimum quality of life is ever present. WHO encourages the 'process of growing older without growing old through the maintenance of physical, social, and spiritual activities throughout a lifetime (5). However, there are many impediments to achieve that goal. For example, the inability to perform a vital function such as eating. The deterioration of the mastication system can produce a very big and negative impact on the quality of life of the patient (6,7). The consequences can be functional, nutritional and psychological. First, functional because we can observe a generalised decline in total body mass and more specifically in the cross-sectional areas of mastication muscles as well as bite force (6,8). In addition, deficient masticatory capacities result in nutritional consequences because patients usually suffer from malnutrition and involuntary weight loss due to inadequate food intake. (8,9) And finally, it is important to mention the negative psychological impact on the patient. Many examples illustrate this notion: reduced appetite and/or pleasure when eating; aesthetic facial changes such as fall of tip of nose or double chin due to slackening of the muscles depressing the mandible. The confidence of the patient is compromised and so forth is the quality of life. The elderly population usually presents additional factors such as tooth loss, prothesis rehabilitation, hypotrophy of the mastication muscles which lead to a decline in the efficacy of chewing. Overmore, this population is also more likely to suffer from other concomitant degenerative diseases such as Parkinson's and Alzheimer's(10–12). Neurodegenerative diseases cause motor alterations that affect the musculoskeletal system. On one hand, the former describes a dysfunction in the central nervous system affecting synaptic connections leading to sensori-motor loss(13,14). On the other hand, the latter impedes cognitive functions of the patient often resulting in reduced dysfunctional mastication. Such dementias counterfeit the autonomous life of patients (11).

In addition, it is important to note that the geriatric population is the one most affected by cerebrovascular accidents. Indeed, the incidence of strokes increases with age in both sexes with approximately 50% of strokes occurring in people over the age of 75.This disease also takes its toll on the masticatory system by inducing trauma on the TMJ, the muscles and the teeth (15).

In this study, we are trying to understand the mechanisms of physiological ageing of the mastication muscles, determine the risk factors that lead to a reduced mastication and finally elaborate the clinical handling of such situations in the dental office.

1. Mastication muscles anatomy

The mastication muscles include the temporalis, the masseter, the medial pterygoid (elevating the mandible) and the lateral pterygoid (depressing the mandible). It is important to describe the shape, the origin and insertion of each of those muscles as it subsequently defines its function and role in the masticatory system (16).

The temporalis muscle is wide, flat and fan shaped. Its superficial portion takes origin in the temporal fascia superior to the temporal line, while its deep portion originates in the temporal fossa inferior to the temporal line. The insertion of the temporalis muscle is found on the coronoid process of the mandible and anterior margin of the mandibular ramus. The movements allowed are mainly elevation of the mandible, followed by retraction and additionally unilateral contraction lateral movement. It is innervated by the deep temporal nerves of the mandibular portion of the trigeminal nerve (16,17). (Figure 1).

The masseter muscle is considered the most powerful for mastication. It presents a quadrangular shape and overlies the lateral surface of the ramus of the mandible and extends until the zygomatic arch. We can differentiate three portions: superficial, middle and deep layers all originating and inserting in different regions. It is innervated by the masseteric branch of the mandibular nerve (1,16). (Figure 2).

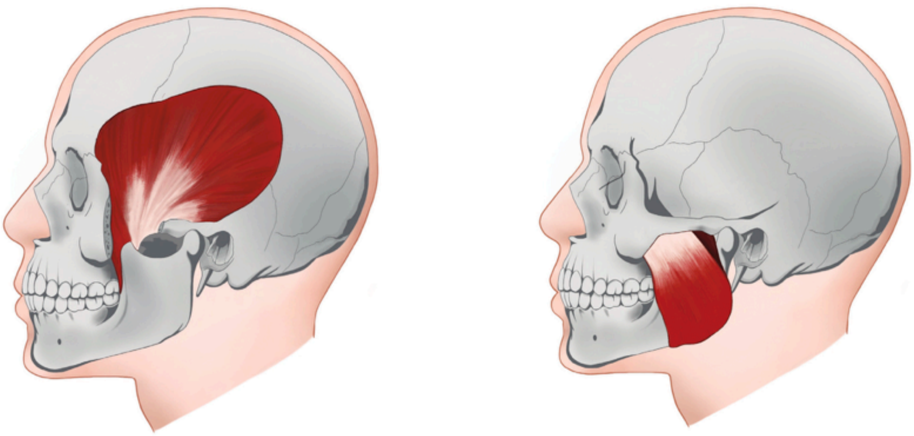


Figure 1 and 2. Location and shape of the temporalis (figure 1) and masseter (figure 2) muscles.

The lateral pterygoid muscle is located well into the infratemporal fossa. It is of quite small size. We can distinguish two heads. The superior head originates in the infratemporal surface and infratemporal crest of the greater wing of the sphenoid while the inferior head takes origin in the lateral surface of the lateral pterygoid plate. Both heads also have different insertions. The superior head inserts in the TMJ capsule while the inferior head inserts in the anterior surface of the neck of the mandibular condyle. The movements performed by these muscles include protrusion, depression as well as protective prevention of excessive backward movement. It is innervated by the lateral pterygoid nerve of the mandibular portion of the trigeminal nerve (1,17). (Figure 3).

The medial pterygoid is larger when compared to the lateral pterygoid muscle. The former has a quadrilateral shape and is isolated by a fibrous aponeurosis. Similar to the lateral pterygoid, the medial pterygoid muscle is also formed by two heads. The superficial small component origins in the maxillary tuberosity whiles the deep major component originates in the medial surface of the lateral pterygoid plate. Both heads of the medial pterygoid muscle insert in the angle and ramus of the mandible. For the most part, the action it is primarily responsible for performing is the elevation of the mandible. On the other hand, it also assists movements such as rotation forward and to the opposite side as well as side to side movements. It is innervated by the medial pterygoid nerve, a branch of the mandibular nerve (1,16) (Figure 3).

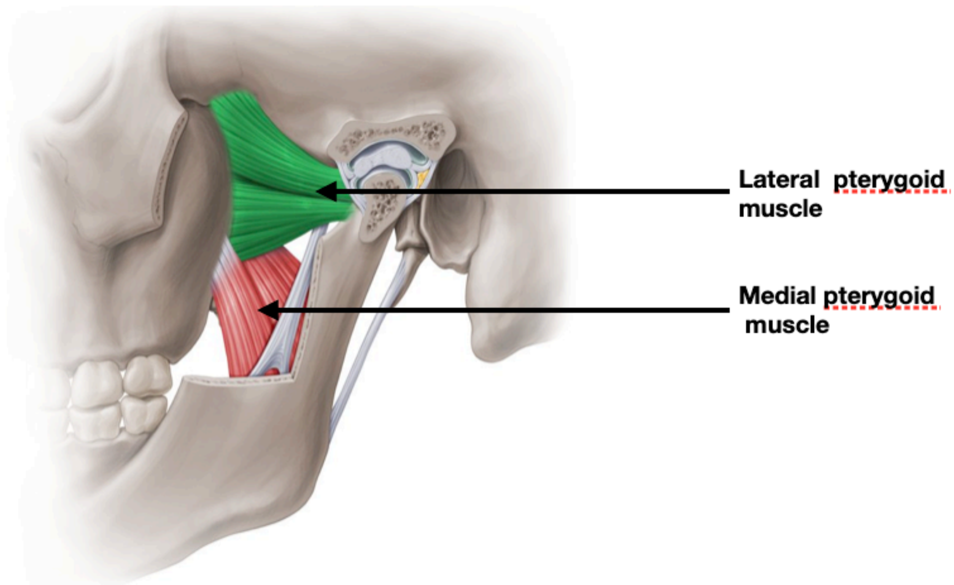
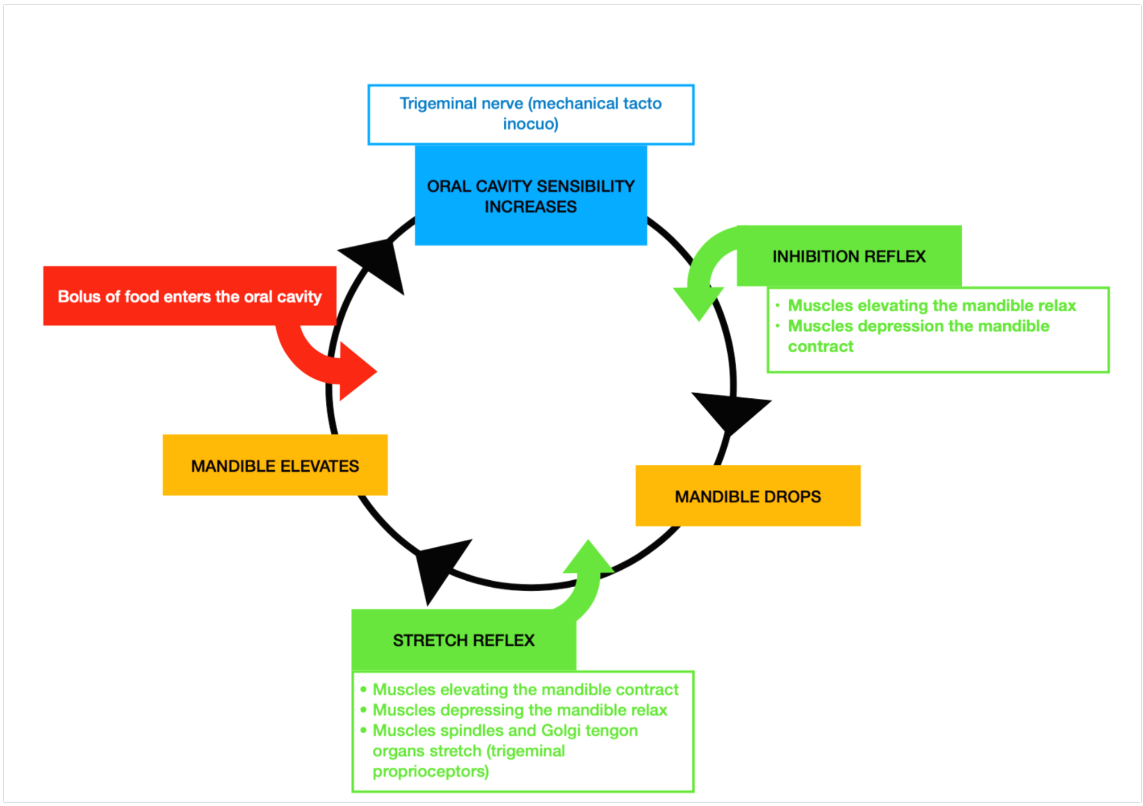


Figure 3. Location of the lateral and the medial pterygoid muscles

2. The masticatory reflex

The masticatory reflex is the chief motor control of the mastication muscles. It works as a continuous cycle. Foremost, when food enters the oral cavity, its sensibility increases thanks to the trigeminal nerve triggering the inhibition reflex. This reflex allows for the elevating muscles of the mandible to relax meanwhile contracting the muscles responsible for depressing the lower mandible. Subsequently, the jaw drops activating the stretch reflex through trigeminal proprioceptors. This prompts the activation of the mastication muscles: elevation muscles contract while depressing muscles relax therefore closing the jaw. This cycle is repeated until bolus is of adequate consistency and afterwards swallowed thereby ending the cycle (1). (Figure 4).



<u>Figure 4.</u> The masticatory reflex

Objectives of the study:

Principal objective: To understand the physiological anatomy and physiology of mastication muscles and the impact of ageing on the masticatory system.

Secondary objective:

- To determine and understand the mechanisms of the risk factors and concomitant diseases such as neurodegenerative diseases that contribute to the increase of loss of function of the mastication muscles related to frailty.
- To determine the clinical handling of such situations in the dental clinic.

Materials and methods:

Performing a literature review using international database websites such as PubMed, Research Gate, Mendeley and Google Scholar, I searched keywords related to mastication muscles and ageing. I also reviewed bibliography from subjects taught during previous years of the dentistry degree at the university such as ‘Anatomy of the Head and Neck’ and ‘Physiology of the Stomatognathic system. Key words included: masticatory muscles; masticatory system; bite force; masticatory performance; mastication impairment ageing; elderly; old patients; frailty; age related factors; tooth loss; xerostomia; saliva; degenerative diseases; Parkinson’s disease; Alzheimer’s disease. The research was conducted in English, French and Spanish. Once the selection of the documents in the databases had been carried out, the inclusion and exclusion criteria were used to select the articles. We excluded all articles dating prior to 2001 limiting our bibliography to the last 20 years. Articles were excluded because sometimes they were in different languages, others presented irrelevant text content and others simply because of the lack of free access to full text. The oldest article dates to 2001 describing the mandibular division of the trigeminal nerve. Only one article dating back to 1995 was included, it described the ageing of human muscle in structure, function and adaptability. This was relevant as it was supportive material to various notions of our subject. Articles about both human and animal subjects were included.

Discussion:

1.MASTICATORY SYSTEM COMPONENTS

1.1 Muscles

Healthy mastication functions as a whole system working effortlessly. It is composed of five groups of muscles according to their respective functions. Each group functions in pairs: one for the right side and one for the left side of the face:

- Primary muscles of mastication: they are the muscles most responsible for movements of the lower jaw. They include the masseter and the temporal muscle responsible for closing of the mandible when chewing; in addition, the medial pterygoid is also responsible for closing the mandible but also for lateral movements; and finally, the lateral pterygoid whose main function is opening the mandible, lateral movements and anterior protrusion.

- The accessory muscles of mastication directly associated with mandibular bone: the digastric, the geniohyoid, the mylohyoid, the omohyoid, the sternohyoid, the sternothyroid, the stylohyoid and the thyrohyoid muscles.

The muscles also work in pairs depending on the side of the body (left and right). Their main function isthe full and effortless coordination of mandibular movements of closing and opening through their attachment to the lower jaw and other bones.

- The accessory muscles of mastication that are indirectly associated with mandibular bone: mainly the sternocleidomastoid, the anterior, medius and posterior scalenus muscles. Their main location is the cervical area. Their attachments include the temporal bone, the sternum, the clavicle and some vertebrae. Their main function is movement coordination of the mandible in relation to the skull.
- The extrinsic muscles of the tongue used to elevate, depress, protrude and withdraw the tongue in order to move the bolus around the oral cavity.
- The intrinsic muscles of the tongue which permit the tongue to create shapes and move from one side of the jugal mucosa to the other.

The mastication system moves regarding a tridimensional plane and all groups of muscles must work simultaneously with the movement of the mandibular bone and the TMJ for achieving healthy function (18).

1.2 Temporomandibular Joint

According to Langlais Color Atlas (19), the temporomandibular joint (TMJ) is composed of the condylar head and neck, the disk and the joint capsule. The disc has an hourglass shape, is made of fibrous cartilage and is located above the condyle and below the glenoid fossa. The joint capsule holds in the articular disc embedded in synovial fluid. It is attached posteriorly to the joint capsule, superiorly to the temporal bone, inferiorly to the posterior condyle, and anteriorly to the capsule and external pterygoid muscle. During opening, the condyle first “rotates” in the glenoid fossa then “translates” as the mouth opens wider. Upon normal maximum opening, the condylar head approximates the articular eminence of the base of the skull.

1.3 Reminder on muscular tissue histology

We will only talk about the striated muscle tissue which consists of 4 components: muscular, conjunctive, vascular and nervous. We will recall only the muscular and the nervous components.

Muscular component

The body of the striated muscle is connected to the skeleton by tendons. It is made up of bundles of muscle fibers, one muscle fiber corresponding to a muscle cell called rhabdomyocite. The cytoplasm of these cells, called sarcoplasm, contains myofibrils. Each myofibril consists of an alignment of elementary contractile units called sarcomeres (figure 4) (1,17,20)

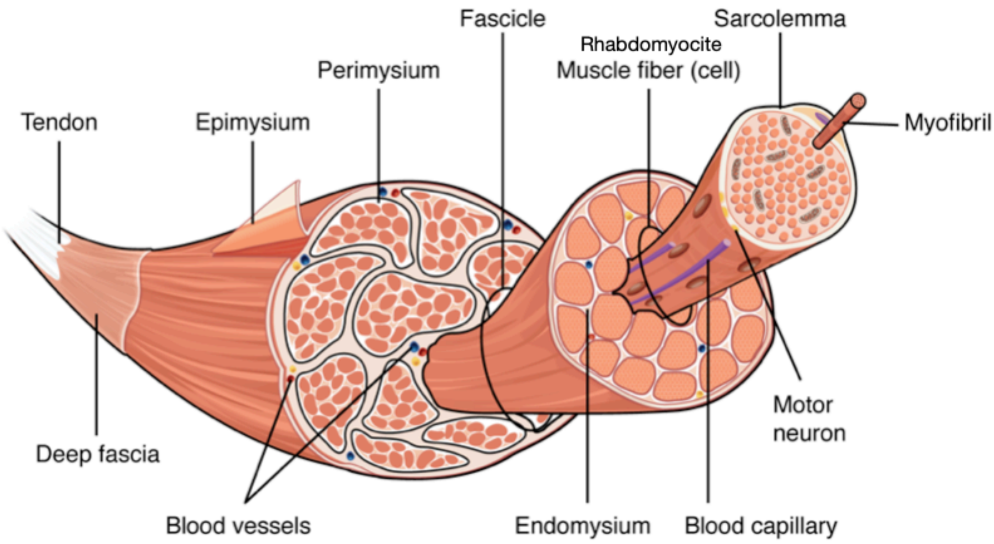
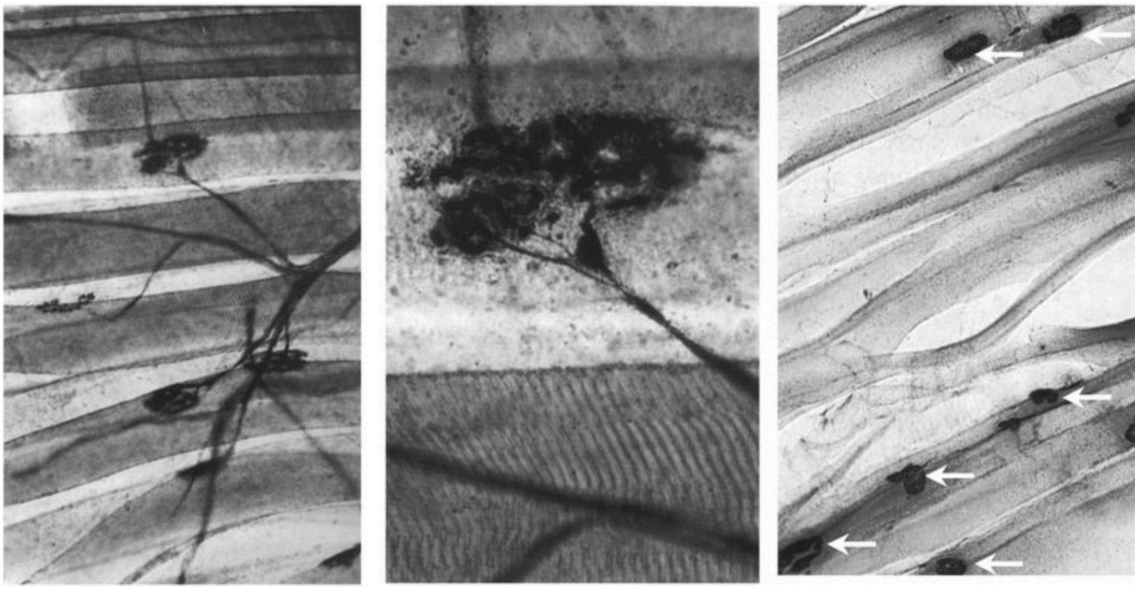


Figure 4. *Muscle components*

There are 2 types of fibres differentiated according to the richness in glycogen, mitochondria and myoglobin (myoglobin captures and fixes oxygen before transmitting it to the mitochondria). First, we will talk about the red fibres type **I**. They are rich in mitochondria and myoglobin but poor in glycogen. They have an aerobic function. Their fatiguability is low and their contraction is slow; they are found in the postural muscles found in the back, the abdomen and the pelvis. On the other hand, white fibres also known as type **II**, are rich in glycogen and poor in mitochondria and myoglobin. Their functioning is anaerobic, their fatiguability is high and their contraction is rapid. They are found in the phasic muscles (muscles that relax and contract during a certain time lapse generally for movement) (1,17,20)

Nerve component:

The motor innervation of each muscle cell is provided by a motor nerve fiber from an alpha motor neuron whose cell body is located in the anterior horn of the spinal cord. The motor neuron sends out an axon whose endings each synapse at a neuromuscular junction or motor plate. A motor neuron can therefore control several muscle fibers via the terminal axonal arborization. A motor neuron for several muscle fibers constitutes a motor unit (1). (Figure 5).



<u>Figure 5.</u> Histological modifications of the mastication muscles due to ageing.

It has been proven by various studies (8,9,21) that a generalised reduction in skeletal muscle mass was observed in the geriatric population. Sarcopenia, which is by definition a geriatric problem, also affects the muscles of the orofacial sphere. Generally speaking, the studies show:

- Atrophy of the masticatory muscles: with reduced muscle surface area, loss of muscle density with infiltration of adipose tissue and connective fibres, especially in the masseter and medial pterygoid (NEWTON et al).

- A generalised muscular force decreases in the geriatric population observed via a study showed by Yamaguchi and Al (9). It proved that grip strength can be used as a direct indicator of skeletal muscle mass and masseter muscle mass. The study included a sample of 489 elderly individuals aged over 85 years old. They observed that grip strength and masticatory muscle strength decrease similarly with ageing, and more so in men than women. This could be explained by the effects of hormones such as growth factor and testosterone. Overmore, a study by Galhager (22) using total body potassium (TBK) as an indicator of skeletal muscle mass showed a significant decrease of TBK in the elderly population compared to the younger population.

