

The International Journal of Orthodontia and Oral Surgery

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VOL. VI

ST. LOUIS, APRIL, 1920

No. 4

ORIGINAL ARTICLES

THE MUSCLES AND LIGAMENTS OF THE MANDIBLE AS RELATED TO CERTAIN FUNCTIONS AND DEVELOPMENT

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THERE is no bone of the body that is more influenced by the attachment of the muscles than is the mandible, neither do we find any bone that has such varying groups of muscles attached to it in relation to the origin, functions, and nerve supply. The mandible has often been classed as a bone of environment, and as a result of these environments various muscles have been brought to play to perform various functions, all of which have an influence upon the mandible. It must be remembered that the mandible of man is concerned in five functions: first, as an organ of mastication for the support of the teeth; second, in the act of respiration; third, in speech; fourth, in deglutition in conjunction of the hyoid muscles and muscles of the pharynx; and fifth, it has an esthetic function in that it forms the lower part of the face. It has attached to it various groups of muscles which can be grouped as muscles of mastication, respiration, deglutition, speech, and expression.

The muscles associated with the mandible also have a very widely distributed nerve supply, which, however, can be divided quite accurately into certain groups connected with some particular function. Briefly, we may say that the muscles associated with the mandible receive their nerve supply from the fifth, seventh, eleventh, and twelfth cranial nerves. It is well to remember that because of this wide distribution of nerve supply, certain groups of muscles may be particularly affected without any change occurring in other groups. For example, we may have lack of development in the muscles of expression, which are controlled or supplied by the seventh nerve, while the muscles of mastication which are supplied by the fifth nerve may have developed normally and be performing their proper functions.

It is also well to remember that none of the muscles associated with the

mandible play a direct part in holding or keeping the mandible in any definite position. The mandible is maintained in a certain position by the ligaments, the inclined planes of the teeth, and by atmospheric pressure, in which the muscles play an indirect part. In a consideration of atmospheric pressure we must remember that the muscles of expression and respiration as well as deglutition play an active part in producing atmospheric conditions in the nasal and oral cavity which hold the mandible in position. It is because of the difference in the atmospheric relations between normal and abnormal breathers that we find the mandible assuming two different degrees of development, one of which results in a normal occlusion, and the other in an abnormal development of the mandible.

In considering these muscles of the mandible, it is well to remember that

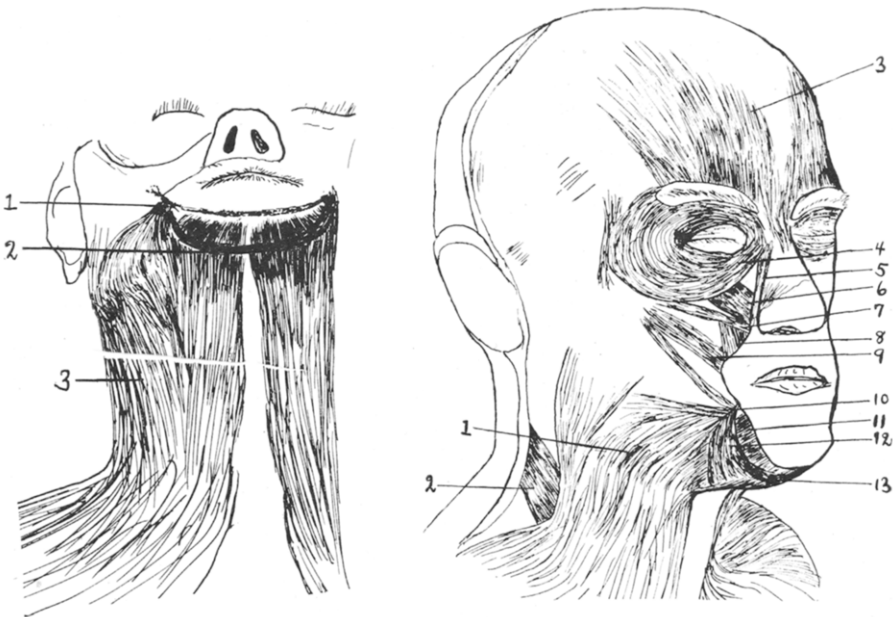


Fig. 1.