- An extension of the contraction time due to the decrease in type II fibres in favour of type I fibres (slow contraction). The hypothesis is that it is either a disappearance or atrophy of type II fibres or a transformation of these fibres into type I.
- An extension and loss of motor units that reduce muscle activity: A study by MM Porter and Al proved that the motor units slow down the conduction of nerve impulses, particularly in the distal regions of the axon. The size of the motor units increases with age, so there are more muscle fibers in a motor unit (21)

A study by Yamaguchi and Al also proved that tooth loss has a stronger link to masticatory system degeneration than ageing itself (9)

The ageing of the masticatory muscles therefore seems to have an impact on the masticatory capacities of the elderly.

A study by Cicek (23)investigated biochemical, physiological and histological masticatory muscle age-related changes. Their main focus concerned matrix metalloproteinase-2 (MMP-2) and type I collagen found in the masseter and temporal muscles of elderly and young mice. MMPs are enzymes regulated by the presence of ionic calcium. They are responsible for various important functions such as the release of growth factors and growth factor receptors, cell proliferation regulation. Overmore, they actively break down extracellular matrix components rendering cellular regeneration easier. It was found that that calcium levels in masticatory muscles of young mice were significantly higher than old mice. It was also noted that MMP levels were higher in the masseter and temporal muscles of adult mice than those of young mice This can be interpreted in the following manner: in order to have proper regulation for growth and tissue proliferation, MMPs and extracellular matrix proteins (such as calcium) must work hand in hand to achieve balance. If harmony is not achieved, there is tissue pathology, and an intensive increase of MMP-2 levels is observed resulting in tissue destruction. MMPs play a pivot role in the development of fibrotic lesions. MMP-2 influences new muscle fibre formation by promoting and enhancing degradation of collagen (24). Indeed, when the rate of breaking down of collagen by MMPs is lower than the production of collagen, the latter accumulates in extracellular connective tissue (25) . MMP-2 influences new muscle fibre formation by promoting and enhancing degradation of collagen. Collagen type I represents over 90% of all collagens found in the body, it is the most frequent type of collagen. The amount of collagen found in the extracellular matrix of masticatory muscles increases with age. Using Masson’s trichome staining, it was reported that the masseter muscle showed higher staining than the temporal muscle. The former being the most powerful muscle of mastication. In this study, it was found that old mice presented samples containing more fibrotic lesions which contain high amounts of collagen. In other words, the total density of collagen in mastication muscles was reportedly higher in adult mice than young mice. This can be explained as a defence mechanism of the body in order to minimise functional muscle loss due to reduced levels of collagen type IV in the muscle mass due to ageing. Overmore, they observed a decrease in the level of muscle mass and increase of connective tissue surrounding the muscles rich in collagen type I and low in innervation and vascularisation due to high levels of MMP-2. Lastly, during histological findings on eosin and haemotoxylin staining, masticatory muscles of young mice proved large nuclei as well as small cytoplasm amount and sizeably larger cells. However, in comparison, in adult mice muscle fibers, the nuclei were smaller, the cytoplasm amount was bigger, and the cells were visibly smaller in size. Furthermore, an increase of necrotic muscle fibers was observed in adult mice. In addition, vascularisation of young muscle fibres is considerably higher whereas old muscle fibres of masticatory muscles showed shrinking of blood vessels due to ageing. Finally, we can safely state that aged muscle fibres of mastication are less healthy in appearance, less functional in regulatory processes, experience more degeneration thereby rendering them less effective concerning masticatory function (23).

2. AGEING AND THE MASTICATORY SYSTEM

In order to review age related changes to the masticatory system, it is important to differentiate between our subjects.

A study by Peyron divided the geriatric population in 3 categories (8)

- the young old aged 60 to 65 years old.

- The middle old aged 70 to 75 years old.
- The very old aged 80 to 85 years old.

Some parameters of mastication ability are slightly influenced by age, however age-related factors such as tooth loss, hyposalivation, and systemic diseases play more key roles in mastication impairment. Therefore, we will differentiate between two groups of patients. The healthy ageing category including subjects in the young and middle aged old groups with most of their teeth and no systemic or chronic diseases impairing mastication; and the very aged population presenting critical dentition states and poor general health where mastication disorders are frequently observed.

2.1 Healthy Ageing

A study by Peyron (6) and al examined the influence of ageing upon mastication. The population included subjects missing 1 or 2 teeth replaced by adequate fixed bridges and therefor considered to have a complete dentition. A mean increase in the total number of cycles was observed. Indeed this accounts for an increase of 3 cycles every 10 years of life or a 50% increase in the total number of cycles from 25 to 75 years old. However, the increase in the duration of cycles was only observed for early mastication phase and not middle or last phases. The mean EMG bursts of temporalis and masseter muscles remain constant with age. This could be explained by the fact that the proportion of motor units used compared with the total amount of motor units available increases with age. Mandibular closing muscles of older people therefore seem to be working closer to their maximum capacity than that of younger people. Although the total amount of EMG activity needed to prepare a bolus of food increases with age, it is independent of the hardness of food. The authors observed an approximately identical increase in amount of individual cycles with test foods increased in hardness in all subjects independently of their age. In sum, this portrays obviously the ability of adaptation in the healthy elderly. Only minor adaptations are needed to compensate for physiological changes such as increase in number of cycles needed to prepare a bolus of food ready for swallowing. It seems that the presence of a complete dentition conditions the preservation of a well functioning masticatory system, more so than ageing itself .

However, it would be wrong to categorically dissociate ageing and masticatory disorders. Ageing is frequently associated with local and/or general diseases, decrease in general state of health and decrease in oral health (tooth loss, hyposalivation, sensory-motor impairement). The consequences of old age are responsible for masticatory impairment.

2.2 Age related risk factors of masticatory system impairment

2.2.1 Tooth loss

Masticatory ability and dento-buccal state are closely related. Indeed, a lack of oral hygiene associated with systematic diseases, drug intake, socio-economic factors and difficult access to dental care is an ongoing problem concerning the geriatric population. Tooth loss and larger edentulous areas increase with age. Chewing and mastication difficulties manifests along with tooth loss. Indeed a study shows that when 20 teeth are present per arcade, the masticatory performance is satisfactory. Starting 7 missing teeth per arcade, difficulty in chewing and mastication arise.

Dentition state and masticatory function are closely related. Indeed, Muller and al considered maximum bite force as a key factor in masticatory performance.

A study Nozomi and Al examined the relation between tooth loss, low masticatory ability and nutritional indices in the elderly population. 3134 subjects were chosen with a median age over 71. The maximum occlusal force was used as a measurement index of masticatory function. It was proved that in both males and females, the maximum occlusal force significantly decreased with the number of teeth (26)

A study by Yamaguchi et Al investigated the relationship between ageing, skeletal muscle mass, masseter muscle thickness (MMT) and tooth loss in the elderly population. It was confirmed that tooth loss was greater indicator of MMT than skeletal muscle mass. In the elderly population, MMT in the edentulous patients was found to be smaller than dentate patients (9)

A study conducted by Zang et Al analysed masticatory disability scores (MDS) in 2 groups of patients. The first category included subjects with 10 or more natural teeth in each jaw; the second category included subjects with less than 10 natural teeth in each jaw taking. The authors took into account factors such as age and prosthesis use. They concluded that age itself did not contribute to chewing difficulties. Indeed, the main factors were age-related: maximum bite force and salivary flow, both decreasing with age. Results show that in the first category, patients reported minor chewing difficulties and that factors such as age and dentition state play little to no role in MDS. However, in the group with less than 10 natural teeth in each jaw, age appeared to be a key factor. However, when they included the dentition status in the second category and more specifically took into account molar and premolar regions, they noticed that MDS scores increased significantly. It was concluded that a sufficient premolar region in subjects with critical dental status was closely associated with masticatory difficulties. Indeed, the presence of three to four premolar pairs appear to be crucial in chewing performance (27).

Overmore, another study proved that masticatory performance values increase after dental treatment. Indeed, a study measuring MMT values in completely edentulous patients at the time of prosthetic dentures rehabilitation insertion and 3 months follow up showed significantly increased MMT values. However, MMT were still higher in dentate patients (28). In addition, a study by Goncalves and Al examined the subject of mastication improvement after partial implant-supported prosthesis use. Similar to previous authors, they used maximum bite force (MBF) and MMT as an indicator for masticatory ability. They came to the conclusion that MBF significantly increased after prosthetic rehabilitation. MMT increase was also observed during contraction after implant insertion. They found higher values with implant fixed dental prosthesis and implant supported dental prosthesis than removable partial dentures in partially edentulous patients (29). Another study showed that teeth rehabilitated with dental prosthesis compensate for decreased masticatory ability for to 50% compared to intact dentition (27)

2.2.3 Xerostomia

The geriatric population is one that is most affected by xerostomia. This is defined as the subjective feeling of having dry mouth(30,31). Xerostomia is listed as a side effect in a wide range of medication used by the elderly population to treat chronic and systemic illnesses such as diuretics, beta blockers, antihistamines, anticonvulsants, etc. (30,32)The healthy human body produces 1-1,5L of saliva each day. Saliva plays a crucial role in the mastication process and is responsible for various basic functions in:

processing of food: such as lubrication of the bolus, chemical digestion and gustatory functions

Protective functions: lubrication and protection of the mucousa, physical and mechanical cleaning, control of the microbiota in the oral cavity

Regulatory functions: maintaining the pH, tooth integrity and homeostasis control (1).

Since saliva has so many capital functions in the stomatognathic system, it is only logical that its disruption influences the masticatory process negatively. It has been proven that in a healthy masticatory system, chewing increases salivary output. A study by Bourdiol et Al (33)tested the effects of chewing during non-feeding conditions (at rest and on parafim) and feeding conditions (meat chewing) in two groups of young and old adults. Their findings suggest that age itself has little influence on salivary flow during non-feeding conditions. Results of parotid saliva flow and whole saliva flow of old adults are within the same range than that of young adults. Overmore they observed a more important salivary flow during chewing in old adult. This could be explained by decreased bite force and longer chewing periods used as a form of adaptation. In addition, they observed higher salivary flow rates when chewing meat compared to parafilm in all ages. This is yet another adaptation method of the masticatory system facing different food textures (33). However, it is important to remind the readers that these results only apply to subjects still capable of healthy mastication. With less intact teeth present in the oral cavity, it becomes harder to stimulate the salivary glands and less saliva is present for producing an adequate food bolus ready to be swallowed (8).

A study by Hyo-Jung Kim et al (31) investigated the effects of a simple oral exercise (SOE) performed 2 minutes before meals in elderly patients of over 65 years of age. The exercise included stretching of the tongue in upwards, downwards, right and left directions. Overmore, it included the stimulation of the oral vestibule and buccal mucosa. The SOE documented a decrease in performance time, improvements in mastication, salivation and swallowing functions and an increase in unstimulated flow rates. The improvements were observed immediately but also maintained after a 1 week follow up. It is recommended that elderly patients with masticatory disorders perform the SOE prior to each meal (31).

2.2.4 Parkinson’s disease

It is a chronic neurodegenerative disorder, with a slow and progressive evolution, affecting the central nervous system, and which is responsible for essentially motor disorders (34). Parkinson’s Disease (PD) is the second most common neurodegenerative disease after Alzheimer's disease (35). The disease is characterised by the loss of black matter neurones. These neurones have the function of making and releasing dopamine. This substance is a neurotransmitter that is essential for controlling the body's movements. Several biological processes are suspected to lead to neuronal loss such as mitochondrial dysfunction, apoptosis, accumulation of proteins toxic to neurons, oxidative stress, etc (36).

The symptoms of Parkinson's disease are as follows (the triad):

- A slowness of movement
- Unilateral resting tremor, which affects the limbs more frequently. Usually, the head is spared, but the tongue, lips, jaw, and the upper jaw, with the chin may be affected.
- Muscle stiffness.

The oral health of these patients may decline rapidly due to tremors, muscle rigidity and cognitive deficits. Parkinson's patients have an impassive facial appearance due to a reduction in the movement of the facial expression muscles. The triad of symptoms induces orofacial pain, temporomandibular joint discomfort, cracked teeth, attrition, and can lead to difficulties in controlling and retaining dentures (34). Parkinsonian patients, as the disease progresses, describe more and more difficulties in speaking, chewing and swallowing (37). A study by BAKKE (38) showed by comparing two groups of elderly people (one group with Parkinson's disease and a control group without) that orofacial dysfunction was more widespread in the group of Parkinson's patients, chewing and mouth opening were poorly performed. The study also showed that the impact of oral health was more negative in Parkinson's patients than in the free patients. The progression of the disease aggravates facial and dental problems. BAKKE (38) asked the affected group to describe their masticatory capacity; these patients described it as poor and that it decreases with disease progression. Indeed, the time for eating meals is greatly prolonged due to:

- Difficulty in getting food to the oral cavity
- Slow chewing
- With less tongue movement: the food bolus is very slow.
- propelled backwards
- Difficulty swallowing due to pharyngeal motor deficit.

2.2.5 Alzheimer's disease

Alzheimer's disease (AD) is a progressive neurodegenerative disorder that affects many of the cognitive functions necessary for a person's independence and quality of life. Symptoms most often appear after age 65. The prevalence of the disease increases strongly with age. Alzheimer's disease is the most common form of dementia in the elderly (11). Symptoms worsen as the disease progresses and three stages are described (39):

- Mild dementia stage: presence of frank amnestic syndrome affecting mainly short-term, episodic and semantic memory; loss of object awareness; recognition disorder. Procedural memory is preserved.

- Moderate dementia stage: more significant memory problems; comprehension and language problems; agnosia; inability to perform certain daily activities such as dressing; loss of the ability to coordinate movements; psychobehavioral problems (thinking, mood and perception).

- Severe stage of dementia: all memories are affected, motor disorders that lead to a loss of walking, difficulty eating, sphincter disorders, spatio-temporal disorientation (total loss of autonomy);

The relation between dementia and masticatory function have been largely investigated in a range of epidemiological and neuroscientific studies. For example: a study by Onozuka et al (40) observed during mastication increased cerebral blood flow in various regions of the brain (motor and supplementary motor area, sensory area, insula, thalamus and cerebellum) during mastication (40).In addition, various studies proved that tooth loss is a risk factor for developing all cause dementia and AD (41,42). It has also been proved that asymmetrical performance of mastication muscles (due to loss of masticatory reflex, loss of teeth) causes trigeminal nerve unbalance resulting in cognitive functions impaiment. In addition, restoring occlusal harmony and therefor restoring adequate trigeminal afferent activity leads to cognitive improvements (43). Overmore, the decrease in bite force and tooth loss have been related to the development of dementia in older people. Chewing activity and bite force are associated with cognitive function, as mastication is important for neural stimulation in the cerebral cortex (44). And finally, hardness of food curtails cognitive deterioration (45).

Indeed, impaired mastication leads to cognitive deficit, malnutrition and disrupts the performance of activities of daily living. Patients with cognitive deficit and/or loss of physical abilities are more likely to have poor oral hygiene and impaired masticatory function. Other factors may influence both cognitive and masticatory functions such as age, socioeconomic status, wearing dentures or not, presence of orofacial pain...

2.2.6 Stroke

Stroke is a sudden neurological deficit of vascular origin caused by an infarction or haemorrhage in the brain, resulting in a lack of oxygen to the nervous system. Signs of a stroke include:

- A deformity of the mouth on the affected side
- Weakness on one side of the body (arm or leg)
- Speech problems

Ageing is regarded as the most important predictor of stroke incidence and mortality, and thus, their rates increase by age. 88% of global strokes occur above age 65 years, 72% of which is > 75 years (46).

It is interesting for us to review the effects of a cerebrovascular stroke in relation to mastication muscles. A study by Schimmel et Al (47) demonstrated that maximal bite force does not vary significantly between stoke and non-stroke patients. Overmore, it was noted that the effects of a stroke on masticatory muscles is trivial compared to that of limb and facial dysfunction. This could be explained by the bilaterality of the trigeminal nerve motor neurone control. However, the authors observed a significant decrease in maximum lip force and chewing efficacy. Bite force is distinguished from these two factors as it is chewing uses only a fraction of the available maximum bite force (47).

A study by Umay (12) investigated the consequent dysphagia that occurs in stroke patients compared to healthy patients. They found a significant decrease in motor action potential (MAP) of perioral and swallowing muscles including the orbicularis oris, the masseter and the intrinsic tongue muscles. Muscles involved in the oral phase of swallowing are in coordination with one another meaning that the impairment of one of them can have consequences on the whole swallowing system. Masseter muscle weakness can result in masticatory impairment, mandibular instability and even increase risk of aspiration. Minor structural changes only start occurring 4 hours after the stroke incident has happened. After 1 week, it is common to notice consequential muscle atrophy in big muscles (even in non-affected extremities) but also in small swallowing muscles up to 30 days after the stroke. In addition, it is possible to observe at least 16% muscle strength loss after 10 days of immobility. Overmore, previous studies state that long term irreversible changes occur in affected muscles such as atrophy, reduction of cross-sectional fibre areas and finally an increase in intramuscular fat deposition (12)

3. CLINICAL HANDLING

Geriatric patients require more complex measures of prevention, intervention and oral health rehabilitation. In order to maintain a well-functioning masticatory system in the elderly population, it is important to keep a good oral health. The oral cavity of patients must be evaluated using the WHO oral assessment objective and standardised dental tests and indices (4th and 5th edition)(26,48,49). Teeth affected by carries must be adequately restored as to have proper occlusion with the rest of teeth. Teeth and gums diseases lead to permanent tooth loss, which as aforementioned, plays a crucial in fighting against masticatory impairment. According to a report of Andrade et al. (2012) 97,7% of the elderly need oral prosthesis. It was proved by various studies that teeth rehabilitated with dental prosthesis compensate for decreased masticatory ability for to 50%compared to intact dentition (27). We must differentiate between different prosthetic options to compensate for the teeth that have been lost. The use of removable dentures for prosthetic rehabilitation is very common in the geriatric population. In patients with masticatory dysfunction, they have been proved to improve performance however remaining lower than natural dentition and other prosthetic options (28,50,51). Oral rehabilitation with dental implants have shown distinct better results in improving masticatory function in edentulous patients (50–52). This could be explained by an increase in stability and retention provided by the implant fixation in the bone and an increase in the patient adaptation and psychological acceptability.

Hygiene instructions must be repeated to the ageing patient. Generally because this type of patients has difficulty assimilating and remembering large quantities of information. The information given must be explained simply and spread through different appointments.

Conclusion

The mastication system appears to age slowly and progressively in the absence of general pathologies and the functional consequences only appear very late. In a healthy aged mastication, masticatory muscles undergo histological, physiological and biochemical changes displaying the consequences of muscle atrophy. Sarcopenia is not exclusive to the masticatory muscles and are generalised in the whole body (grip strength, appendicular force). However, the results of chewing performances of health old adults and healthy young adults are similar. Therefore we can safely then state that ageing itself has little influence of masticatory impairment.

The risk factors related to growing old include bad oral health, tooth loss and xerotomia. The most influential being tooth loss. Neurodegenerative diseases such as Alzheimer's, Parkinson's and strokes are also considered age-related risk factors for masticatory impairment. Overmore, cognitive functions and mastication appear to be associated.

Good oral and general health is essential to help the ageing masticatory system function properly. It is then obvious to ensure an adapted management and a regular follow-up of the oral health of the elderly, not only at the time of the appearance of general pathologies but also in the patient until then autonomous which show the first signs of frailty.

RESPONSIBILITIES

The geriatric population is increasing in the world, and so are the dental conditions related to ageing such as tooth loss, caries incidence, gingival recession, loss of structure of the periodontium, etc. There is need to maintain the health and wellbeing of the elderly patient in order to keep adequate oral functions such as nutrition and phonation. The review of articles provided by this study allows the reader to gather knowledge regarding the consequences of ageing on the masticatory system. Regarding social sustainability, this paper helps clinicians have an overview of the situations regarding masticatory impairment. This allows the dentist to perform an easier and faster diagnosis, be more prepared to face such disorders in the dental clinic and to ultimately be able to improve the quality of life of the patient.

Since tooth loss is the principal risk factor regarding masticatory dysfunction, it is important to keep the teeth stable on the dental arches. Regarding economic sustainability, this will allow the patient to avoid the costly price of dental prosthetics.