Fig. 2.

Fig. 1.—1. *M. triangularis*. 2. *M. transversus menti*. 3. *M. platysma myoides*.
 Fig. 2.—1. *Platysma*. 2. *Sternocleidomastoideus*. 3. *Frontalis*. 4. *Orbicularis oculi*. 5. *Labii quadratus caputangulare (nasi)*. 6. *Caput infraorbit*. 7. *Zygomaticus minor*. 8. *Labii quadratus superioris*. 9. *Zygomaticus major*. 10. *Risorius*. 11. *Labii inferioris*. 12. *M. triangularis*. 13. *M. transversus menti*.

they have different nerve distributions that can also be separated and divided into groups and layers each one of which may be said to have certain definite and distinct functions from the others. We will consider them more in the order of their distributions rather than in the order of their importance. The external surface of the mandible, including the body of the mandible after the removal of the skin, will be found to be covered with a superficial layer of muscular fascia, which is composed of practically four muscles, some of which have been grouped by writers as a single muscle. We have first the platysma myoides which is a small flat muscle that is decidedly a muscle of expression, and has practically no influence upon the mandible (Fig. 1). Great importance has been laid upon this muscle by Dr. Rogers¹ as being concerned in the lack of development of the mandible in mouth breathers, but from actual dissections

and consultations of various anatomic authorities, we find that no one has considered the muscle of any importance in producing any change on the mandible, except Dr. Rogers.

The platysma arises from the superficial fascia which covers the clavicular part of the pectoralis major and deltoid muscles and is attached to the outer surface of the face and the inferior maxilla and the angle of the mouth where the fibers blend with anguli oris and orbicularis oris. The action of this muscle is to draw the angle of the mouth downward and outward, and, secondly, it may act as a feeble depressor of the mandible, and third, it raises and wrinkles the skin of the neck. The muscle does not really belong to the group known as a depressor of the mandible, but belongs to the facial muscles, which can be further understood when we remember that the nerve supply of the platysma is the inframandibular branch of the cervicofacial division of the facial nerve. Associated in this region with the platysma is the triangularis muscle which is flat and triangular and lies below the angle of the mouth and covers the foramen mentale. Its origin is just below the mental foramen and is inserted in the skin at the corner of the lip. Connected with the triangular muscle is the transversus menti which is made up of fibers that run from the platysma and join the fellow on the opposite side. The action of the transversus menti and the triangularis is to draw the corner of the mouth down and act as depressors of the upper lip. These muscles are also supplied by the facial nerve.

Fig. 2 also shows another muscle that may be considered as one of the facial group; namely, the risorius which has its origin from the masseter fascia, inserted at the angle of the mouth at the point of the insertion of the triangularis muscle. The risorius when acting alone draws the corner of the mouth backward and forms a dimple. It has often been called the "Laughing Muscle" and while being associated with the triangularis and transversus menti, it produces a directly opposite facial result. The risorius tends to denote an expression of pleasure, the action of the triangularis and the transversus menti by themselves drop the corners of the mouth producing a directly opposite effect, or one of sadness. The risorius is also supplied by branches of the facial nerve. These four muscles have very little direct action upon the mandible, but make up a portion of the superficial layer and are classed as muscles of expression because of the action and nerve supply. The platysma is the only one which has any fibers inserted directly into the body of the mandible, these fibers are of such small importance as to practically eliminate the platysma as a depressor of the mandible. However, in mouth breathing the inactivity of these muscles may have a detrimental effect in giving an unpleasing expression to the patient's face as is so often noticed in disturbed atmospheric relations.

Muscles of expression which play a part in the action of the upper lip and therefore become important factors in exerting an indirect influence upon the mandible in mouth breathers and abnormal lip habits, may be considered in groups according to their action. We find three muscles which may be termed the quadratus labii superioris made up of the three elevators of the upper lip and the nose; these muscles arise from a point corresponding to the nasal process of the maxillary bone; the maxillary bone in the region of the infraorbital foramen and the zygomatic portion of the maxillary. They all converge downward

and inward towards the sulcus nasolabialis, and in action draw the alæ of the nose and upper lip upward and outward. This group of muscles is supplied by the facial nerve. The zygomaticus major and elevator labii anguli oris arise, respectively, from the zygomatic region of the maxillary and the upper part of the canine fossa, are inserted into the angle of the upper lip and pull the upper lip and angle of the mouth upward. The zygomaticus major located still farther outward on the surface of the malar bone near the zygomatic arch runs downward and inward and is attached in the angle of the mouth to the lower border and the above-named muscles. All of these muscles are supplied by the facial nerve. Acting together they raise the upper lip. The quadratus labii inferioris can be mentioned with the depressors of the lips, with the transversus menti, and arise from the platysma region and are inserted at the border of the mouth and tend to draw down the corners of the mouth in an opposite direction to the muscles which have been previously named. The elevator mentalis shown

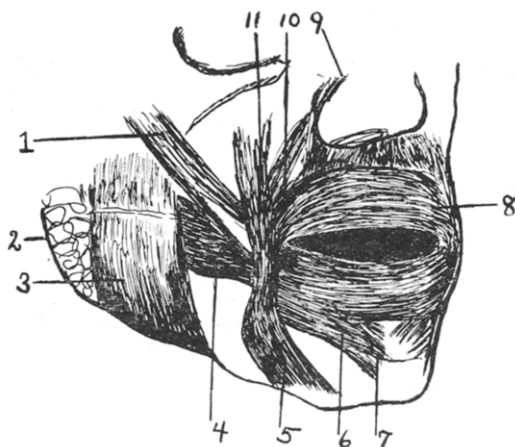


Fig. 3.—1. Zygomaticus M. 2. Parotid. 3. Masseter. 4. Buccinator. 5. M. triangularis. 6. M. incisivus labii inferioris. 7. M. mentalis. 8. Orbicularis oris. 9. Transversus nasi. 10. Labii superioris. 11. M. caninus.

in Fig. 3, arises from the incisal fossa of the mandible and is inserted into the skin of the chin. The action of this muscle is to raise the chin, as a result of which the lower lip is protruded.

The orbicularis oris is composed of fibers which surround the oral opening and which is contributed to by some of the fibers of all the muscles which have been mentioned and fibers which may be said to be common to the orbicularis oris alone. The orbicularis oris is a complex muscle consisting of three layers. The superficial layer is the prolongation of the fibers of the elevators and depressors at the angle of the mouth and extends as far as the center of the lip, but the fibers are not continuous to those of the opposite half. They are reinforced by the elevators of the upper lip and the zygomaticus, risorius, platysma and depressor labii inferioris. The middle layer is made up of the fibers derived from the buccinator. The deeper layer is composed of fibers which may be said to consist entirely of muscular fibers contributing to the orbicularis alone, and consists of two pairs of muscles associated with the upper portion, namely,

the *musculus incisivus* and *nasolabialis*. One pair is associated with the lower lip, known as the *musculus incisivus*, which arises from the incisor fossa of the mandible and turns outward blending with the other fibers mentioned. These various fibers are supplied with branches of the facial nerve and the action of the muscle is to close the oral opening and press the lip against the alveolar margin. The depressors and elevators of the lip as well as the *zygomaticus*, may be said to constitute the middle layer of the muscles of expression, the superficial layer being composed of the *platysma*, the *triangularis*, the *transversus menti* and the *risorius*. The middle layer is derived from the buccinator. The deep layer is the *musculus incisivus superioris* and *nasolabialis* and *musculus incisivus inferioris*, the last three pairs being already mentioned in conjunction of the *orbicularis*.

The buccinator muscle is much larger than any of the others which we have mentioned, with the possible exception of the *orbicularis oris* which was a blending of all the various muscles and fibers of expression, and we therefore feel the buccinator should be given more attention than we have paid to the other muscles. The action of the buccinator is little understood, and it has often been classed as a muscle of mastication and so considered by some anatomists. The buccinator belongs to the muscles of expression and becomes a muscle of mastication indirectly, only because it may be influential in keeping the food under the surface of the molars and premolars by contraction. It has no direct action on the movement of the mandible, although it is attached to both the mandible and the maxilla, which are considered points of origin. The buccinator rises from the outer surface of the alveolar border of the mandible and the maxilla opposite the molar teeth and a portion of the fibers arise from the anterior surface of the pterygo-mandibular ligaments. The fibers are inserted in the angle of the mouth and help to make up the middle strata of the *orbicularis oris*. It is supplied by the temporo-facial branches of the facial nerve, and by the buccal branches of the cervicofacial division. The nerve supply of this muscle therefore places it outside of the muscles of mastication which shows it is developed from the same structures that have made up the other muscles of expression. The action draws the angle of the mouth outward and presses the lips and cheeks against the teeth to force food under the masticating surfaces. The buccinator muscle is penetrated by the duct of the parotid gland as shown in Fig. 3.