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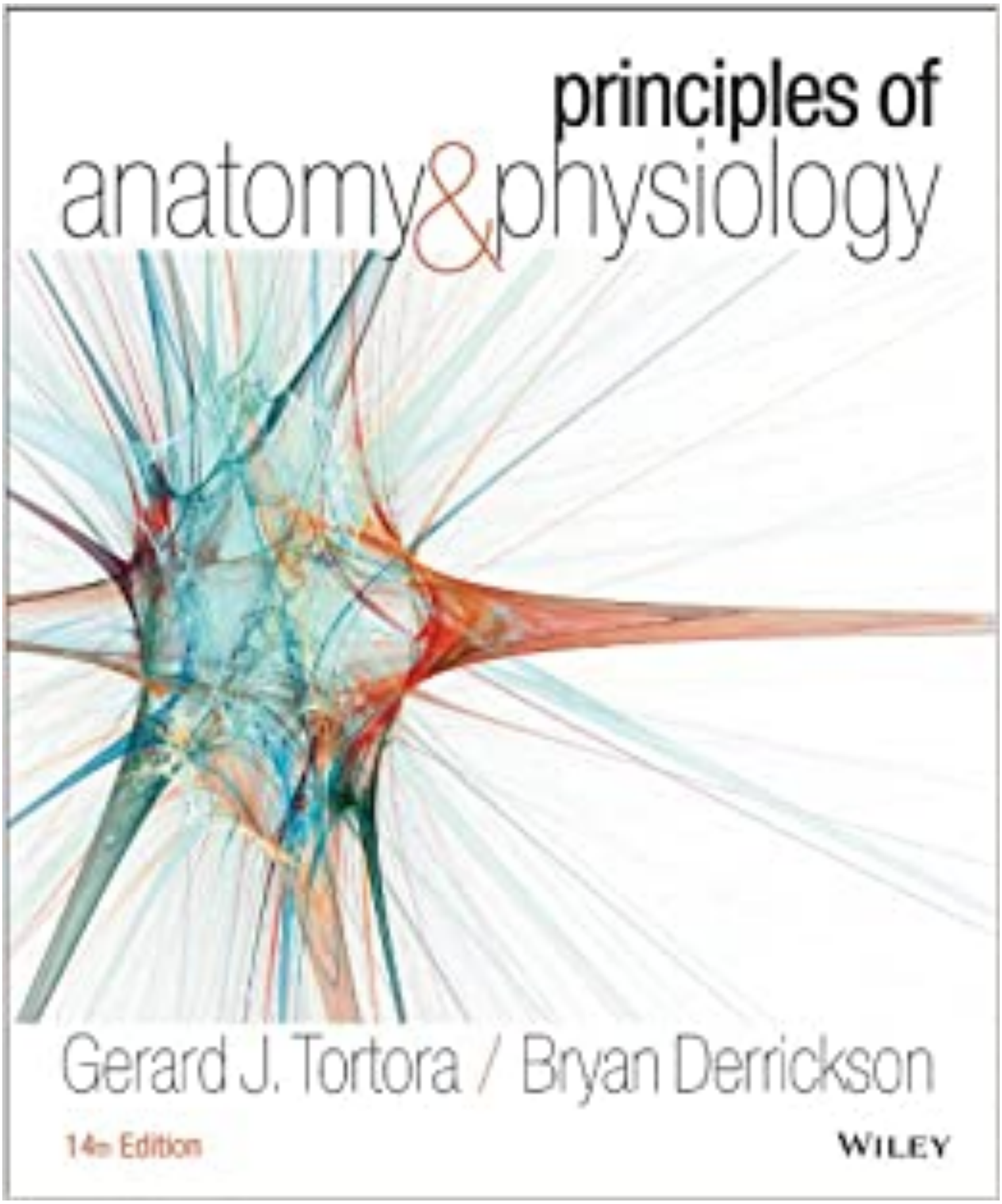
Annex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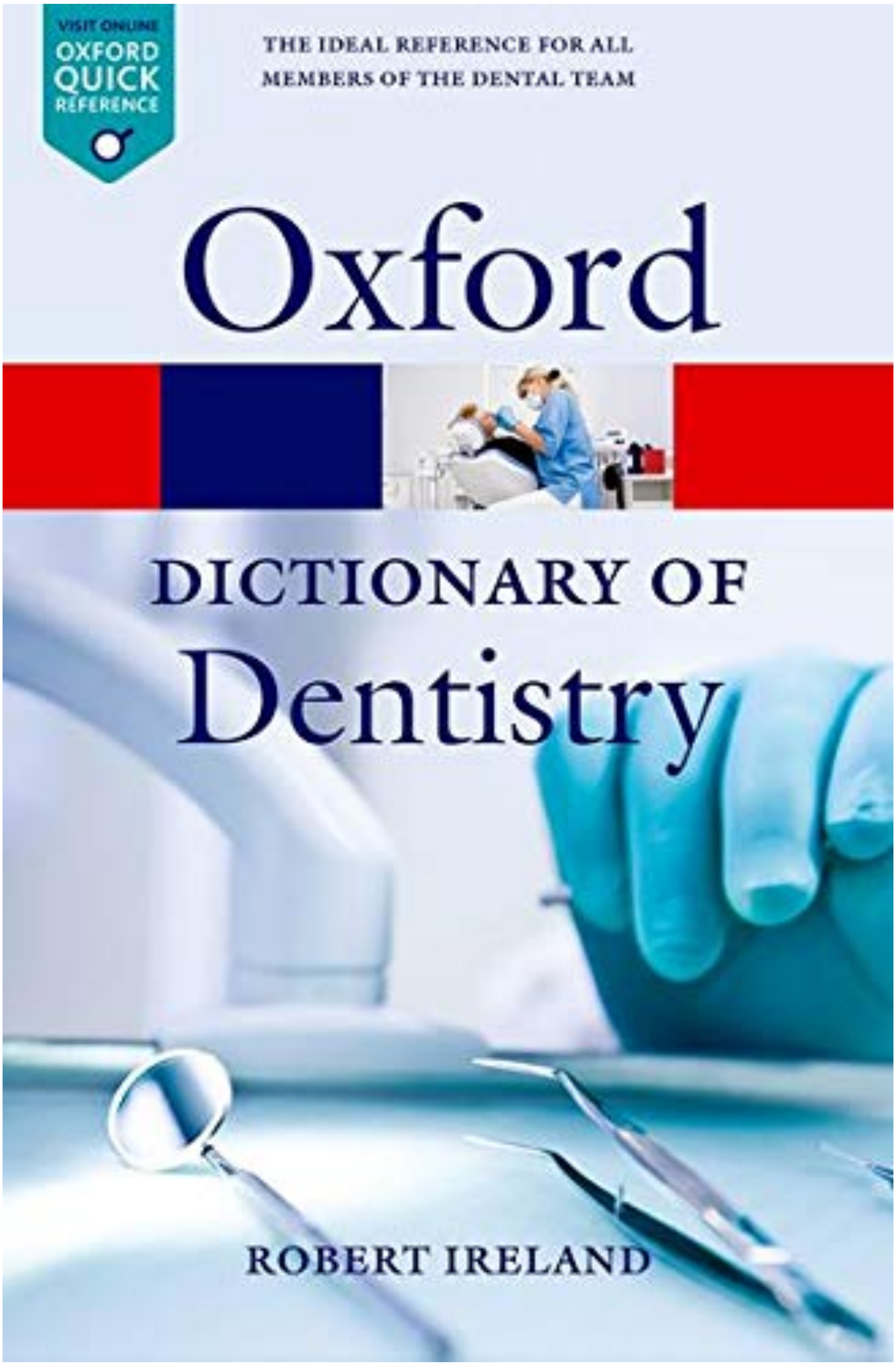
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The trigeminal nerve. Part IV: the mandibular division

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Affiliations
PMID: 11482826 DOI: 10.1080/08869634.2001.11746164

Abstract

The mandibular or third division of the trigeminal nerve is the largest of the three divisions. It is considered a mixed nerve. That is, like the ophthalmic and maxillary divisions, the mandibular conveys afferent fibers. But unlike the former two divisions, the mandibular also contains motor or efferent fibers to the muscles of mastication, the mylohyoid and anterior digastric muscles, and the tensor veli palatini and tensor tympani muscles. So intimately associated with dentistry, the mandibular nerve has also been termed the dental nerve by anatomists in the past. This extensive and complicated division of the trigeminal nerve can cause confusion to both patient and doctor. Pain is often referred within its branches and even into other trigeminal divisions, chiefly the maxillary. This fourth and last article about the trigeminal nerve will present in detail the mandibular division.

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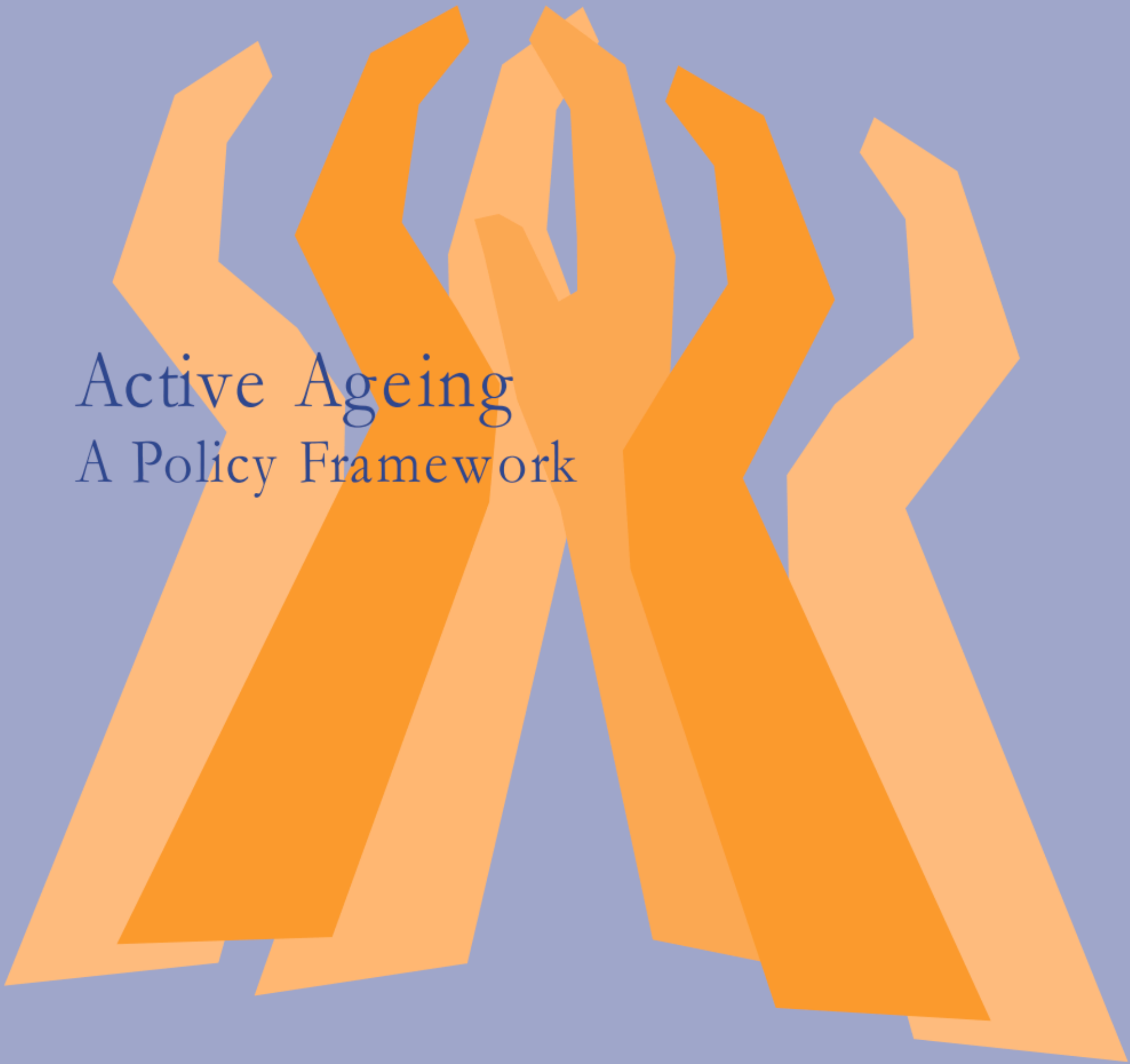

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10.1152/jn.01122.2003.

Influence of Age on Adaptability of Human Mastication

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Submitted 20 November 2003; accepted in final form 9 March 2004

Peyron, Marie-Agnès, Olivier Blanc, James P. Lund, and Alain Woda. Influence of age on adaptability of human mastication. *J Neurophysiol* 92: 773–779, 2004; 10.1152/jn.01122.2003. The objective of this work was to study the influence of age on the ability of subjects to adapt mastication to changes in the hardness of foods. The study was carried out on 67 volunteers aged from 25 to 75 yr (29 males, 38 females) who had complete healthy dentitions. Surface electromyograms of the left and right masseter and temporalis muscles were recorded simultaneously with jaw movements using an electromagnetic transducer. Each volunteer was asked to chew and swallow four visco-elastic model foods of different hardness, each presented three times in random order. The number of masticatory cycles, their frequency, and the sum of all electromyographic (EMG) activity in all four muscles were calculated for each masticatory sequence. Multiple linear regression analyses were used to assess the effects of hardness, age, and gender. Hardness was associated to an increase in the mean number of cycles and mean summed EMG activity per sequence. It also increased mean vertical amplitude. Mean vertical amplitude and mean summed EMG activity per sequence were higher in males. These adaptations were present at all ages. Age was associated with an increase of 0.3 cycles per sequence per year of life and with a progressive increase in mean summed EMG activity per sequence. Cycle and opening duration early in the sequence also fell with age. We concluded that although the number of cycles needed to chew a standard piece of food increases progressively with age, the capacity to adapt to changes in the hardness of food is maintained.

INTRODUCTION

The rhythm of mastication is generated by a brain stem central pattern generator (Dellow and Lund 1971), but its output is modulated by other parts of the brain and by the properties of food being processed, including the size, hardness, and texture of the pieces (Lund 1991; Peyron et al. 1997, 2002; Schindler et al. 1998; Thexton et al. 1980). Adaptation of the motor program to the physical characteristics of the food leads to changes in the amplitude and duration of electromyographic (EMG) activity, which in turn alter the duration and form of specific phases of the cycle (Schwartz et al. 1989; Thexton and Hiiemae 1997).

Little is known on the effect of aging on masticatory function. If confounding factors such as missing teeth are taken into account, aging alone has little impact on the ability of subjects to reduce food into small particles (Feldman et al. 1980; Fontijn-Tekamp et al. 2000; Hatch et al. 2001; Wayler and Chauncey 1983). In addition, the sizes of particles in a bolus judged to be ready to swallow by the subjects does not vary with age (Feldman et al. 1980). These findings are surprising because of the general progressive decline in total body muscle mass (Gallagher et al. 1997; Porter et al. 1995) and in muscle mechanical performance (Davies et al. 1986; Harridge et al. 1995) with aging. Furthermore, the cross-sectional areas of the masseters and medial pterygoids diminish in the elderly (Newton et al. 1987), and bite force also falls (Bakke et al. 1990; Hatch et al. 2001). These changes are accompanied by a reduction in salivation (Navazesh et al. 1992) and perhaps in reflex responsiveness (Kossioni and Karkazis 1998; Smith et al. 1991). Therefore we hypothesized that some age-related adaptation of masticatory function must occur to maintain masticatory performance.

Because physiological aging is frequently accompanied by the loss of teeth and by the development of local and systemic conditions that also reduce the ability to masticate (Hatch et al. 2001; Helkimo et al. 1977), we chose to evaluate the effects of physiological aging on mastication in relative isolation. A sample population of subjects aged 25–76 yr who had almost all their teeth and who had no evidence of systemic or oral disease was selected. Masticatory function was evaluated from the electromyographic (EMG) records of the masseter and temporalis muscles and from jaw movements recorded during the mastication of four elastic model foods of standard dimensions that differed in hardness.

METHODS

Subjects

Two advertisements were published in a local newspaper asking people with complete dentitions to volunteer for the study. The sample was made of 29 male (mean: 41.8 yr, from 25 to 73 yr) and 38 female (mean: 42.0 yr, from 28 to 71 yr) French-speaking Caucasians. Seven males and six females were >50 yr. To recruit an adequate number of subjects >50, we included those who had one or two missing teeth replaced by fixed bridges (2 males, 58 and 64 yr old; 3 females 54, 56, and 70 yr old). The quality of each prosthesis was evaluated, and the subject was accepted if the replaced tooth or teeth were in proper contact with those in the other dental arch. All our subjects were therefore considered to have a complete dentition. The relationship between upper and lower teeth was normal as assessed by standard dental criteria (Angle's class I). None of the subjects had received orthodontic treatment. They were free of dental pathology such as caries or periodontal disease. They did not have orofacial pain, and no evidence of tenderness or joint pathology was detected during the physical examination. The subjects were not aware of tooth grinding or excessive tooth clenching. General health was good. None of the subjects were taking medications that affect muscle function, and were not regular users of psychotropic drugs. This study was approved by the Ethics Committee of the Université d'Auvergne.

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ORIGINAL RESEARCH

Electromyographic activity of masticatory muscles in elderly women – a pilot study

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Objectives: To evaluate the effect of age and chosen factors related to aging such as dentition, muscle strength, and nutrition on masticatory muscles electromyographic activity during chewing in healthy elderly women.

Background: With longer lifespan there is a need for maintaining optimal quality of life and health in older age. Skeletal muscle strength deteriorates in older age. This deterioration is also observed within masticatory muscles.

Methods: A total of 30 women, aged 68–92 years, were included in the study: 10 individuals had natural functional dentition, 10 were missing posterior teeth in the upper and lower jaw reconstructed with removable partial dentures, and 10 were edontoulous, using complete removable dentures. Surface electromyography was performed to evaluate masticatory muscles activity. Afterwards, measurement of masseter thickness with ultrasound imaging was performed, body mass index and body cell mass index were calculated, and isometric handgrip strength was measured.

Results: Isometric maximal voluntary contraction decreased in active masseters with increasing age and in active and passive temporalis muscles with increasing age and increasing body mass index. In active masseter, mean electromyographic activity during the sequence (time from the start of chewing till the end when the test food became ready to swallow) decreased with increasing age and during the cycle (single bite time) decreased with increasing age and increasing body mass index. In active and passive temporalis muscles, mean electromyographic activity during the sequence and the cycle decreased with increasing age, increasing body mass index, and loss of natural dentition. Individuals with natural dentition had significantly higher mean muscle activity during sequence and cycle in active temporalis muscles than those wearing full dentures and higher maximal activity during cycle in individuals with active and passive temporalis muscles than in complete denture wearers.

Conclusion: Decrease in electromyographic activity of masticatory muscles in elderly women is related to age, deterioration of dental status, and body mass index.

Keywords: electromyographic activity, masseters, temporalis muscles, masticatory muscles, mastication, elderly women

Background

Age-related loss of muscle strength and function may lead to decline in physical performance. It results from the loss of muscle mass and the qualitative impairment of the muscle tissue with increasing age.[1] Similar changes are observed in masticatory muscles. Palinkas et al recorded a gradual decrease in thickness of masseters at rest and maximal voluntary contraction (MVC) in a study group consisting of people aged >60 years.[2] Cecilio et al stated that electromyographic activity of masticatory muscles decreases in adulthood with advancing age.[3]

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http://dx.doi.org/10.2147/CIA.S118338

Received Date : 12-Aug-2016
Revised Date : 14-Dec-2016
Accepted Date : 22-Dec-2016
Article type : Review

AGE – RELATED CHANGES IN MASTICATION

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Key words : Mastication, Food bolus, Granulometry, Swallowing, Aging, nutrition

Yamaguchi *et al. BMC Geriatrics* (2018) 18:67
https://doi.org/10.1186/s12877-018-0753-z

BMC Geriatrics

RESEARCH ARTICLE Open Access

Relationship of aging, skeletal muscle mass, and tooth loss with masseter muscle thickness

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Abstract

Background: Previous studies have reported a relationship between masseter muscle thickness and tooth loss or limb muscle thickness. However, it is not yet known whether masseter muscle thickness is related to appendicular skeletal muscle mass, and grip strength. The purpose of this study was to determine which of the two variables—tooth loss or appendicular skeletal muscle mass index—is more strongly related to masseter muscle thickness, and to identify a suitable indicator of decreasing masseter muscle thickness in healthy elderly individuals.

Methods: Grip strength, walking speed, body weight, skeletal muscle mass index, tooth loss, and masseter muscle thickness at rest and during contraction were determined in 97 community-dwelling elderly individuals aged ≥65 years (men: 44, women: 53). Masseter muscle thickness was chosen as the dependent variable, while age, skeletal muscle mass index, body weight, grip strength, and tooth loss were chosen as the independent variables. Multiple regression analysis was conducted using the stepwise regression method.

Results: In men, grip strength was the only independent predictor of masseter muscle thickness at rest. Tooth loss and grip strength were independent predictor of masseter muscle thickness during contraction. In women, tooth loss was the independent predictor of masseter muscle thickness both at rest and during contraction, while grip strength and body weight were the independent predictor of masseter muscle thickness at rest only.

Conclusions: We confirmed that in healthy elderly individuals, tooth loss has a stronger relationship with masseter muscle thickness than aging and skeletal muscle mass index do. Masseter muscle thickness in both elderly men and women is also associated with grip strength, suggesting that grip strength can be used as an indicator of masseter muscle thickness in this population.

Keywords: Aging, Elderly, Masseter muscle, Tooth loss, Skeletal muscle

Background

A generalized reduction in skeletal muscle mass and muscle strength occurs with aging. However, in elderly individuals, the influence of tooth loss on weakening of the masseter muscle—one of the masticatory muscles—must also be considered. A previous study showed that the masseter muscle is significantly thinner in an edentulous population than in a dentulous population [1]. Furthermore, the loss of masseter muscle mass due to tooth loss is well known [2].

Recent studies have reported a reduction in the strength of the perioral muscles due to sarcopenia [3]. Sarcopenia, due to aging and other reasons, results in a reduction in skeletal muscle mass, muscle strength, and physical function [4]. With regard to reduction in perioral muscle mass due to sarcopenia and malnutrition, a 2-year longitudinal study in elderly trauma patients showed the cross-sectional area of the masseter muscle to be a better predictor of 2-year mortality than the cross-sectional area of the psoas muscle. The psoas cross-sectional area is known as one of the objective indicators of sarcopenia, but cross-sectional area of the masseter muscle was shown to be a better predictive marker of sarcopenia in this study [5]. In addition, a cross-sectional study in 104 elderly individuals showed that tongue thickness decreases due to undernutrition in this population [6].

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Medicina Oral Patología Oral y Cirugía Bucal

Med Oral Patol Oral Cir Bucal. 2019 May; 24(3): e314–e318.
Published online 2019 Apr 24. doi: 10.4317/medoral.22841

PMCID: PMC6530957
PMID: 31012437

Impact of Parkinson's disease on the efficiency of masticatory cycles: Electromyographic analysis

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Conflict of interest statement: The authors declare that they have no conflicts of interest.

Received 2018 Oct 29; Accepted 2019 Feb 4.

Abstract

Background

This study evaluated the efficiency of masticatory cycles by means of the linear envelope of the electromyographic signal of the masseter and temporalis muscles in individuals with Parkinson's disease.

Material and Methods

Twenty-four individuals were assigned into two groups: with Parkinson's disease, average ± SD 66.1 ± 3.3 years (n = 12) and without the disease, average ± SD: 65.8 ± 3.0 years (n = 12). The MyoSystem-I P84 electromyograph was used to analyze the activity of masticatory cycles through the linear envelope integral in habitual mastication of peanuts and raisins and non-habitual mastication of Parafilm M®.

Results

Epidemiology of Alzheimer's disease: occurrence, determinants, and strategies toward intervention

Chengxuan Qiu, MD, PhD; Miia Kivipelto, MD, PhD; Eva von Strauss, PhD

More than 25 million people in the world today are affected by dementia, most suffering from Alzheimer's disease. In both developed and developing nations, Alzheimer's disease has had tremendous impact on the affected individuals, caregivers, and society. The etiological factors, other than older age and genetic susceptibility, remain to be determined. Nevertheless, increasing evidence strongly points to the potential risk roles of vascular risk factors and disorders (eg, cigarette smoking, midlife high blood pressure and obesity, diabetes, and cerebrovascular lesions) and the possible beneficial roles of psychosocial factors (eg, high education, active social engagement, physical exercise, and mentally stimulating activity) in the pathogenetic process and clinical manifestation of the dementing disorders. The long-term multidomain interventions toward the optimal control of multiple vascular risk factors and the maintenance of socially integrated lifestyles and mentally stimulating activities are expected to reduce the risk or postpone the clinical onset of dementia, including Alzheimer's disease.

Dialogues Clin Neurosci. 2009;11:111-128.

Keywords: *aging; Alzheimer's disease; epidemiology; incidence; prevalence; vascular risk factor; psychosocial factor; intervention*

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Dementia can be defined as a clinical syndrome characterized by a cluster of symptoms and signs manifested by difficulties in memory, disturbances in language and other cognitive functions, changes in behaviors, and impairments in activities of daily living. Alzheimer's disease (AD), which is named after the German psychiatrist Alois Alzheimer, who first described this disorder more than one century ago, is the most common cause of dementia, accounting for up to 75% of all dementia cases. Alzheimer's disease is a progressive neurodegenerative disorder. During the last a few decades, research in epidemiology of dementia and AD has made tremendous progress. In this review, we briefly summarize the major findings from the recent epidemiologic studies of AD concerning occurrence (global prevalence, incidence, and impact), determinants (risk and protective factors), and possible strategies toward intervention.

Global population aging, occurrence, and impact of Alzheimer's disease

Worldwide population aging

Population aging has become a worldwide universal phenomenon. The reports from the UN Aging Program and the US Centers for Disease Control and Prevention have projected that the number of older people (65+ years) in the world is expected to increase from 420 million in 2000 to nearly 1 billion by 2030, with the proportion of older people being increased from 7% to 12%.[1,2] Developing countries will see the largest increase in absolute num-

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NEURAL INDIA
Publication of the Neurological Society of India

Home

ORIGINAL ARTICLE
Year : 2019 | **Volume** : 67 | **Issue** : 6 | **Page** : 1459--1466

What Happens to Swallowing Muscles after Stroke?: A Prospective Randomized Controlled Electrophysiological Study

Ebru Karaca Umay[1], Volkan Yilmaz[1], Ibrahim Gundogdu[1], Erhan Ozturk[1], Eda Gurcay[1], Ozgur Karaahmet[1], Guleser Saylam[2], Tijen Ceylan[2], Aytul Cakci[1],
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Abstract

Background: Stroke is the most frequent reason of neurological dysphagia Electrophysiological studies can be used to evaluate oral, pharyngeal and initial phase of esophageal phase. **Aims:** This study aims to noninvasively evaluate mastication, mimic, and tongue muscles of stroke patients, which play an important role in the oral phase of swallowing process and compare them with healthy individuals. **Setting and Design:** This study was conducted at the Physical Medicine and Rehabilitation Clinic of our hospital between January 2014 and December 2016. **Materials and Methods:** Fifty-one patients who were admitted to our clinic with stroke and 51 healthy individuals were evaluated for the study. Demographic features of individuals were recorded. The swallowing intervals and motor action potentials (MAPs) of trigeminal, facial and hypoglossal nerves were measured. After four weeks of treatment schedule, patients were re-evaluated. **Statistical Analysis:** The Wilcoxon Signed Rank test, the Mann–Whitney U test and Fisher exact test were used in this study. **Results:** The all swallowing intervals were found prolonged compared to the healthy controls ($P < 0.05$). The MAPs of the masseter, orbicularis oculi, and intrinsic tongue muscles were significantly lower in patient group ($P < 0.05$). After treatment, we found significant improvement for all parameters in patient group, but the swallowing intervals were still significantly prolonged, and MAPs of these muscles were still lower ($P < 0.05$). **Conclusion:** Although swallowing is examined as different phases, the process is complicated and should be evaluated totally. In post-stroke dysphagia, oral phase of swallowing process is as important as phayngeal phase and perioral, mastication, and tongue muscles are influenced even in an early period as a month.

How to cite this article:
Umay EK, Yilmaz V, Gundogdu I, Ozturk E, Gurcay E, Karaahmet O, Saylam G, Ceylan T, Cakci A. What Happens to Swallowing Muscles after Stroke?: A Prospective Randomized Controlled Electrophysiological Study.Neurol India 2019;67:1459-1466

How to cite this URL:
Umay EK, Yilmaz V, Gundogdu I, Ozturk E, Gurcay E, Karaahmet O, Saylam G, Ceylan T, Cakci A. What Happens to Swallowing Muscles after Stroke?: A Prospective Randomized Controlled Electrophysiological Study. Neurol India [serial online] 2019 [cited 2021 Apr 13];67:1459-1466
Available from: https://www.neurologyindia.com/text.asp?2019/67/6/1459/273645

Full Text

Neurological dysphagia is common after stroke and can be seen with 65–81% frequency in acute phase. Although 90% of the patients have spontaneous recovery in 2 or 3 weeks, persistent cases (11–50%) up to six months are reported.[1],[2] Recently, studies show that every stroke case is a risk factor for swallowing disorders.[1]

Lin *BMC Geriatrics* (2018) 18:5
DOI 10.1186/s12877-017-0693-z

BMC Geriatrics

DEBATE

Revisiting the link between cognitive decline and masticatory dysfunction

Chia-shu Lin

Abstract

Age-related decline in cognitive functions and dementia are major challenges in geriatric healthcare. Accumulating evidence from clinical, epidemiological and animal research suggests that tooth loss may be a risk factor for the decline of cognitive functions. This issue highlights the role of the brain-stomatognathic axis in geriatric medicine. Whether input from the stomatognathic apparatus can affect the brain remains an open debate. By revisiting the evidence published in the past five years, we argue that the hypothesis regarding the association between cognitive decline and masticatory dysfunction should be carefully interpreted. Most of the available clinical and epidemiological studies present only cross-sectional data. With respect to the prospective studies, important confounding factors, such as nutritional and physical conditions, were not fully controlled for. Animal research has revealed that hippocampal deficits may play key roles in the observed cognitive decline. However, experimental intervention and outcome assessments may not capture the condition of human subjects. Brain neuroimaging research may be suitable for bridging the gap between clinical and animal research, potentially contributing to (a) the clarification of the brain network associated with mastication, (b) the identification of brain imaging markers for exploring the mechanisms underlying long-term changes in masticatory functions, and (c) the elucidation of interactions between mastication and other cognitive-affective processing systems. Three potential models of the brain-stomatognathic axis and relevant hypotheses are summarized, focusing on the sensory feedback mechanisms, the compensation of motor control, and cerebellar deficits. Finally, we highlight four critical aspects of study and experimental design that should be considered in future research: (a) the refinement of the considered behavioral assessments, (b) the inclusion of baseline changes in mental and physical conditions, (c) a prospective experimental design with longitudinal observations, and (d) a precise determination of the effect size of the association between cognitive decline and masticatory dysfunction.

Background

Does tooth loss increase the risk of dementia? Can improvements in chewing ability prevent cognitive impairment or ameliorate cognitive decline? The association between the brain and the stomatognathic system, which plays a key role in chewing and swallowing [1], has recently been hotly debated in the media [2–5]. Behind these arguments is the emerging concept of the 'brain-stomatognathic axis', generally defined as a complex communication network between the brain, including both cortical and subcortical structures, and the stomatognathic system. The top-down control from the brain to the stomatognathic system, such as the coordination between jaw motion and tongue movement, has been established [1, 6]. However, what has remained unclear is whether input from peripheral structures, such as the sensory signals from the jaw and teeth, can likewise affect the brain. Aging is associated with a decline in both stomatognathic (e.g., tooth loss) [7] and brain functions (e.g., cognitive impairment or dementia) [8]. Therefore, the mechanisms underlying the brain-stomatognathic axis have emerged as critical issues in neuroscience as well as in orofacial and geriatric medicine.

Accumulating evidence suggests that cognitive decline may be associated with masticatory dysfunction [9–15]. The term 'cognitive decline' generally refers to the decreased cognitive abilities, including short-term and long-term memory, reasoning, and language abilities, which can be associated with normal aging or dementia

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Physiology & Behavior 89 (2006) 22 – 27

PHYSIOLOGY & BEHAVIOR

Oral physiology and mastication

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Received 7 November 2005; received in revised form 12 January 2006; accepted 23 January 2006

Abstract

Mastication is a sensory-motor activity aimed at the preparation of food for swallowing. It is a complex process involving activities of the facial, the elevator and suprahyoidal muscles, and the tongue. These activities result in patterns of rhythmic mandibular movements, food manipulation and the crushing of food between the teeth. Saliva facilitates mastication, moistens the food particles, makes a bolus, and assists swallowing. The movement of the jaw, and thus the neuromuscular control of chewing, plays an important role in the comminution of the food. Characteristics of the food, e.g. water and fat percentage and hardness, are known to influence the masticatory process. Food hardness is sensed during mastication and affects masticatory force, jaw muscle activity, and mandibular jaw movements. When we chew for instance a crispy food, the jaw decelerates and accelerates as a result of resistance and breakage of food particles. The characteristic breakage behaviour of food is essential for the sensory sensation. This study presents a short review of the influence of oral physiology characteristics and food characteristics on the masticatory process.

Keywords: Mastication; Swallow; Saliva; Food; Perception

1. Introduction

Chewing is the first step in the process of digestion and is meant to prepare the food for swallowing and further processing in the digestive system. During chewing, the food bolus or food particles are reduced in size, saliva is produced to moisten the food and flavors are released. Taste and texture of the food are perceived and have their influence on the chewing process. The water in the saliva moistens the food particles, whereas the salivary mucins bind masticated food into a coherent and slippery bolus that can be easily swallowed [1]. The initiation of swallowing, which is voluntary, has been thought to depend on separate thresholds for food particle size and for particle lubrication [2]. However, instead of this duality, it has also been suggested that swallowing is initiated when it is sensed that a batch of food particles is bound together under viscous forces so as to form a bolus [3]. There are several factors determining the chewing result. The teeth are important in the masticatory system. They form the occlusal area where the food particles are fragmented. This fragmentation depends on the total occlusal area and thus on the number of teeth. Another important factor in mastication is the bite force. The bite force depends on muscle volume, jaw muscle activity, and the coordination between the various chewing muscles. Also the movement of the jaw, and thus the neuromuscular control of chewing, plays an important role in the fragmentation of the food. Another aspect of chewing is how well the tongue and cheeks manipulate the food particles between the teeth. Finally, the production of sufficient saliva is indispensable for good chewing. While saliva and food have been shown to influence the chewing process, the relationship between amount of saliva and mastication has not been extensively studied [4]. Taste and texture of the food are perceived and have their influence on the chewing process. The time until swallowing was shorter and fewer chews were observed as palatability of the food increased [5]. The effects of sensory factors were most evident at the beginning of meals and decreased until the end of meals [6].

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0031-9384/$ - see front matter
doi:10.1016/j.physbeh.2006.01.025

Hindawi
Current Gerontology and Geriatrics Research
Volume 2018, Article ID 9853837, 9 pages
https://doi.org/10.1155/2018/9853837

Review Article

Elderly Stroke Rehabilitation: Overcoming the Complications and Its Associated Challenges

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Received 2 April 2018; Accepted 22 May 2018; Published 13 June 2018

Academic Editor: Carlos Fernandez-Viadero

There have been many advances in management of cerebrovascular diseases. However, stroke is still one of the leading causes of disabilities and mortality worldwide with significant socioeconomic burden. This review summarizes the consequences of stroke in the elderly, predictors of stroke rehabilitation outcomes, role of rehabilitation in neuronal recovery, importance of stroke rehabilitation units, and types of rehabilitation resources and services available in Singapore. We also present the challenges faced by the elderly stroke survivors in the local setting and propose strategies to overcome the barriers to rehabilitation in this aging population.

1. Background

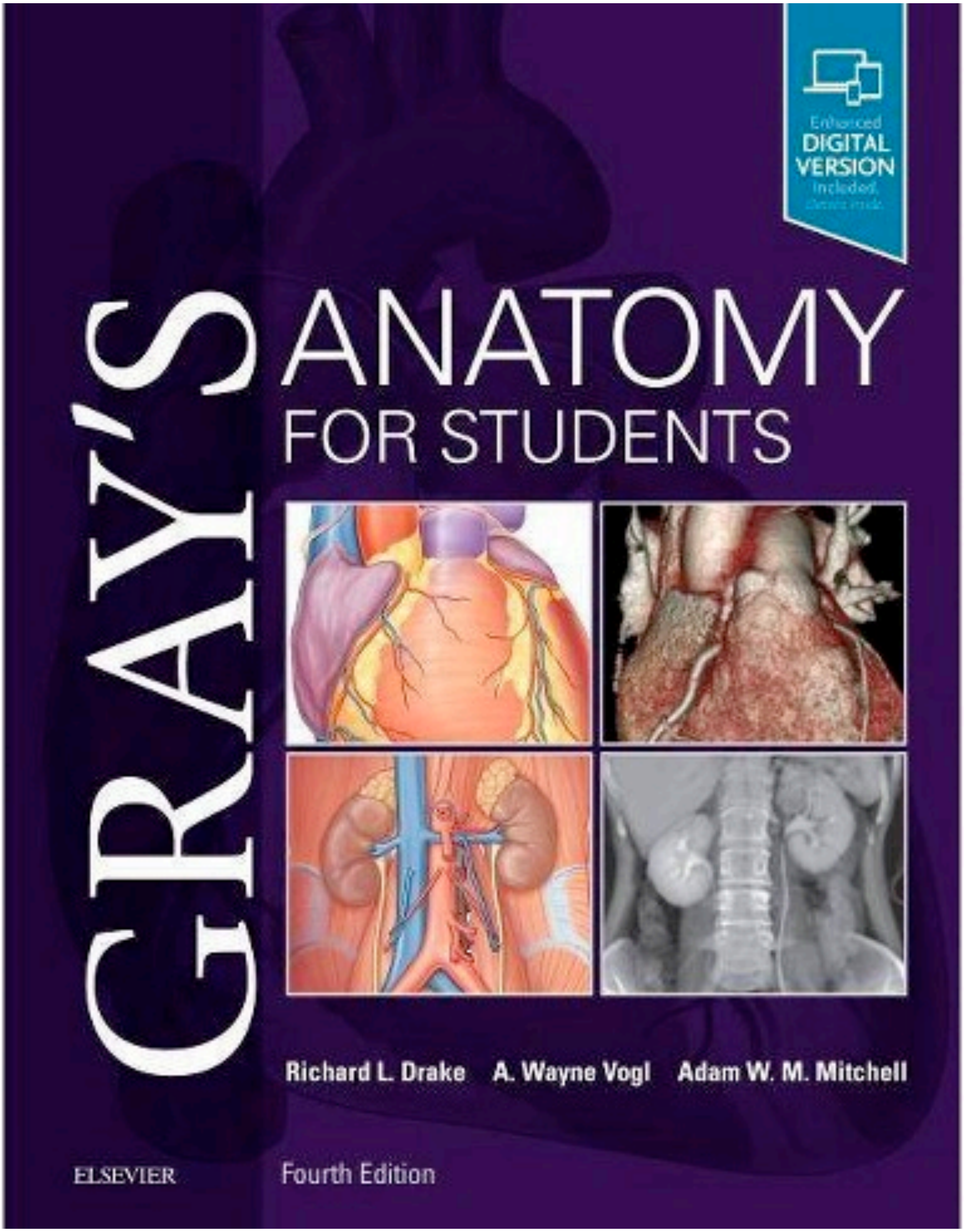
Despite advances in modern medicine, medications, and medical technology, stroke diseases impose a substantial mortality and morbidity risk to the individual with increased economic burden to the society. Globally, stroke is the second leading cause of death after ischemic heart disease, with approximately 6.7 million stroke deaths in 2015 [1]. In Singapore, despite decreasing trend, cerebrovascular diseases are still the fourth leading cause of death, with a prevalence of 6.6% in 2016 [2]. As the population rapidly ages, the burden of stroke is expected to increase significantly, posing challenges to limited healthcare resources.

As such, there is an urgent need to develop an optimal stroke disease management plan, incorporating a comprehensive stroke rehabilitation program.

2. Consequences of Stroke in Elderly Stroke Survivors

The incidence of stroke disease increases with age, in both men and women with approximately 50% of all strokes occurring in people over age 75 and 30% over age 85 [1, 3, 4]. Stroke is among the top leading causes of disability and reduced quality of life [5]. Elderly patients are at higher risk of mortality, poorer functional outcomes, prolonged length of hospital stay, and institutionalization [6].

Motor impairment is the most common deficit after stroke, which either happens as a direct consequence of the lack of signal transmission from cerebral cortex or as a slowly accumulating process of the cerebral injuries or muscle atrophy due to learned disuse [7, 8]. Divani et al. reported the risk of falling and fall-related injuries were higher in stroke elders [9]. Risk factors associated with increased fall risks in stroke survivors include poor general health, time from first stroke, psychiatric problems, urinary incontinence, pain, motor impairment, and a history of recurrent falls [9]. Risk factors associated with fall-related injuries are female gender, poor general health, past injury from fall, psychiatric problems, urinary incontinence, impaired hearing, pain, motor impairment, and presence of multiple strokes [9]. Motor function deficits, increased fall risks, and fall-related injuries can significantly affect the patients' mobility, and their daily living activities which limit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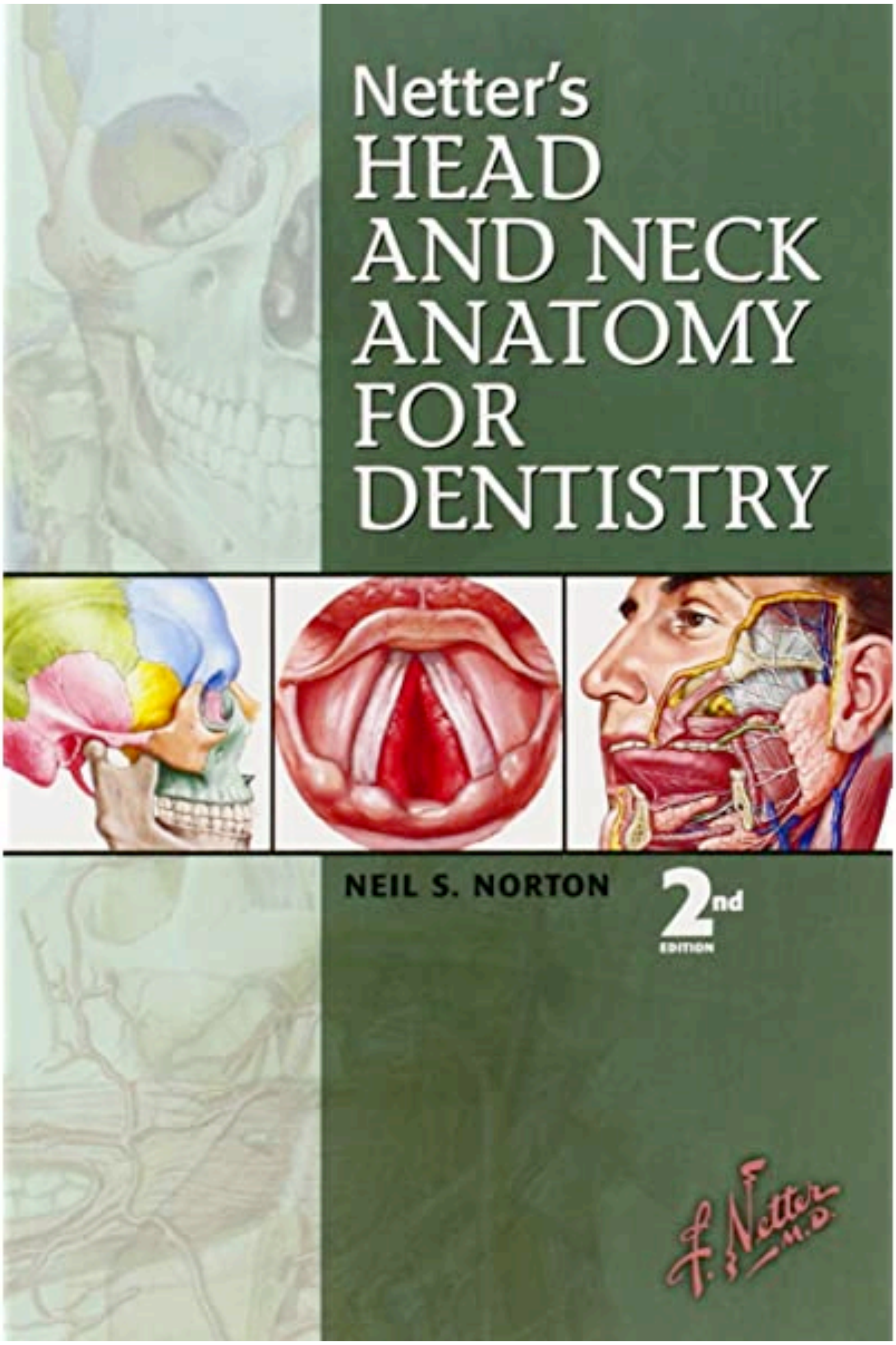
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Le Tissu Nerveux (cours N°2)

I) Pathologies Neuronales et synaptiques :

1) pathologies neurodégénératives : il s’agit d’un ensemble de pathologies qui se caractérise par une **dégénérescence neuronale chronique et progressive qui concerne plus ou moins spécifiquement une ou plusieurs sous-populations neuronales.** Le meilleur exemple est donné par la plus fréquente des maladies neurodégénératives : **la maladie d’Alzheimer.** Au cours de cette pathologie, on observe une perte diffuse des neurones de l’encéphale. Cette dégénérescence bien que diffuse touche préférentiellement 2 zones : le cortex cérébral et l’hippocampe. En particulier, on observe une atteinte précoce des **neurones cholinergiques** de l’hippocampe qui est responsable des troubles de la mémoire constituant l’essentiel des signes cliniques aux stades initiaux de la maladie. La correction du déficit cholinergique par un **inhibiteur de la cholinestérase** permet de retarder transitoirement la progression des troubles de mémoire mais pas la dégénérescence diffuse. Cette perte neuronale est responsable d’une **atrophie cérébrale** c’est-à-dire une diminution du volume de tissu cérébral.