It should also be remembered that all of these muscles of expression which are attached to the mandible are attached to the body of the mandible and none of them concerned with the opening or closing of the mouth. The muscles of mastication consist of four pairs of muscles, being four right and four left, all of which are inserted into the mandible and none of which have their origin or any fibers arising from the maxillary. These are the muscles which supply the movements of the mandible when the masticating or incisal functions of the teeth are being performed. We also find certain of these muscles are quite specialized in regard to their masticating functions, some more important than others, and as a result of this we find them developed in different degrees according to whether the incisors or molars are performing the greatest masticating functions. Fig. 4 shows the superficial portion of the *masseter* which arises from the anterior two-thirds of the lower border of the zygomatic arch and the

deep portion arises from the posterior third of the lower border and the whole of the internal surface of the zygomatic arch. The superficial portion of the masseter fibers are inserted in the lower half, the deep portion in the upper half of the outer surface of the ramus extending from the inferior border of the ramus to a point very close to the coronoid process. The action of the masseter is to close the mouth or move the mandible upward. It is particularly well developed in those animals which perform the masticating functions on the molars. It is therefore related to the occlusion of the molars and premolars. Fig. 4 also shows the origin of the temporal muscles in that it gives the extent of the temporal fossa which extends as high as the inferior temporal ridge of the frontal and parietal bone and as low as the infratemporal crest of the great wing of the sphenoid. The deeper fibers of the temporal muscles arise from the deep portion

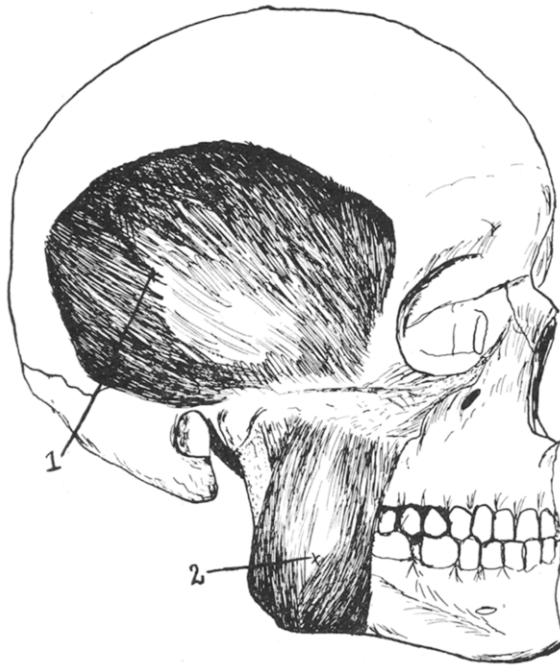


Fig. 4.—1. Fascia temporalis. 2. Masseter.

of the fossa, while the external fibers are, of course, attached to the temporal fascia. Fig. 5 shows the zygomatic arch removed and the gathering together of the fibers of the temporal muscles to be inserted in the coronoid process of the mandible. The action of the temporal muscle is to pull upward on the coronoid process, but owing to the wide origin of the fibers of the temporal, all of the fibers do not have the same action during mastication. In Fig. 5 it will be observed that the anterior fibers of the temporal run almost directly downward and become active when closing the mouth. The middle, posterior, and lower portion of the fibers of the temporal run downward and forward to the coronoid process, with the result that the action of the lower fibers will pull the mandible backward. When the mandible is protruded by the action of the external and internal pterygoid muscles to bring the edge of the incisors together for incision,

the middle and posterior fibers of the temporal acting on the coronoid process in conjunction with the anterior fibers pull the mandible backward and upward with sufficient force to perform incision. The action of the temporal muscle in moving the mandible posteriorly during incision is not very well understood by certain men in the profession. The use of the temporal muscle has been recommended as one of the important factors in muscle training in distocclusion cases.¹ There is no question about the value of the friction of the muscle during mastication as a means of producing development, but the action of the temporal muscle in a distocclusion case, especially the posterior and lower fibers, might be detrimental, as they would have a tendency to pull the mandible distally, which is the thing some men seem to want to avoid, especially where they be-