Appendicular skeletal muscle mass: effects of age, gender, and ethnicity

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Gallagher, Dympna, Marjolein Visser, Ronald E. De Meersman, Dennis Sepúlveda, Richard N. Baumgartner, Richard N. Pierson, Tamara Harris, and Steven B. Heymsfield. Appendicular skeletal muscle mass: effects of age, gender, and ethnicity. *J. Appl. Physiol.* 83(1): 229–239, 1997.—This study tested the hypothesis that skeletal muscle mass is reduced in elderly women and men after adjustment first for stature and body weight. The hypothesis was evaluated by estimating appendicular skeletal muscle mass with dual-energy X-ray absorptiometry in a healthy adult cohort. A second purpose was to test the hypothesis that whole body ^{40}K counting-derived total body potassium (TBK) is a reliable indirect measure of skeletal muscle mass. The independent effects on both appendicular skeletal muscle and TBK of gender (n = 148 women and 136 men) and ethnicity (n = 152 African-Americans and 132 Caucasians) were also explored. Main findings were *1*) for both appendicular skeletal muscle mass (total, leg, and arm) and TBK, age was an independent determinant after adjustment first by stepwise multiple regression for stature and weight (multiple regression model r^2 = ~0.60); absolute decrease with greater age in men was almost double that in women; significantly larger absolute amounts were observed in men and African-Americans after adjustment first for stature, weight, and age; and >80% of within-gender or -ethnic group between-individual component variation was explained by stature, weight, age, gender, and ethnicity differences; and *2*) most of between-individual TBK variation could be explained by total appendicular skeletal muscle (r^2 = 0.865), whereas age, gender, and ethnicity were small but significant additional covariates (total r^2 = 0.903). Our study supports the hypotheses that skeletal muscle is reduced in the elderly and that TBK provides a reasonable indirect assessment of skeletal muscle mass. These findings provide a foundation for investigating skeletal muscle mass in a wide range of health-related conditions.

body composition; total body potassium; aging

AGING IN BOTH ANIMALS AND HUMANS is associated with a loss of skeletal muscle mass and a decline in muscle function (3, 32). Skeletal muscle atrophy and functional impairment with senescence in humans may be associated with osteoporotic fractures (28), the prolonged disability that accompanies hospitalizations for acute illness, falls with subsequent injury, and the frailty with inactivity often observed in geriatric populations (13).

Although skeletal muscle loss with aging in humans is well documented, several unresolved questions remain that relate to the magnitude of loss and whether gender and ethnic differences exist in the age-associated muscle decline. The first concern is that earlier investigations of skeletal muscle in humans were based largely on methods of questionable validity (14, 33). Two such methods, urinary creatinine excretion and total body potassium (TBK), assume that muscle is the sole or main source of intracellular creatine (30) and potassium (31), respectively. Recent studies challenge these assumptions (14, 33) and raise concerns related to the use of these methods in estimating age-related muscle loss.

An attempt was made to improve the use of TBK as a marker of skeletal muscle by devising a two-compartment method based on TBK and total body nitrogen (TBN) (5). This method assumes that the TBK-to-TBN ratios in skeletal muscle and nonskeletal muscle lean tissues are known and constant (6). A recent study suggests, however, that skeletal muscle mass estimates derived from the TBK-TBN method are substantially lower than that observed by using whole body multislice computerized tomography (33).

Much of the present understanding of skeletal muscle mass and aging is based on studies of urinary creatinine (33) and TBK (10, 22, 23) in adult populations. Questions surrounding the validity of these methods in accurately quantifying skeletal muscle mass raise concerns about the interpretation of earlier studies of skeletal muscle in relation to aging, gender, and ethnicity.

A second limitation associated with earlier investigations of changes in skeletal muscle mass with aging is the inadequate control of factors known to influence muscle, such as body weight and stature. Older subjects in some studies were shorter and weighed more or less than their younger counterparts (7, 22, 23). The independent influence of these important factors on skeletal muscle mass is usually not considered, and the prevailing hypothesis is that skeletal muscle mass is relatively reduced in the elderly. A related concern is that little is known about how women and men compare across the age span with regard to loss in muscle mass. Women on average weigh less and are shorter than men (19), and, in most previous studies, between-gender comparisons of skeletal muscle did not adequately control for body weight, stature, and age differences (7).

A Study Of Chewing Muscles: Age-Related Changes In Type I Collagen And Matrix Metalloproteinase-2 Expression

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PII: S0003-9969(19)30460-1

DOI: https://doi.org/10.1016/j.archoralbio.2019.104583

Reference: AOB 104583

To appear in: *Archives of Oral Biology*

Received Date: 8 May 2019

Revised Date: 23 September 2019

Accepted Date: 3 October 2019

[Cell Adhesion & Migration 3:4, 337-341; October/November/December 2009]; ©2009 Landes Bioscience

Commentary & View

Role of matrix metalloproteinases in skeletal muscle

Migration, differentiation, regeneration and fibrosis

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Key words: matrix metalloproteinases, skeletal muscle satellite cells, migration, differentiation, regeneration, fibrosis

Matrix metalloproteases (MMPs) are key regulatory molecules in the formation, remodeling and degradation of extracellular matrix (ECM) components in both physiological and pathological processes in many tissues. In skeletal muscle, MMPs play an important role in the homeostasis and maintenance of myofiber functional integrity by breaking down ECM and regulating skeletal muscle cell migration, differentiation and regeneration. Skeletal muscle satellite cells, a group of quiescent stem cells located between the basement membrane and the plasmalemma of myofibers, are responsible for lifelong maintenance and repairing, which can be activated and as a result migrate underneath the basement membrane to promote regeneration at the injured site. MMPs are able to degrade ECM components, thereby facilitating satellite cell migration and differentiation. This current review will focus on the critical roles of MMPs in skeletal muscle injury and repair, which include satellite cell activation with migration and differentiation. The effect of MMPs on muscle regeneration and fibrous scar tissue formation, as well as therapeutic insights for the future will be explored.

Introduction

Matrix metalloproteinases (MMPs) are a family of enzymes that can selectively digest individual components of the extracellular matrix (ECM)[1,2] in the processes of both normal physiological and pathological states.[3-6] Twenty-five members of the MMP family have been identified, of which six are membrane-type (MT) MMPs. Each MMP interacts in specific ways with certain elements of the ECM. MMP collagenases (MMP-1, -8, -13 and -18) have the ability to cleave interstitial collagen types I, II and III, and MMP gelatinases (MMP-2 and -9) degrade denatured collagen types IV, VII and X in many tissues.[1-3] MMPs are generally secreted as zymogens and are able to extracellularly activate by several proteinases. In vitro studies have indicated that plasmin could directly activate a group of pro-domains of MMPs, such as proMMP-1, proMMP-3, proMMP-9, proMMP-10 and proMMP-13.[4] However, the activation of proMMP-2 involves hydrolysis by MT1-MMP during plasmin stimulation. Several other active MMPs also can further activate the proMMPs to constitute the positive feedback mechanisms in many tissues.[4,6] On the other hand, MMPs are also adjusted by specific tissue inhibitors of metalloproteinases (TIMPs). Four members of the TIMP family have been identified including TIMP-1, which is synthesized by most types of connective tissue cells as well as by macrophages. TIMP-1 is also able to act against all types of collagenase, stromelysin and gelatinase.[2] MMPs, alone or in conjunction with the plasminogen/plasmin system, have the ability to degrade extracellular matrix components. This ability is a requirement for cell migration and tissue remodeling, both of which play essential roles in many physiological and pathological processes.[2-6]

Skeletal muscle healing after injury and the formation of skeletal muscle during development are similar processes because they both involve progressive specifications, such as proliferation, migration and differentiation of muscle precursors. The fusion of skeletal muscle satellite cells to form terminally differentiated, contractile, highly patterned myofibers is a key step of the process that relates metalloproteases.[7,8] A role for MMPs in myogenesis has long been proposed, and some of the responsible proteases have been identified.[3-6,9] Recent studies have demonstrated the important roles of MMP-1,[3] MMP-2,[6,10,11] MT1-MMP[10,12] and MMP-9,[5,6,13] in skeletal muscle satellite cell migration and differentiation both in vitro cultured muscle cells and in vivo animal models including *mdx* mice, a X-link dystrophic skeletal muscle mouse model. The interaction of MMPs and TIMPs in the skeletal muscle system with various conditions has also been well studied.[9,14]

Muscle Cell Migration and Differentiation In Vitro

It has been reported that MMPs and TIMPs play important roles in skeletal muscle-derived myoblast migration and differentiation

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Submitted: 01/29/09; Accepted: 06/24/09

Previously published online as a *Cell Adhesion & Migration* E-publication:
http://www.landesbioscience.com/journals/celladhesion/article/9338

Multifunctional roles of MT1-MMP in myofiber formation and morphostatic maintenance of skeletal muscle

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Accepted 4 July 2006
Journal of Cell Science 119, 3822-3832 Published by The Company of Biologists 2006
doi:10.1242/jcs.03158

Summary

Sequential activation of muscle-specific transcription factors is the critical basis for myogenic differentiation. However, the complexity of this process does not exclude the possibility that other molecules and systems are regulatory as well. We observed that myogenic differentiation proceeded through three distinct stages of proliferation, elongation and fusion, which are distinguishable by their cellular morphologies and gene expression patterns of proliferation- and differentiation-specific markers. Treatment of the differentiating myoblasts with inhibitors of matrix metalloproteinases (MMPs) revealed that MMP activity at the elongation stage is a critical prerequisite to complete the successive myoblast cell fusion. The MMP regulated the myogenic differentiation independently from the genetic program that governs expression of the myogenic genes. Membrane-type 1 matrix metalloproteinase (MT1-MMP) was identified as a major contributor to this checkpoint for morphological differentiation and degraded fibronectin, a possible inhibitory factor for myogenic cell fusion. A MT1-MMP deficiency caused similar myogenic impediments forming smaller myofibers in situ. Additionally, the mutant mice demonstrated some central nucleation of the myofibers typically found in muscular dystrophy and MT1-MMP was found to cleave laminin-2/4 in the basement membrane. Thus, MT1-MMP is a new multilateral regulator for muscle differentiation and maintenance through processing of stage-specific distinct ECM substrates.

Key words: MT1-MMP, ECM remodeling, Myogenesis, Myopathy

Introduction

Mammalian skeletal musculature is essential for body movement, breathing and postural behavior. Although the tissue is stable under normal conditions, skeletal muscle can regenerate when a loss of muscle mass occurs after injury. Muscle satellite cells that reside in the skeletal musculature act as myoblast precursors and regenerate myofibers through a process similar to embryonic myogenesis (Schultz et al., 1985). Although muscle regeneration requires multiple aspects of tissue organization, only the genetic program that governs myoblast differentiation has been studied extensively. Muscle injury generates signals that activate quiescent satellite cells, leading them to proliferating myoblasts that are characterized by an up-regulation of MyoD, a basic helix-loop-helix transcription factor (Bischoff, 1986; Cooper et al., 1999). Upon differentiation, the myoblasts withdraw from the cell cycle and enter terminal differentiation, during which additional transcription factors, such as myogenin and myogenic regulatory factor 4 (MRF4), that regulate late phase myogenesis, are up-regulated (Nabeshima et al., 1993; Zhu and Miller, 1997). These MRFs also direct the expression of muscle-specific genes, such as myosin heavy chain (MHC) and muscle creatine kinase (MCK) by binding to their promoter sequences directly (Chakraborty et al., 1991; Wheeler et al., 1999).

Concomitant with the cellular genetic program are dramatic changes in cell morphology. Under in vitro culture conditions, the proliferating myoblast morphology resembles that of fibroblasts. Once shifted to a differentiation condition, the myoblasts cease proliferating and begin elongating and becoming spindle shaped with bipolar edges. Finally, the elongated myoblasts fuse to form large multinucleated myotubes that correspond to the myofibers found in situ in skeletal muscle tissues. The differentiation proceeds in the tissue environment surrounded by extracellular matrix (ECM) and the differentiated myofibers must be integrated into the skeletal muscle framework to form a functional contractile unit. Thus, it is not surprising that the ECM molecules also influence the differentiation process. For example, excess exogenous fibronectin, a glycoprotein that binds to ECM components including collagen, fibrin and heparin, inhibits myotube formation (Podleski et al., 1979). By contrast, myotube formation is enhanced by laminin, a component of the basement membrane (Foster et al., 1987). Thus, it appears that some ECM components play different roles during myocyte differentiation, and thus must be substituted with appropriate molecules, depending on the differentiation stages. Indeed, the fibronectin concentration detected on myoblast surfaces is reported to decrease during myoblast differentiation (Chen, 1977).

Journal of Cell Science

Okamoto et al. BMC Oral Health (2019) 19:110
https://doi.org/10.1186/s12903-019-0778-5

BMC Oral Health

RESEARCH ARTICLE Open Access

Relationship between tooth loss, low masticatory ability, and nutritional indices in the elderly: a cross-sectional study

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Abstract

Background: Low masticatory ability and the resulting decrease in intake of masticable foods can result in undernutrition. The present study investigated the relationship between tooth loss, low masticatory ability, and nutritional indices in the elderly.

Methods: The data analyzed in this study were retrieved from the baseline data of the 2007 Fujiwara-kyo study, a prospective cohort study of community-dwelling elderly individuals. Subjects included 1591 men and 1543 women, both with a median age of 71 years. The maximum occlusal force was measured as an objective index of masticatory ability. Foods were divided into five groups based on hardness: Group 1 (bananas, etc.), 0.53 kg; Group 2 (boiled rice, etc.), 1.22 kg; Group 3 (raisins, etc.), 2.93 kg; Group 4 (raw carrots, etc.), 4.38 kg; and Group 5 (beef jerky), 6.56 kg. To obtain a subjective index of masticatory ability, a questionnaire-based survey was conducted to determine whether subjects could masticate foods within each group. As nutritional indices, serum albumin levels and body mass index (BMI) data were used.

Results: The median number of teeth was 21. The proportion of subjects for whom all five food groups were masticable showed a significant decrease in the number of teeth in both males and females. Logistic regression analysis showed that, after adjustment for confounders, no significant relationships were observed between the number of teeth and the masticatory ability with nutritional indices in males. In females, a maximum occlusal force of 100 to 300 N (OR = 1.65; 95% CI = 1.06–2.55) or less than 100 N (OR = 1.95; 95% CI = 1.15–3.31) showed a significant correlation with serum albumin levels below 4.4 g/dL (reference: 500 N or more). In addition, the masticability of all five food groups showed a significant correlation with BMI < 21.0 kg/m^2 (OR = 0.62; 95% CI = 0.46–0.85) in females.

Conclusions: A low number of teeth was associated with low masticatory ability in both males and females. Low masticatory ability was associated with low plasma albumin levels and low BMI in females. Not smoking, maintaining grip strength, preventing cancer, and masticatory ability are important for preventing undernutrition.

Keywords: Tooth loss, Masticatory ability, Serum albumin, BMI

Background

In elderly people, tooth loss is associated with an impairment of daily activities and an increased incidence of severe diseases. Among people older than 65 years, the incidence of functional disability [1, 2] and mortality rate [3] are higher in those with fewer than 20 teeth. In a 10-year, prospective, cohort study of community-dwelling people older than 60 years, those who were entirely edentulous were more likely to demonstrate reduced walking speeds and cognitive function [4]. The all-cause mortality rate [5, 6], cardiovascular disease-related mortality rate [5, 6], stroke-related mortality rate [6], and stroke incidence [5] were greater in edentulous subjects.

One hypothesis for the connection between the number of teeth and serious disease points to inflammation caused by periodontal disease. Multiple tooth loss is often due to periodontal disease, and the causative bacteria of periodontal disease and inflammatory

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Clinical Oral Investigations (2019) 23:633–640
https://doi.org/10.1007/s00784-018-2477-z

ORIGINAL ARTICLE

The relationship between masticatory ability, age, and dental and prosthodontic status in an institutionalized elderly dentate population in Qingdao, China

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Received: 15 January 2018 / Accepted: 25 April 2018 / Published online: 7 May 2018

Abstract

Objectives To identify relationships between masticatory ability and age, and dental and prosthodontic status amongst an institutionalized elderly dentate population in China.

Materials and methods A sample of 512 elders living in eight nursing homes in Qingdao was categorized based on a hierarchical dental functional classification system with and without tooth replacements. Masticatory disability scores (MDSs) were analyzed using multiple regression models with only age, and age and dentition variables for participants having ≥ 10 natural and those having < 10 natural teeth in each jaw.

Results Overall, associations between MDS and age, number of teeth, and number of teeth replaced by dental prostheses were identified. For participants having ≥ 10 natural teeth in each jaw, no significant associations between MDS and age and dental and prosthodontic status were found. Participants having < 10 natural teeth in each jaw had higher MDS (increasing chewing difficulties) at higher ages. However, when "premolar region sufficient" and "molar region sufficient" were included, MDS was not associated with age, but with these dentition variables. For participants having ≥ 10 teeth including prosthodontically replaced teeth in each jaw, age was the only variable associated with MDS. For participants having < 10 teeth including teeth replaced in each jaw, the significant factor was "premolar region sufficient." Overall, lower MDS was associated with increasing number of teeth, as well as with increasing number of teeth replaced by dental prostheses.

Conclusions In this population of institutionalized dentate elderly, masticatory ability was significantly associated with dental and prosthodontic status.

Clinical relevance For institutionalized elderly, having less than ten natural teeth in each jaw is associated with chewing problems. Most important dentition factor is the presence of three to four premolar pairs. Teeth added by partial removable dental prostheses compensate impaired masticatory ability due to tooth loss for 50% compared to natural teeth.

Keywords Masticatory ability · Institutionalized elderly · Dental status · Prosthodontic status

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Introduction

Masticatory ability is an important determinant of oral wellbeing, particularly for elderly individuals [1, 2]. Chinese studies report a high risk of eating difficulties for older people with fewer than 20 teeth [3, 4]. A study amongst older Americans found that people with severe tooth loss (≤ 10 remaining teeth) were less likely to meet the dietary recommendations of the Healthy Eating Index 2005 than those with light to moderate tooth loss (≥ 11 remaining teeth) [5, 6]. The relationship between dental status and dietary intake was also confirmed in a longitudinal study amongst older Japanese

JOURNAL ARTICLE

Effect of complete edentulism on masseter muscle thickness and changes after complete denture rehabilitation: an ultrasonographic study.

Bhoyar P, Godbole S, Thombare R et al. See more

Journal of investigative and clinical dentistry (2012) 3(1) 45-50

DOI: 10.1111/j.2041-1626.2011.0088.x

Abstract

The aim of the present study was to determine the changes in masseter muscle thickness due to the state of complete edentulism and the effect of complete denture rehabilitation on the masseter muscle. Real-time ultrasonography of the masseter muscle at relaxed and contracted states was carried out for twelve patients (six dentulous and six completely edentulous). Edentulous patients were scanned at the time of denture insertion and at the end of 3 months' follow up. The mean masseter muscle thickness of the edentulous patients was significantly increased after the 3-month follow-up than the thickness at the time of denture insertion, but was significantly lower than that of the dentulous patients of the same age group. Within the limitations of this study, it can be concluded that change occurs in the masseter muscle thickness after rehabilitation with complete dentures in the form of increased muscle thickness. However, the thickness of the muscle remains smaller than that of dentate individuals.