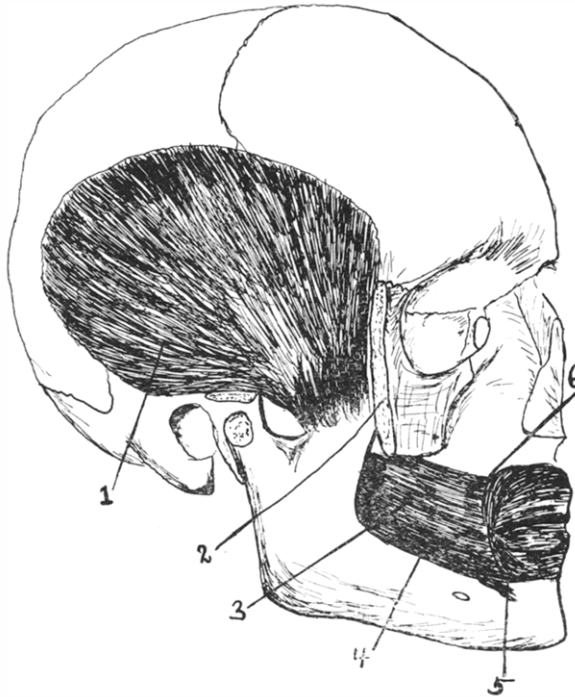


Fig. 5.—1. M. temporalis. 2. Zygomatic arch. 3. Parotid duct. 4. M. Buccinator. 5. M. incisus labii inferioris. 6. M. incisus superioris.

lieve they have moved the mandible forward in the correction of distocclusion. I very much doubt whether in the correction of a case of distocclusion any change occurs in the position of the mandible. I question the value of the action of the temporal in the retention of distocclusion cases, but also believe that no harm can result because of the fact that the mandible has not been moved forward in these distocclusion cases, which some men are inclined to think has occurred. If the mandible had been moved forward in the treatment of a distocclusion case, with the hope of keeping it forward, the muscular training and the education of the temporal muscle or continued use of the temporal muscle would be a detrimental factor because it would have a tendency to pull the

mandible distal to its old position. Both the temporal and the masseter are supplied by branches of the fifth cranial nerve.

The muscles of mastication, which are attached to the inner portion of the ramus, include the internal and external pterygoids. The action of these mus-

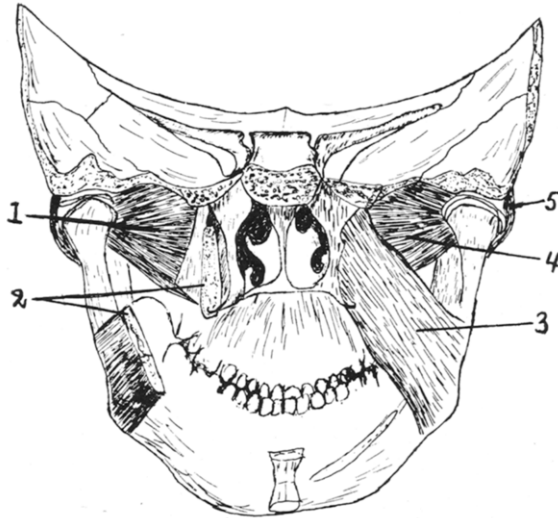


Fig. 6.—1. External pterygoid M. 2. Internal pterygoid M. (cut). 3. Internal pterygoid M. 4. External pterygoid M. 5. External capsular ligament.