Cite

CITATION STYLE

CLINICAL INVESTIGATIONS

Mastication Improvement After Partial Implant-supported Prosthesis Use

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Abstract: *Partially edentulous patients may be rehabilitated by the placement of removable dental prostheses, implant-supported removable dental prostheses, or partial implant fixed dental prostheses. However, it is unclear the impact of each prosthesis type over the masticatory aspects, which represents the objective of this paired clinical trial. Twelve patients sequentially received and used each of these 3 prosthesis types for 2 months, after which maximum bite force was assessed by a strain sensor and food comminution index was determined with the sieving method. Masseter and temporal muscle thicknesses during rest and maximal clenching were also evaluated by ultrasonography. Each maxillary arch received a new complete denture that was used throughout the study. Data were analyzed by analysis of variance for repeated measures, followed by the Tukey test (*$p < .05$*). Maximum bite force and food comminution index increased (*$p < .0001$*) after implant-supported dental prosthesis and implant fixed dental prosthesis use, with the higher improvement found after the latter's use. Regardless of implant-retained prosthesis type, masseter muscle thickness during maximal clenching also increased (*$p < .05$*) after implant insertion. Partial implant-supported prostheses significantly improved masseter muscle thickness and mastication, and the magnitude of this effect was related to prosthesis type (International Clinical Trial Registration RBR-9J26XD).*

Key Words: clinical trials, mastication, removable prosthodontics, fixed prosthodontics, oral rehabilitation, ultrasound.

Introduction

Posterior teeth play important roles in comminuting food, and postcanine teeth loss significantly reduces masticatory performance (van der Bilt *et al.*, 2006). Moreover, loss of a first-molar occlusal pair is a key factor in prosthetic restoration (Fueki *et al.*, 2011).

Several prosthetic options are available to restore chewing function in patients with missing teeth (Abt *et al.*, 2012; de Freitas *et al.*, 2012). However, few studies (Kapur, 1991; Liedberg *et al.*, 2004) have determined the effects of prosthetic treatment on mastication in partially edentulous patients, and their findings are controversial. Kapur (1991) reported that removable dental prostheses (RDPs) and partial implant fixed dental prostheses (IFDPs) achieved similar chewing efficiency. In contrast, Liedberg *et al.* (2004) showed higher food comminution in patients with fixed dental prostheses than in RDP wearers. Because masticatory impairment can adversely affect quality of life (Lepley *et al.*, 2010), the effects of different prostheses on mastication are important to determine.

Several methods have been used to evaluate mastication, including occlusal force measurements (Goshima *et al.*, 2010; Muller *et al.*, 2012; Ohara *et al.*, 2013), sieving test (Gotfredsen and Walls, 2007; van der Bilt, 2011), color-changeable gum test (Goshima *et al.*, 2010; Muller *et al.*, 2012), and muscle thickness evaluation (Bhoyar *et al.*, 2012; Muller *et al.*, 2012; Ohara *et al.*, 2013). In addition, correlations among bite force, chewing performance, and masticatory muscle thickness (Raadsheer *et al.*, 1999; Muller *et al.*, 2012) have been established, and it is known that masticatory muscle action is influenced by occlusal factors, such as partial edentulism (Bhoyar *et al.*, 2012). Thus, masticatory muscle function can be reduced by severe tooth loss or a soft diet consumption, as typically selected by edentulous patients, leading to muscle atrophy (Tsai *et al.*, 2012).

Dental implants are increasingly used to replace missing teeth (Abt *et al.*, 2012; de Freitas *et al.*, 2012), and studies have

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JOURNAL ARTICLE

Masticatory function in patients with xerostomia.

Dusek M, Simmons J, Buschang P et al. See more

Gerodontology (1996) 13(1) 3-8

DOI: 10.1111/j.1741-2358.1996.tb00144.x

Abstract

The effects of reduced salivary output in patients suffering from xerostomia on masticatory function has not been previously studied. This study compares masticatory performance and kinematic activity of patients suffering from xerostomia with age-, sex-, and number of occluding pairs-matched healthy controls. Masticatory function was evaluated by assessment of chewing motion and muscle activity during chewing an artificial food (CutterSil), chewing gum and swallowing a bolus of almond. Chewing motion was recorded with the Optotrak computer system. Bilateral muscle activity of both masseter and anterior temporalis was recorded using surface electrodes. Results of this study revealed significant differences between patients and controls in their ability to process food and masticatory muscle activity. The majority of patients could not break down the artificial food, others had a larger median particle size than the controls. A significant difference was also observed in the number of chewing cycles required to swallow almonds, the patients required more than twice as many chews as the controls, $P < 0.001$. The right masseter muscle displayed significantly less activity for the patient than the controls. These findings suggest that patients with xerostomia exhibit reduced ability to process food. The observed decline in masticatory performance is probably due to reduced activity of the muscles of mastication.

Cite

CITATION STYLE

APA

Clinical Interventions in Aging

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ORIGINAL RESEARCH

Improvements in oral functions of elderly after simple oral exercise

This article was published in the following Dove Press journal:
Clinical Interventions in Aging

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Purpose: Conventional oral exercises in previous studies are considered impractical for continuous use in the elderly because of the extended duration needed for effective outcomes. Therefore, in the present study, a simple oral exercise (SOE) was developed to reduce performance time, focusing on improvements in mastication, salivation, and swallowing functions. The aim of this study was to determine the short-term effects of the SOE with respect to improving mastication, salivation, and swallowing function in elderly subjects ≥65 years of age.

Patients and methods: The study included 84 subjects, all of whom performed the SOE 2 times per day for 1 week. Masticatory performance was assessed using the mixing ability index (MAI). Unstimulated saliva and the degree of moisture of the tongue/buccal mucosa were evaluated, and the repetitive saliva swallowing test was performed. On the basis of each of these four measurements, subjects were dichotomized into two groups with high (good) and low (poor) conditions. The same evaluations were conducted before and immediately after intervention, as well as after 1 week of intervention. A subjective evaluation with questionnaires was performed after 1 week of intervention. The changes were analyzed using repeated-measures ANOVA, Cochran's Q test, and McNemar's test.

Results: The mean MAI increased by 6% immediately after the intervention, and by 16% in the poor-chewing group. Similarly, the amount of unstimulated saliva increased by 0.1 ml/min immediately after the SOE, and by 29% in the poor-salivation group. The degree of tongue moisture increased by 3% and was maintained. In the poor-swallowing group, 25% and 40% of the subjects were upgraded to the good-swallowing group immediately after intervention, as well as after 1 week of intervention, respectively. The subjects experienced less discomfort as their oral function improved.

Conclusion: The SOE was effective in immediately improving oral functions, and improvement was maintained for 1 week.

Keywords: deglutition disorders, elderly, mastication, oral exercise, salivation, xerostomia

Introduction

Oral health is closely related to systemic health, and poor oral health can lead to deterioration of systemic disease.[1] Impaired oral health affects dietary habits, nutrition, sleep, mental status, and social relationships.[2] It is important for elderly individuals to improve and/or maintain oral function because this population exhibits various risk factors that threaten oral function; moreover, such individuals are susceptible to various diseases based on aging-related changes in bodily functions.[3]

Among oral symptoms, decreased salivation in the elderly may cause various diseases, such as oral soft tissue disease, dental caries, periodontal disease, and oral candidiasis.[4] In addition, xerostomia—the subjective sensation of dry mouth—can

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http://doi.org/10.2147/CIA.S205236

Turkish Journal of Geriatrics
2010; 13 (4): 285-290

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REVIEW ARTICLE

XEROSTOMIA IN ELDERLY POPULATION

ABSTRACT

Saliva, which is necessary for oral homeostasis, oral function and maintenance of oral health, is very important for the quality of life. There are various oral complications related to xerostomia. Secretion of saliva and its composition are largely age independent in healthy people. Dry mouth complaint is common in elderly people as a result of a Sjogren's syndrome, radiotherapy, medication use and systemic disorders. Diagnosis of hyposalivation is based on the patient's history and clinical examination. Salivary flow rates can be measured with sialometry. It is very important to elicit an accurate drug and family history. Current treatment ap¬proaches for management of xerostomia are directed toward providing relief of symptoms and resulting complications. In order to decide on the most effective way for the treatment of xerostomia in geriatric patients, well organized clinical studies are needed.

Key Words: Xerostomia; Saliva; Etiology; Treatment.

DERLEME

YAŞLI BİREYLERDE AĞIZ KURULUĞU

ÖZ

Oral hemostaz, fonksiyon ve sağlığın korunması açısından gerekli olan tükürük yaşam kalitesi açısından çok önemlidir. Ağız kuruluğu birçok komplikasyona yol açabilir. Sağlıklı bireylerde tükürüğün salgısı ve birleşimi yaşa bağımlı değildir. Yaşlı bireylerde, Sjögren's Sendrom'u, radyasyon tedavisi, kullanılan ilaçlar ve sistemik rahatsızlıklara bağlı olarak, ağız kuruluğu sıktır. Tükürük bezi salgısındaki azalmanın teşhisi hasta anamnezini ve klinik muayeneyi temel alır. Tükürük akışı sialometre ile ölçülebilir. Hastanın ailesel hikayesinin ve ilaç kullanımının tam olarak belirlenmesi önemlidir. Çeşitli nedenler sonucu oluşan ağız kuruluğunun bilinen tedavisi, var olan semptomların ve ortaya çıkan komplikasyonların hafifletilmesini içerir. Günümüzde yaşlı bireylerdeki ağız kuruluğunun daha etkin tedavisine karar verilebilmesi için iyi organize edilmiş klinik çalışmalara ihtiyaç vardır.

Anahtar Sözcükler: Ağız kuruluğu; Tükürük; Etyoloji; Tedavi.

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Geliş Tarihi: 23/07/2009
(Received)

Kabul Tarihi: 14/09/2009
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JOURNAL ARTICLE

Effect of age on salivary flow obtained under feeding and non-feeding conditions

Bourdiol P, Mioche L, Monier S

Journal of Oral Rehabilitation (2004) 31(5) 445-452

DOI: 10.1111/j.1365-2842.2004.01253.x

Abstract

Age, health status and disease treatments are thought to influence salivary flow. In this study, age effect on salivation was compared in non-feeding (at rest and during parafilm chewing) and feeding (during meat chewing) conditions for two groups of healthy subjects, 25 young subjects (mean age 27-4 years) and 20 old subjects (mean age 71-2 years). In non-feeding conditions, parotid flow was assessed at rest (3 min) and during parafilm chewing (1 min) from the absorptive capacity of a cotton roll placed in front of the upper duct apertures. Remaining saliva emanating mainly from the submandibular/sublingual glands was determined at rest by a sublingual cotton roll. In order not to impede in the chewing process during parafilm chewing, no cotton roll was placed in the lower part of the mouth and the remaining saliva was simply spit out for evaluation. Assessments were made under feeding conditions during the mastication of meat of different textures. The saliva content of the bolus was evaluated at different stages of the chewing process by weighing the mouth contents after spitting. No direct age effect was found on the different salivary flow rates measured during different conditions of stimulation. However, a significant correlation was found between the salivary flow rates at rest and those obtained during meat chewing in the elderly group but not in the young group. In elderly adults, rest salivary flow rate appears as a good predictor of salivary flow during the consumption of food. Within each group, significant correlations were found between salivation elicited by meat and by parafilm chewing. These results confirm the lack of direct global age effect on salivary flow rate by chewing in the 3 min after the stimulation, although adaptations to the measurement conditions are different between both groups of subjects.

Author supplied keywords

JOURNAL ARTICLE

Parkinson disease: Parkinson disease systemic and orofacial manifestations, medical and dental management

Friedlander A, Mahler M, Norman K et al. See more

Journal of the American Dental Association (2009) 140(6) 658-669

DOI: 10.14219/jada.archive.2009.0251

Abstract

Background. More than 1.5 million Americans have Parkinson disease (PD), and this figure is expected to rise as the population ages. However, the dental literature offers little information about the illness. Types off Studies Reviewed. The authors conducted a MEDLINE search using the key terms "Parkinson's disease", "medical management" and "dentistry." They selected contemporaneous articles published in peer-reviewed journals and gave preference to articles reporting randomized controlled trials. Results. PD is a progressive neurodegenerative disorder caused by loss of dopaminergic and nondopaminergic neurons in the brain. These deficits result in tremor, slowness of movement, rigidity, postural instability and autonomic and behavioral dysfunction. Treatment consists of administering medications that replace dopamine, stimulate dopamine receptors and modulate other neurotransmitter systems. Clinical Implications. Oral health may decline because of tremors, muscle rigidity and cognitive deficits. The dentist should consult with the patient's physician to establish the patient's competence to provide informed consent and to determine the presence of comorbid illnesses. Scheduling short morning appointments that begin 90 minutes after administration of PD medication enhances the patient's ability to cooperate with care. Inclination of the dental chair at 45°, placement of a bite prop, use of a rubber dam and high-volume oral evacuation enhance airway protection. To avoid adverse drug interactions with levodopa and entacapone, the dentist should limit administration of local anesthetic agents to three cartridges of 2 percent lidocaine with 1:100,000 epinephrine per half hour, and patients receiving selegiline should not be given agents containing epinephrine or levonordefrin. The dentist should instruct the patient and the caregiver in good oral hygiene techniques.

European Journal of Neuroscience / Volume 30, Issue 5 / p. 735-741

The second brain and Parkinson's disease

Thibaud Lebouvier, Tanguy Chaumette, Sébastien Paillusson, Charles Duyckaerts, Stanislas Bruley des Varannes, Michel Neunlist, Pascal Derkinderen

First published: 28 August 2009
https://doi.org/10.1111/j.1460-9568.2009.06873.x

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Abstract

Parkinson's disease is the second most common neurodegenerative disease after Alzheimer's disease. It has been classically considered that the pathological hallmarks of Parkinson's disease, namely Lewy bodies and Lewy neurites, affect primarily the substantia nigra. Nevertheless, it has become increasingly evident in recent years that Parkinson's disease is a multicentric neurodegenerative process that affects several neuronal structures outside the substantia nigra, among which is the enteric nervous system. Remarkably, recent reports have shown that the lesions in the enteric nervous system occurred at a very early stage of the disease, even before the involvement of the central nervous system. This led to the postulate that the enteric nervous system could be critical in the pathophysiology of Parkinson's disease, as it could represent a route of entry for a putative environmental factor to initiate the pathological process (Braak's hypothesis). Besides their putative role in the spreading of the pathological process, it has also been suggested that the pathological alterations within the enteric nervous system could be involved in the gastrointestinal dysfunction frequently encountered by parkinsonian patients. The scope of the present article is to review the available studies on the enteric nervous system in Parkinson's disease patients and in animal models of the disease. We further discuss the strategies that will help in our understanding of the roles of the enteric nervous system, both in the pathophysiology of the disease and in the pathophysiology of the gastrointestinal symptoms.

Published in final edited form as:
J Parkinsons Dis. 2013 ; 3(4): 461–491. doi:10.3233/JPD-130230.

The Role of Oxidative Stress in Parkinson's Disease

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Abstract

Oxidative stress plays an important role in the degeneration of dopaminergic neurons in Parkinson's disease (PD). Disruptions in the physiologic maintenance of the redox potential in neurons interfere with several biological processes, ultimately leading to cell death. Evidence has been developed for oxidative and nitrative damage to key cellular components in the PD substantia nigra. A number of sources and mechanisms for the generation of reactive oxygen species (ROS) are recognized including the metabolism of dopamine itself, mitochondrial dysfunction, iron, neuroinflammatory cells, calcium, and aging. PD causing gene products including DJ-1, PINK1, parkin, alpha-synuclein and LRRK2 also impact in complex ways mitochondrial function leading to exacerbation of ROS generation and susceptibility to oxidative stress. Additionally, cellular homeostatic processes including the ubiquitin-proteasome system and mitophagy are impacted by oxidative stress. It is apparent that the interplay between these various mechanisms contributes to neurodegeneration in PD as a feed forward scenario where primary insults lead to oxidative stress, which damages key cellular pathogenetic proteins that in turn cause more ROS production. Animal models of PD have yielded some insights into the molecular pathways of neuronal degeneration and highlighted previously unknown mechanisms by which oxidative stress contributes to PD. However, therapeutic attempts to target the general state of oxidative stress in clinical trials have failed to demonstrate an impact on disease progression. Recent knowledge gained about the specific mechanisms related to PD gene products that modulate ROS production and the response of neurons to stress may provide targeted new approaches towards neuroprotection.

Keywords

Neurodegeneration; neuroprotection; neuroinflammation; reactive oxygen species; dopamine; mitochondria

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CONFLICT OF INTEREST

None.

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RESEARCH ARTICLE

Orofacial Functions and Chewing Effiency in Elderly Patients with Parkinson's Disease Rehabilitated with Removable Prostheses

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Abstract:

Background:

Parkinson's Disease (PD) is the second most common neurodegenerative disease after Alzheimer's disease. It is one of the movement disorders that can affect oro-facial conditions. It is more common in the elderly, having an average age of onset of around 60 years.

Objective:

The aim was to study orofacial functions in patients suffering from PD with partial or total edentulism, wearing removable prostheses.

Methods:

Forty-eight (48) elders, rehabilitated with removable dentures, were included: 24 patients suffering from Parkinson's disease constitute the Study Group (SG), and 24 subjects not suffering from Parkinson's disease or neurological degenerative diseases represent the Control Group (CG).

In SG, the severity of Parkinson's disease was assessed according to the Unified Parkinson's Disease Rating objective motor scale III, and oro-facial dysfunctions were evaluated using Nordic Orofacial Test-Screening (NOT-S). The duration of the use of dental prostheses expressed in years has been reported. In both the groups, the subjective chewing index for the analysis of masticatory ability and the two-color chewing gum test for the analysis of masticatory efficiency were conducted .

Results:

There was a statistically significant difference between the SG and CG compared to the NOT-S ($P = 0.001$).

Analyzing the study group, a statistically significant correlation was found between the masticatory efficiency and prosthetic years of use ($r_s = 0.436$; $P < 0.05$); instead, no statistically significant correlation was found between the masticatory efficiency and the severity of Parkinson's disease.

Conclusion:

In our study, we did not find differences between SG and CG in terms of the degree of masticatory efficiency; therefore, only a correlation between the duration of use of dental prostheses and the degree of masticatory efficiency was found.

Keywords: Parkinson's disease, Removable prostheses, Orofacial functions, Chewing efficiency, Degenerative disease, Geriatric patients.

Article History	Received: November 04, 2019	Revised: December 17, 2019	Accepted: December 27, 2019

1. INTRODUCTION

Parkinson's disease is a chronic degenerative disease of the central nervous system. The prevalence of Parkinson's disease in industrialized countries is estimated to be around 0.3% of the entire population. Relatively rare before the fifties, the prevalence increased up to 1% in subjects over 60 and 4% in subjects over 80 years. In Italy, it is estimated that there are currently 200,000 people suffering from Parkinson's disease [1]. Parkinson's disease is linked to a reduction in dopamine in

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European Journal of Oral Sciences / Volume 119, Issue 1 / p. 27-32

Orofacial function and oral health in patients with Parkinson's disease

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First published: 19 January 2011
https://doi.org/10.1111/j.1600-0722.2010.00802.x

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Abstract

Bakke M, Larsen SL, Lautrup C, Karlsborg M. Orofacial function and oral health in patients with Parkinson's disease. Eur J Oral Sci 2011; 119: 27–32. © 2011 Eur J Oral Sci

No comprehensive study has previously been published on orofacial function in patients with well-defined Parkinson's disease (PD). Therefore, the aim of this study was to perform an overall assessment of orofacial function and oral health in patients, and to compare the findings with matched control subjects. Fifteen outpatients (nine women and six men, 61–82 yr of age; Hoehn & Yahr Stages 2–4; and with motor impairment ranging from 17 to 61 according to the Unified Parkinson's Disease Rating Scale, Objective Motor Part III) were examined in their 'on' state together with 15 age- and gender-matched controls. Orofacial function and oral health were assessed using the Nordic Orofacial Test, masticatory ability, performance and efficiency, oral stereognosis, jaw opening, jaw muscle tenderness, the Oral Health Impact Profile-49, number of natural teeth, and oral hygiene. Orofacial dysfunction was more prevalent, mastication and jaw opening poorer, and impact of oral health on daily life more negative, in patients with PD than in controls. The results indicate that mastication and orofacial function are impaired in moderate to advanced PD, and with progression of the disease both orofacial and dental problems become more marked. It is suggested that greater awareness of the special needs in PD patients and frequent dental visits are desirable to prevent dental diseases and decay and to support masticatory function.

International Journal of
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Communication

Oral Health and Care for Elderly People with Alzheimer's Disease

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Received: 30 June 2020; Accepted: 6 August 2020; Published: 7 August 2020

check for updates

Abstract: Dementia is one of the main causes of disability among elderly people. It is a progressive neurodegenerative disease that affects elderly people's ability to perform daily living activities. Alzheimer's disease is the main subtype of dementia and causes declining memory, reasoning, and communication skills. They also have behavioural and psychological symptoms, such as depression and aggression. It is essential for them to maintain good oral health, as oral health is an important and integral part of their general health. Neglecting oral health allows dental diseases to develop, and these diseases are difficult and costly to treat. However, dental diseases can be treated with ambulatory care rather than hospitalisation and emergency care. Elderly people should establish daily oral hygiene care routines during the early stages of Alzheimer's disease. They should have regular dental examinations and early minimal interventions to prevent the need for extensive and complicated procedures. Maintaining oral health becomes challenging, however, when Alzheimer's disease progresses to the middle and late stages. Because elderly people might forget or lose interest in keeping their teeth healthy, caretakers and community health workers may need to take over this task. Dentists should provide guidance on the maintenance of oral health, as the techniques used to provide this support vary depending on the elderly people concerned. The purpose of this paper is to provide an overview of oral health and the importance of oral care for elderly people with Alzheimer's disease. The paper also discusses appropriate dental interventions and techniques for maintaining good oral health and helping people with Alzheimer's to enjoy a satisfactory quality of life.

Keywords: oral health; oral hygiene; Alzheimer's disease; dementia

1. Introduction

Improvements in standards of living and people's quality of life have contributed to an increase in life expectancy and thus an ageing population [1]. Increasing age is an important risk factor for Alzheimer's disease. The World Health Organization defined Alzheimer's disease as a neurodegenerative disease of unknown aetiology, characterised by progressive memory and cognitive impairment [2]. It is the most common form of dementia, accounting for around 50–80% of dementia cases worldwide [3]. In fact, the prevalence of Alzheimer's disease worldwide has doubled during the past couple of decades [4].

Alzheimer's disease is costly not only as a terminal disease but also financially and socially. On the financial side, as elderly people lose their ability to engage in work, they become financially dependent on their family members. In the latter stages, employing caregivers or being institutionalised may be necessary. On a larger scale, a number of government subsidies are spent on providing services and facilities for such elderly people. In 2015, the annual socioeconomic cost of Alzheimer's disease in

Journal of Dental Research

Mapping Brain Region Activity during Chewing: A Functional Magnetic Resonance Imaging Study

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First Published November 1, 2002 | Other | Find in PubMed
https://doi.org/10.1177/0810743

Abstract

Mastication has been suggested to increase neuronal activities in various regions of the human brain. However, because of technical difficulties, the fine anatomical and physiological regions linked to mastication have not been fully elucidated. Using functional magnetic resonance imaging during cycles of rhythmic gum-chewing and no chewing, we therefore examined the interaction between chewing and brain regional activity in 17 subjects (aged 20-31 years). In all subjects, chewing resulted in a bilateral increase in blood oxygenation level-dependent (BOLD) signals in the sensorimotor cortex, supplementary motor area, insula, thalamus, and cerebellum. In addition, in the first three regions, chewing of moderately hard gum produced stronger BOLD signals than the chewing of hard gum. However, the signal was higher in the cerebellum and not significant in the thalamus, respectively. These results suggest that chewing causes regional increases in brain neuronal activities which are related to biting force.

Keywords

functional magnetic resonance imaging, gum chewing, masticatory system, brain activation, human

CLINICAL INVESTIGATION

Tooth Loss and Risk of Dementia in the Community: the Hisayama Study

Kenji Takeuchi, DDS, PhD, Tomoyuki Ohara, MD, PhD,[†‡] Michiko Furuta, DDS, PhD,* Toru Takeshita, DDS, PhD,* Yukie Shibata, DDS, PhD,* Jun Hata, MD, PhD,[‡§¶] Daigo Yoshida, PhD,[‡§] Yoshihisa Yamashita, DDS, PhD,* and Toshiharu Ninomiya, MD, Ph*

OBJECTIVES: To clarify the effect of tooth loss on development of all-cause dementia and its subtypes in an elderly Japanese population.

DESIGN: Prospective cohort study.

SETTING: The Hisayama Study, Japan.

PARTICIPANTS: Community-dwelling Japanese adults without dementia aged 60 and older (N = 1,566) were followed for 5 years (2007–2012).

MEASUREMENTS: Participants were classified into four categories according to baseline number of remaining teeth (≥20, 10–19, 1–9, 0). The risk estimates of the effect of tooth loss on the development of all-cause dementia, Alzheimer's disease (AD), and vascular dementia (VaD) were computed using a Cox proportional hazards model.

RESULTS: During follow-up, 180 (11.5%) subjects developed all-cause dementia; 127 (8.1%) had AD, and 42 (2.7%) had VaD. After adjusting for potential confounders, there was a tendency for the multivariable-adjusted hazard ratio of all-cause dementia to increase with decrease in number of remaining teeth (*P* for trend = .04). The risk of all-cause dementia was 1.62 times as great in subjects with 10 to 19 teeth, 1.81 times as great in those with one to nine teeth, and 1.63 times as great in those with no teeth as in those with 20 teeth or more. An inverse association was observed between number of remaining teeth and risk of AD (*P* for trend = .08), but no such association was observed with risk of VaD (*P* for trend = .20).

CONCLUSION: Tooth loss is associated with an in risk of all-cause dementia and AD in the Japanese tion. **J Am Geriatr Soc 65:e95–e100, 2017.**

Key words: Alzheimer's disease; epidemiolog health; prospective cohort study; vascular demen

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DOI: 10.1111/jgs.14791

The increase in the incidence of dementia is a sub public health concern in aging societies. Approx 46.8 million people worldwide have dementia, and t dence is 9.9 million per year.[1] The number of peop with dementia will nearly double every 20 years, causes of dementia, especially Alzheimer's disease (A unclear, and there is a lack of treatments and health settings for this disorder.[2,3] Therefore, intensified r studies are needed to identify factors that have the p to decrease the risk of dementia and thereby decre burden of this disease on health systems.

A growing number of research studies have on the link between oral health and cognitive st particular, many research studies have assessed the tion between number of teeth and cognitive funct but the results of observational longitudinal studies effect of tooth loss on cognitive function are incon A recent systematic review of the literature sugges tooth loss was associated with greater risk of c impairment and dementia,[16] whereas another report tooth loss was not consistently associated wit outcomes.[17] The inconsistency might be due to r ological deficiencies in this field, such as the representativeness of the population, definitive ass of cognitive function, and professional clinical oral nation. Thus, the existing evidence of a causal r ship between tooth loss and development of dem insufficient.

The purpose of the current study was to eluci effect of tooth loss on the development of dementia subtypes by targeting a general population of elderl

Original Article | Published: 30 July 2016

Correlation of cognitive and masticatory function in Alzheimer's disease

Camila Heitor Campos, Giselle Rodrigues Ribeiro, José Luiz Riani Costa & Renata Cunha Matheus Rodrigues Garcia

Clinical Oral Investigations **21**, 573–578(2017)

Abstract

Objectives

This study investigated chewing function in elderly individuals with Alzheimer's disease (AD) and correlated chewing function with cognitive status.

Materials and methods

Sixteen elderly individuals with mild AD (mean age 76.7 ± 6.3 years; 8 men, 8 women) and 16 age and gender-matched healthy controls (mean age 75.23 ± 4.4 years; 8 men, 8 women) were included in this study. All volunteers wore removable prostheses: 11 were totally edentulous and five were partially edentulous in each group. Chewing function was evaluated via masticatory performance (MP) using Optocal chewable test material and a sieve fractionation method. Cognitive functioning

PLOS | ONE

RESEARCH ARTICLE

Oral Implant-Prostheses: New Teeth for a Brighter Brain

Vincenzo De Cicco[1], Massimo Barresi[2]*, Maria Paola Tramonti Fantozzi[1], Enrico Cataldo[3], Vincenzo Parisi[4], Diego Manzoni[1]

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Abstract

Several studies have demonstrated that chewing can be regarded as a preventive measure for cognitive impairment, whereas masticatory deficiency, associated with soft-diet feeding, is a risk factor for the development of dementia. At present the link between orofacial sensorimotor activity and cognitive functions is unknown. In subjects with unilateral molar loss we have shown asymmetries in both pupil size and masticatory muscles electromyographic (EMG) activity during clenching: the molar less side was characterized by a lower EMG activity and a smaller pupil. Since implant-prostheses, greatly reduced both the asymmetry in EMG activity and in pupil's size, trigeminal unbalance, leading to unbalance in the activity of the Locus Coeruleus (LC), may be responsible for the pupil's asymmetry. According to the findings obtained in animal models, we propose that the different activity of the right and left LC may induce an asymmetry in brain activity, thus leading to cognitive impairment. According to this hypothesis, prostheses improved the performance in a complex sensorimotor task and increased the mydriasis associated with haptic tasks. In conclusion, the present study indicates that the implant-prosthesis therapy, which reduces the unbalance of trigeminal proprioceptive afferents and the asymmetry in pupil's size, may improve arousal, boosting performance in a complex sensorimotor task.

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Citation: De Cicco V, Barresi M, Tramonti Fantozzi MP, Cataldo E, Parisi V, Manzoni D (2016) Oral Implant-Prostheses: New Teeth for a Brighter Brain. PLoS ONE 11(2): e0148715. doi:10.1371/journal.pone.0148715

Editor: Mikhail A. Lebedev, Duke University, UNITED STATES

Received: August 12, 2015

Accepted: December 15, 2015

Published: February 26, 2016

Data Availability Statement: All relevant data are within the paper.

Funding: The research was supported by grants of the University of Pisa, Iacer Company and Implafavourite Company. The contribution of the GB Bietti Foundation, IRCCS, was supported by Italian Ministry of Health and by Fondazione Roma. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing Interests: Products sold by Implafavorite were used in this study. The support from these

Introduction

Previous studies reported that mastication improves cognitive processing speed [1], alertness [2], attention [3], intelligence [4], as well as reaction time [5,6], event-related potentials latencies [7] and cerebral blood oxygen-dependent (Bold) signal [6]. It has been proposed that chewing may enhances arousal and modulate cognitive functions [7] by enhancing the activity of Ascending Reticular Activating System [8]. In additions to these short-term effects on performance, it has been suggested that the cerebral cortex activity elicited by mastication may lead to long term effects on the cerebral nervous system and be helpful in preventing degradation of brain functions [9,10,11]. Indeed, epidemiological studies have reported that tooth loss before 35 years of age was a significant risk factor for dementia or Alzheimer Disease [12,13].

Neurobiology of Aging
Volume 67, July 2018, Pages 23-30

Regular article

Tooth loss is associated with accelerated cognitive decline and volumetric brain differences: a population-based study

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https://doi.org/10.1016/j.neurobiolaging.2018.03.003

Abstract

Tooth loss has been related to cognitive impairment; however, its relation to structural brain differences in humans is unknown. Dementia-free participants (n = 2715) of age ≥60 years were followed up for up to 9 years. A subsample (n = 394) underwent magnetic resonance imaging at baseline. Information on tooth loss was collected at baseline, and cognitive function was assessed using the Mini–Mental State Examination at baseline and at follow-ups. Data were analyzed using linear mixed effects models and linear regression models. At baseline, 404 (14.9%) participants had partial tooth loss, and 206 (7.6%) had complete tooth loss. Tooth loss was significantly associated with a steeper cognitive decline (β: –0.18, 95% confidence interval [CI]: –0.24 to –0.11) and remained significant after adjusting for or stratifying by potential confounders. In cross-sectional analyses, persons with complete or partial tooth loss had significantly lower total brain volume (β: –28.89, 95% CI: –49.33 to –8.45) and gray matter volume (β: –22.60, 95% CI: –38.26 to –6.94). Thus, tooth loss may be a risk factor for accelerated cognitive aging.

Japanese Dental Science Review (2015) 51, 34—40

Available online at www.sciencedirect.com

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Review Article

How masticatory function and periodontal disease relate to senile dementia

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Received 23 April 2014; received in revised form 18 July 2014; accepted 8 September 2014

KEYWORDS
Masticatory function;
Dementia;
Periodontal disease;
Elderly persons

Summary This study reviews the research of dementia, a pathology for which numerous studies have found associations with masticatory function in the elderly. These issues are presently major problems in geriatric medical and welfare settings, and we discuss the prospects for future research into mastication. Dementia and masticatory function have been examined in a range of epidemiological and neuroscientific studies, and associations between the two have been reported. However, a causal relationship has not been satisfactorily established. Biochemical studies have also clarified the basis of the association between dementia and periodontal disease, but have not yet yielded sufficient evidence. Studies offering a high level of evidence, such as intervention studies and meta-analyses, are expected to be undertaken in this area in the future. Maintenance and recovery of masticatory function is of great importance with respect to achieving healthy longevity. Dental science will have considerable obligations and will have to take on an important role in this regard. For dental treatment to take on such important roles in the fields of health, medicine and welfare, it is necessary to provide information that will be understood not just by other medical and healthcare professionals, but also by the general public.

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http://dx.doi.org/10.1016/j.jdsr.2014.09.002

Avan et al. BMC Medicine (2019) 17:191
https://doi.org/10.1186/s12916-019-1397-3

BMC Medicine

RESEARCH ARTICLE Open Access

Socioeconomic status and stroke incidence, prevalence, mortality, and worldwide burden: an ecological analysis from the Global Burden of Disease Study 2017

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Abstract

Background: Socioeconomic status (SES) is associated with stroke incidence and mortality. Distribution of stroke risk factors is changing worldwide; evidence on these trends is crucial to the allocation of resources for prevention strategies to tackle major modifiable risk factors with the highest impact on stroke burden.

Methods: We extracted data from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2017. We analysed trends in global and SES-specific age-standardised stroke incidence, prevalence, mortality, and disability-adjusted life years (DALYs) lost from 1990 to 2017. We also estimated the age-standardised attributable risk of stroke mortality associated with common risk factors in low-, low-middle-, upper-middle-, and high-income countries. Further, we explored the effect of age and sex on associations of risk factors with stroke mortality from 1990 to 2017.

Results: Despite a growth in crude number of stroke events from 1990 to 2017, there has been an 11.3% decrease in age-standardised stroke incidence rate worldwide (150.5, 95% uncertainty interval [UI] 140.3–161.8 per 100,000 in 2017). This has been accompanied by an overall 3.1% increase in age-standardised stroke prevalence rate (1300.6, UI 1229.0–1374.7 per 100,000 in 2017) and a 33.4% decrease in age-standardised stroke mortality rate (80.5, UI 78.9–82.6 per 100,000 in 2017) over the same time period. The rising trends in age-standardised stroke prevalence have been observed only in middle-income countries, despite declining trends in age-standardised stroke incidence and mortality in all income categories since 2005. Further, there has been almost a 34% reduction in stroke death rate (67.8, UI 64.1–71.1 per 100,000 in 2017) attributable to modifiable risk factors, more prominently in wealthier countries.

(Continued on next page)

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Masticatory function and nutrition in old age

KEYWORDS
Nutrition, quality of life, oro-facial function, dental state, dental prosthesis

Figure above: Elderly Patient with a combination of root caries and periodontal problems

SUMMARY

Nowadays, many people retain their natural teeth until late in life as a result of the large success of preventive strategies. However, there is still a very high prevalence of edentulism especially in elderly patients and many of these patients are provided with inadequate dental prostheses. In addition, many elderly citizens suffer from systemic diseases leading to increased drug prescription with age. This may have direct or indirect negative effects on the health and integrity of oral tissues like teeth, mucosa or muscles. There is growing evidence that a close interaction between the general medical condition and oral health exists. From a dental point of view, the chewing ability and capacity and its interaction with the nutritional status seem to be especially important. For example, complete denture wearers present a significant oral disability, which often leads to a gradual deterioration of their individual dietary habits. The improvement of maximum bite force and chewing efficiency may be an important prerequisite for an adequate nutrition. Those functional parameters can often be improved by providing functional dental prostheses or by stabilizing complete dentures with endosseous implants. Nevertheless, an improvement of the nutritional status can only be achieved through a close collaboration with dieticians or clinical nutritionists.

Masticatory Function and Bite Force in Stroke Patients

Article *in* Journal of Dental Research · February 2011

DOI: 10.1177/0022034510383860 · Source: PubMed

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Stavros Kiliaridis
University of Geneva

Frauke Müller
University of Geneva

World Health Organization

Oral Health Assessment Form for Adults, 2013

Annex 1

Leave blank	Year	Month	Day	Identification No.	Orig/Dupl	Examiner
(1) ☐☐☐☐ (4)	(5) ☐☐	☐☐	☐☐ (10)	(11) ☐☐☐☐ (14)	☐ (15)	(16) ☐☐ (17)

General information: **Sex** 1=M, 2=F ☐ (18) **Date of birth** (19) ☐☐☐☐☐☐ (24) **Age in years** (25) ☐☐ (26)

____
(Name)

Ethnic group (27) ☐☐ (28) **Other group**(29) ☐☐ (30) **Years in school** (31) ☐☐ (32) **Occupation** ☐ (33)

Community (geographical location) (34) ☐☐ (35) **Location** Urban (1) Periurban (2) Rural (3) ☐ (36)

Other data ______________________ (37) ☐☐ (38) **Other data** ____________________ (39) ☐☐ (40)

Other data ______________________ (41) ☐☐ (42) **Extra-oral examination** __________ (43) ☐☐ (44)

Dentition status

		18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28	
Crown	(45)																	60)
Root	(61)																	(76)
Crown	(77)																	(92)
Root	(93)																	(108)
		48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38	

Permanent teeth

Status

0 = Sound
1 = Caries
2 = Filled w/caries
3 = Filled, no caries
4 = Missing due to caries
5 = Missing for any another reason
6 = Fissure sealant
7 = Fixed dental prosthesis/crown abutment, veneer, implant
8 = Unerupted
9 = Not recorded

Periodontal status (CPI Modified)

		18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28	
Bleeding	(109)																	(124)
Pocket	(125)																	(140)
Bleeding	(141)																	(156)
Pocket	(157)																	(172)
		48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38	

Gingival bleeding

Score
0 = Absence of condition
1 = Presence of condition
9 = Tooth excluded
X = Tooth not present

Pocket

Score
0 = Absence of condition
1 = Pocket 4–5 mm
2 = Pocket 6 mm or more
9 = Tooth excluded
X = Tooth not present

World Health Organization

Oral Health Assessment Form for Adults, 2013

Loss of attachment

Severity
0 = 0–3 mm
1 = 4–5 mm Cemento-enamel junction (CEJ) within black band
2 = 6–8 mm CEJ between upper limit of black band and 8.5 mm ring
3 = 9–11 mm CEJ between 8.5 mm and 11.5 mm ring
4 = 12 mm or more CEJ beyond 11.5 mm ring
X = Excluded sextant
9 = Not recorded

* Not recorded under 15 years of age

Index teeth

	17/16	11	26/27	
(173)				(175)
(176)				(178)
	47/46	31	36/37	

Enamel fluorosis ☐ (179)

Severity
0 = Normal
1 = Questionable
2 = Very mild
3 = Mild
4 = Moderate
5 = Severe
8 = Excluded (crown, restoration, "bracket")
9 = Not recorded (unerupted tooth)

Dental erosion

Severity ☐ (180)

0 = No sign of erosion
1 = Enamel lesion
2 = Dentinal lesion
3 = Pulp involvement

Number of teeth affected

(181) ☐☐ (182)

Dental trauma

Status ☐ (183)

0 = No sign of injury
1 = Treated injury
2 = Enamel fracture only
3 = Enamel and dentine fracture
4 = Pulp involvement
5 = Missing tooth due to trauma
6 = Other damage
9 = Excluded tooth

Number of teeth affected

(184) ☐☐ (185)

Oral mucosal lesions

☐ (186)
☐ (187)
☐ (188)

☐ (189)
☐ (190)
☐ (191)

Condition

0 = No abnormal condition
1 = Malignant tumour (oral cancer)
2 = Leukoplakia
3 = Lichen planus
4 = Ulceration (aphthous, herpetic, traumatic)
5 = Acute necrotizing ulcerative gingivitis (ANUG)
6 = Candidiasis
7 = Abscess
8 = Other condition (specify if possible)
9 = Not recorded

Location

0 = Vermillion border
1 = Commissures
2 = Lips
3 = Sulci
4 = Buccal mucosa
5 = Floor of the mouth
6 = Tongue
7 = Hard and/or soft palate
8 = Alveolar ridges/gingiva
9 = Not recorded

Denture(s)

Upper ☐ (192) **Lower** ☐ (193)

Status

0 = No denture
1 = Partial denture
2 = Complete denture
9 = Not recorded

Intervention urgency ☐ (194)

0 = No treatment needed
1 = Preventive or routine treatment needed
2 = Prompt treatment (including scaling) needed
3 = Immediate (urgent) treatment needed due to pain or infection of dental and/or oral origin
4 = Referred for comprehensive evaluation or medical/dental treatment (systemic condition)

WHO/NMH/NPH/ORH/School/03.3

WHO INFORMATION SERIES ON SCHOOL HEALTH DOCUMENT ELEVEN

Oral Health Promotion:

An Essential Element of a Health-Promoting School

World Health Organization
Geneva, 2003

Education Development Center, Inc.

British Journal of Nutrition (2008), **99**, 121–128
doi: 10.1017/S0007114507795284

Is the goal of mastication reached in young dentates, aged dentates and aged denture wearers?

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(Received 6 March 2006 – Revised 25 May 2007 – Accepted 31 May 2007)

The objective of the present study was to assess the impact of age and dentition status on masticatory function. A three-arm case–control study was performed. Group 1 (*n* 14) was composed of young fully dentate subjects (age 35·6 ± 10·6 years), group 2 (*n* 14) of aged fully dentate subjects (age 68·8 ± 7·0 years) and group 3 (*n* 14) of aged full denture wearers (age 68·1 ± 7·2 years). Mastication adaptation was assessed in the course of chewing groundnuts and carrots to swallowing threshold. Particle size distribution of the chewed food, electromyographic (EMG) activity of the masseter and temporalis muscles during chewing, and resting and stimulated whole saliva rates were measured. Aged dentate subjects used significantly more chewing strokes to reach swallowing threshold than younger dentate subjects ($P<0·05$), with increased particle size reduction, longer chewing sequence duration ($P<0·05$) and greater total EMG activity ($P<0·05$) for both groundnuts and carrots. In addition, aged denture wearers made significantly more chewing strokes than aged dentate subjects ($P<0·001$) to reach swallowing threshold for groundnuts. Particle size reduction at time of swallowing was significantly poorer for denture wearers than for their aged dentate counterparts, despite an increase in chewing strokes, sequence duration and EMG activity per sequence. Masticatory function was thus adapted to ageing, but was impaired in denture wearers, who failed to adapt fully to their deficient masticatory apparatus.

Mastication: Full dental prostheses: Food bolus: Elderly

Mastication is the first major phase in a series of mechanical and chemical transformations of food, ending in the release of nutrients in blood. The role of mastication in the overall process is now better understood. For example, impaired mastication is known to affect food choice adversely, favouring the selection of an unbalanced diet[1,2]. In turn, reduced variety in selected foods may decrease blood levels of certain nutrients[3] (see references in Hutton *et al.*[4]). Some less well-documented findings suggest a direct impact of poor mastication on the digestive process (see references in N'Gom & Woda[5]).

An immediate role of mastication concerns deglutition. Mastication breaks down the food and mixes the resulting particles with saliva to prepare a food bolus that is safe to swallow. To be safe, the food bolus must be smooth, plastic and cohesive[6]. Smoothness and plasticity are needed to facilitate harmless transit past the aero-digestive crossing and then through the oesophagus. Cohesiveness is particularly necessary because otherwise bolus scattering would favour particle aspiration into the airways[6,7]. To obtain such a food bolus, the initial mouthful must be transformed into many small-sized food particles bound together by a mixture of saliva and liquids derived from the food itself[6]. Recent studies have shown that in young healthy subjects the particle size distribution of ready-to-swallow food boluses displays narrow inter-individual variability[8]. This shows that during a usual swallow, the food bolus meets precise particle size conditions, among others, before deglutition is triggered. Fulfilling these conditions is a vital requirement since it helps to prevent dysfunctional deglutition, which is known to be linked to high morbidity[9,10]. An acceptable particle size distribution of the food bolus before swallowing can therefore be considered as a crucial criterion in the assessment of normality of the masticatory function.

A complex motor function such as mastication must adapt to changes that occur in every individual. There are two complementary ways to assess the adaptation of mastication. The first is monitoring the physiological processes involved by simple means such as electromyography or mandibular movement recordings[11]. This approach is known to reflect normal adaptation to food properties, in young[12] and ageing[13,14] subjects. Adaptation may, however, become less efficient with larger anatomical changes such as those found, for example, in full denture wearers[15,16]. Full assessment of adaptation thus also requires measuring how well the function performs with respect to the food bolus after mastication, just before swallowing.

Abbreviation: EMG, electromyographic.

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Tanaka et al. International Journal of Implant Dentistry (2017) 3:8
DOI 10.1186/s40729-017-0070-x

International Journal of Implant Dentistry

RESEARCH Open Access

Short-term follow-up of masticatory adaptation after rehabilitation with an immediately loaded implant-supported prosthesis: a pilot assessment

Mihoko Tanaka[1,2*], Collaert Bruno[2], Reinhilde Jacobs[3,4], Tetsurou Torisu[1] and Hiroshi Murata[1]

Abstract

Background: When teeth are extracted, sensory function is decreased by a loss of periodontal ligament receptions. When replacing teeth by oral implants, one hopes to restore the sensory feedback pathway as such to allow for physiological implant integration and optimized oral function with implant-supported prostheses. What remains to be investigated is how to adapt to different oral rehabilitations.

The purpose of this pilot study was to assess four aspects of masticatory adaptation after rehabilitation with an immediately loaded implant-supported prosthesis and to observe how each aspect will recover respectively.

Methods: Eight participants with complete dentures were enrolled. They received an implant-supported acrylic resin provisional bridge, 1 day after implant surgery. Masticatory adaptation was examined by assessing occlusal contact, approximate maximum bite force, masticatory efficiency of gum-like specimens, and food hardness perception.

Results: Occlusal contact and approximate maximum bite force were significantly increased 3 months after implant rehabilitation, with the bite force gradually building up to a 72% increase compared to baseline. Masticatory efficiency increased by 46% immediately after surgery, stabilizing at around 40% 3 months after implant rehabilitation. Hardness perception also improved, with a reduction of the error rate by 16% over time.

Conclusions: This assessment demonstrated masticatory adaptation immediately after implant rehabilitation with improvements noted up to 3 months after surgery and rehabilitation. It was also observed that, despite gradually improved bite force in all patients, masticatory efficiency and food hardness perception did not necessarily follow this tendency. The findings in this pilot may also be used to assess adaptation of oral function after implant rehabilitation by studying the combined outcome of four tests (occlusal contact, maximum bite force, masticatory efficiency, and food hardness perception).

Keywords: Physiologic adaptation, Masticatory function, Immediate loading, Dental implants

Background

Tooth loss represents a major oral disability comparable to an amputation, with severe impairment of oral functions [1]. While denture wearers can rely on mucosal sensors, anchoring prosthetic teeth to the bone via osseointegrated implants has been assumed to create a (partial) sensory substitution for missing periodontal ligament receptors from stimuli transmitted via the bone [2]. The restoration of the sensory feedback pathway is necessary for the physiological integration of implant-supported prostheses in the human body. It helps to optimize essential oral functions, such as chewing and biting. Studies on such functions usually report an improvement of oral functions with implant-supported prostheses as opposed to conventional dentures [3–9]. Improved oral function also impacts on quality of life [10], often scored with ratings for function, pain,

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Journal of Oral Rehabilitation / Volume 26, Issue 1 / p. 7-13

Masticatory performance and chewing experience with implant‐retained mandibular overdentures

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First published: 25 December 2001
https://doi.org/10.1046/j.1365-2842.1999.00353.x

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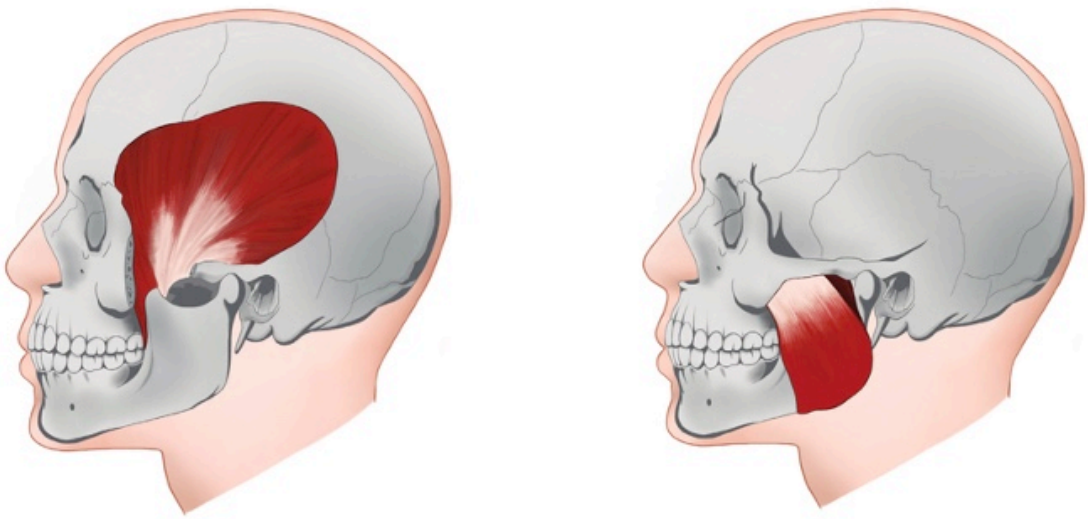
* 1987 version; Bayer, Leverkusen, Germany.

Abstract

The relationship between masticatory performance and chewing experience has not yet been explored for patients with implant‐retained overdentures. Although many relationships have been found between parameters of objective and subjective oral function, the structure of these relationships remain unclear. Therefore, we studied in a randomized clinical trial the relationship between the comminution of an artificial test food, i.e. masticatory performance, and the subjective chewing experience. The trial involved a comparison between two groups receiving implant treatment and one group receiving conventional complete dentures (CD). The implant treatment involved either a mainly implant‐supported mandibular overdenture on a transmandibular implant (TMI) or an implant‐tissue‐supported mandibular overdenture on two IMZ implants (IMZ). Masticatory performance as well as chewing experience were substantially better for the implant‐retained overdentures compared with the complete denture group. No significant differences emerged between the TMI and the IMZ group. A multiple regression analysis did not provide any comprehensibility in the relationship between masticatory performance and the variables of chewing experience. In the linear structural relation analysis (LISREL) no direct relationship was found between masticatory performance and functional complaints mandibular denture. The results show that an improvement in masticatory performance does not imply the same improvement in chewing experience and vice versa.



<u>Figure 1 and 2</u>. Location and shape of the temporalis (figure 1) and masseter (figure 2) muscles.

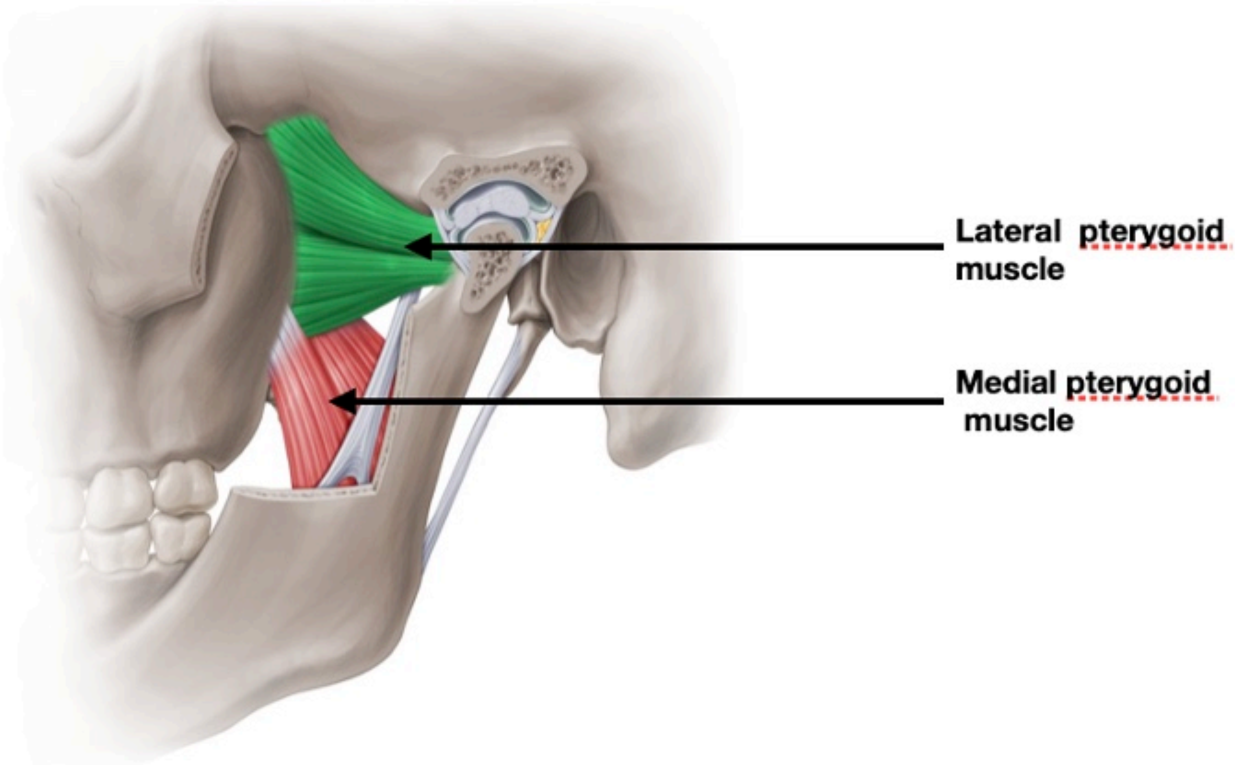
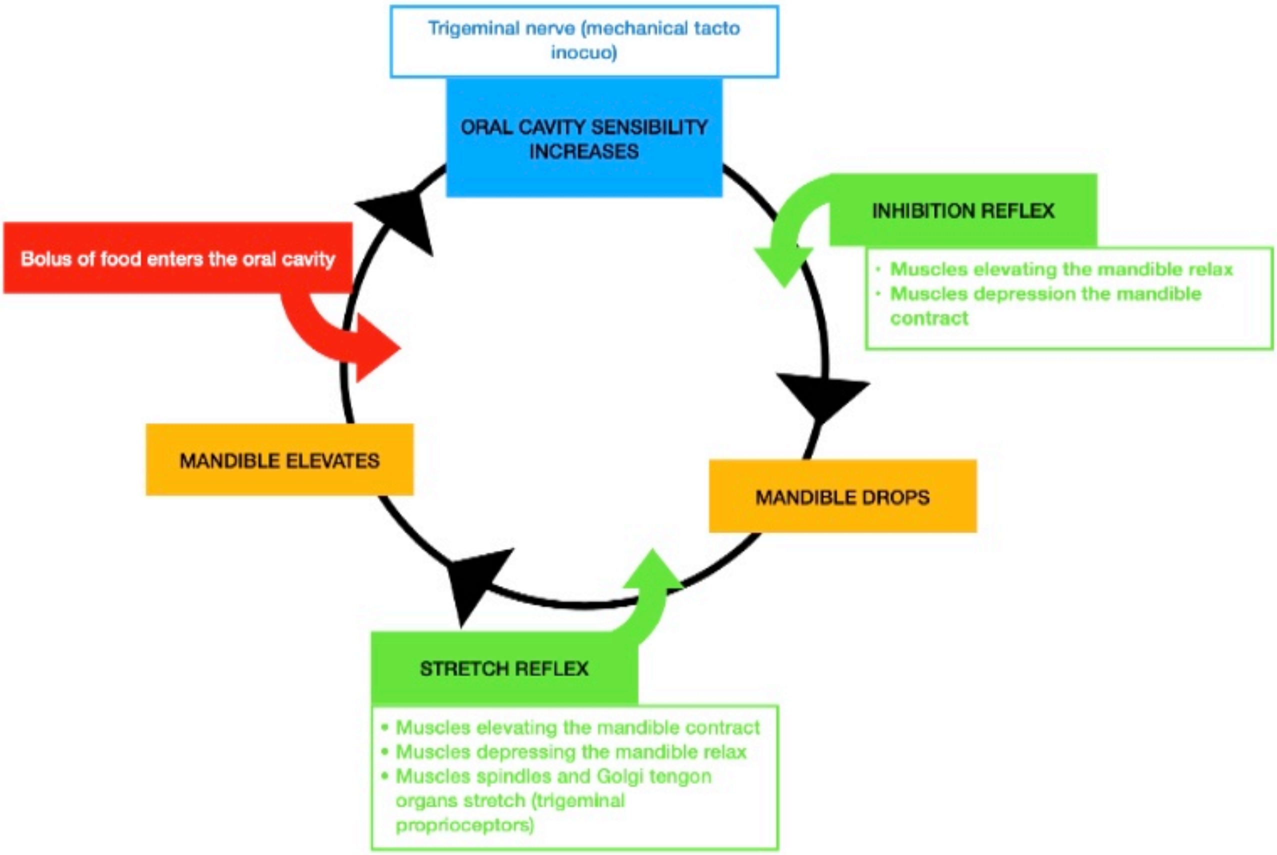


Figure 3. Location of the lateral and the medial pterygoid muscles



<u>Figure 4.</u> The masticatory reflex

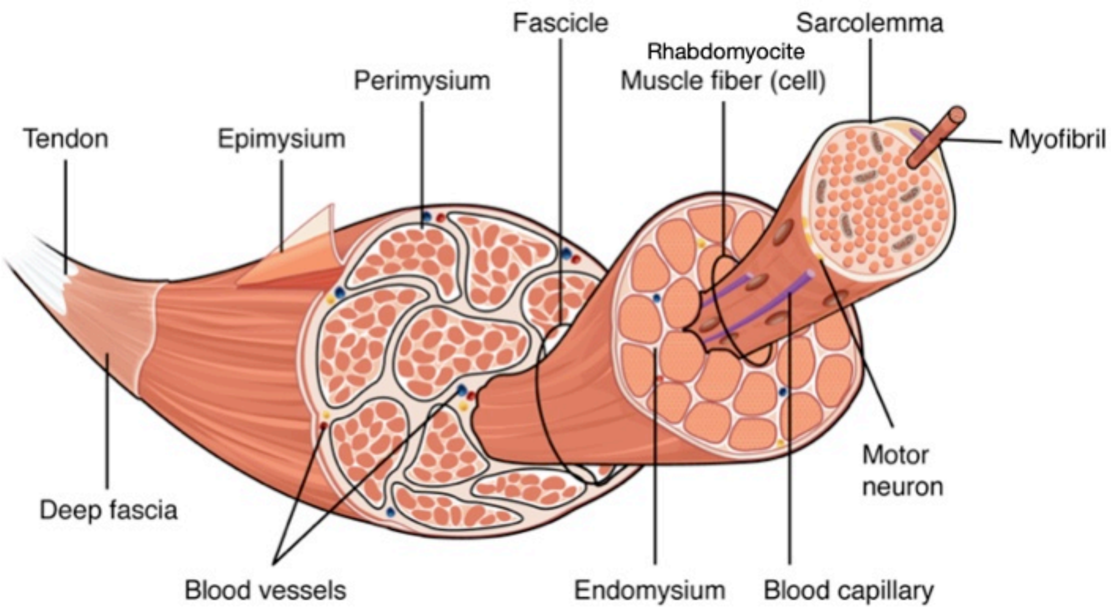


Figure 4. *Muscle components*

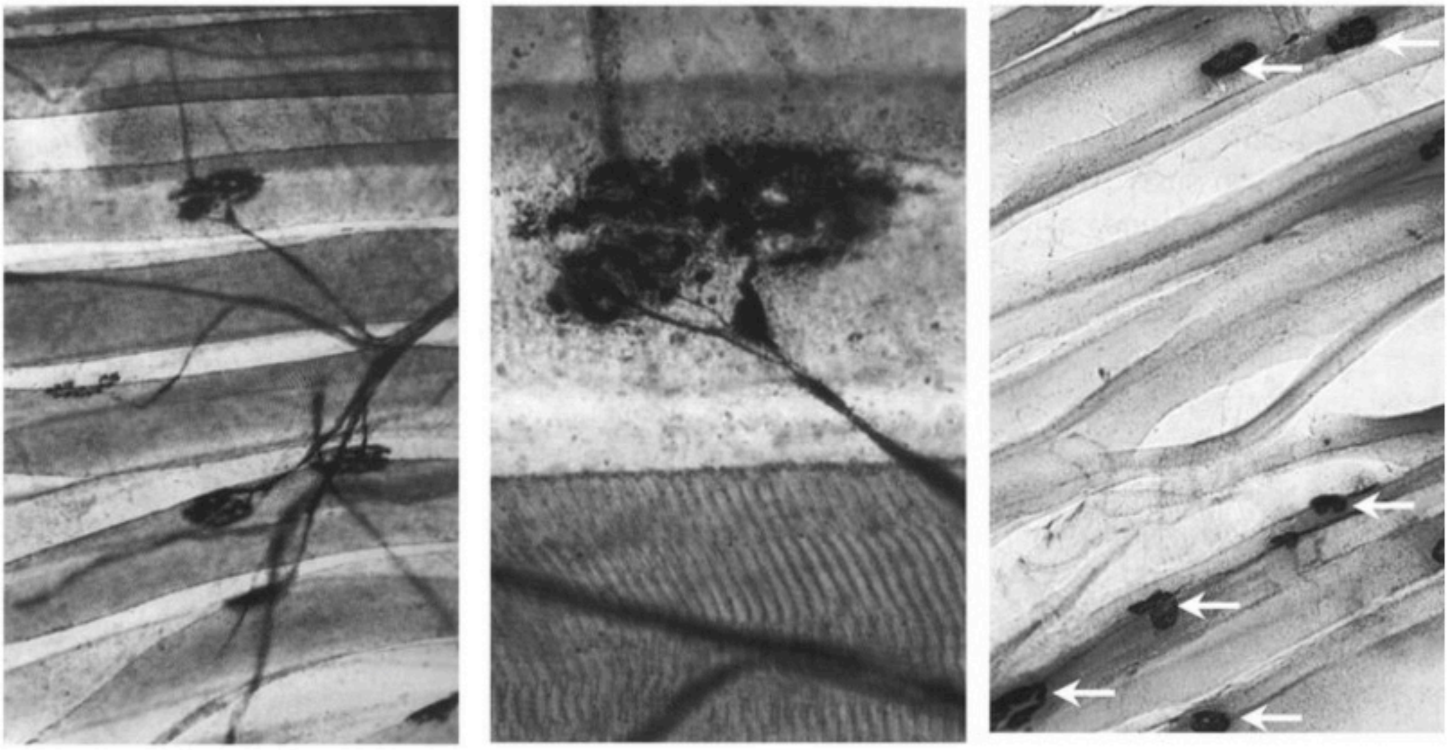


Figure 5. Histological modifications of the mastication muscles due to ageing.