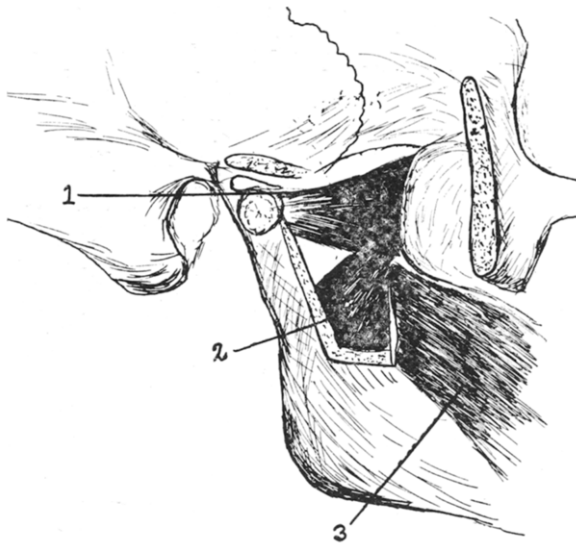


Fig. 7.—Pterygoid muscles, right side, external view. 1. M. Pterygoid externus. 2. Internal pterygoid M. 3. M. Buccinator.

cles is very little understood, judging from the various papers that have been published upon the subject in times past. Fig. 6, 7, and 8 show different views of the pterygoid muscles. These figures have been made with as little regard to other anatomic structures as was possible and still give their correct origin and

insertion. Fig. 6 shows that both muscles arise from the internal and external surface of the outer pterygoid plate of the sphenoid, extend backward and outward. The internal pterygoid runs backward, downward, and outward; the external pterygoid runs almost directly backward and outward without any downward tendency. The internal pterygoid is inserted in the inner surface of the ramus near the angle of the mandible and directly internal to the insertion of the masseter. Action of the internal pterygoid is to close the mouth by pulling upward on the ramus and also slightly forward. However, the muscle most active in protruding the mandible is the external pterygoid, which, when acting on the right and left sides, moves the mandible forward. If the external pterygoid acts on one side alone in conjunction with the internal pterygoid on that side, the mandible will be swung forward and laterally with the result that the entire mandible will be shifted toward the opposite side as far as the temporo-mandibular ligament will allow it to be shifted. In the movement of the human

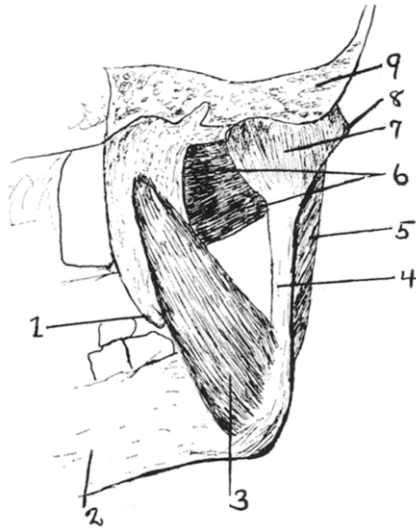


Fig. 8.—1. Hamulus pterygoideus. 2. Mandible. 3. Pterygoid interus. 4. Ramus mandibulæ. 5. Masseter. 6. Pterygoid externus. 7. Condyle. 8. Zygomaticus. 9. Os temporale.

mandible, the mandible does not rotate on the opposite condyle and the glenoid fossa because of the fact that the pterygoid muscles running backward and outward will necessarily produce a lateral shifting if only one muscle acts at a time. This lateral motion of the mandible is limited only by the length of the temporomandibular ligaments. Fig. 7 shows the zygomatic arch and a portion of the ramus of the mandible removed in order to give an external view of the external and internal pterygoids which have been called the internal muscles of mastication. In Fig. 8 the internal pterygoid plate of the sphenoid has been removed in order to show the origin of the internal pterygoid and the internal surface of the external pterygoid plate. The pterygoids are supplied by branches of the fifth cranial nerve.

It will be observed that all of these muscles attached to the ramus have action which moves the mandible forward, backward or upward. None of these muscles are so attached as to open the mouth, consequently the downward

motion of the mandible has to be supplied by another group of muscles which has been termed depressors of the mandible or elevators of the hyoid. Therefore the muscles associated in depressing the mandible have a twofold action. For example, if the mandible is held in position by the muscles of mastication, then those muscles which originally depressed the mandible become elevators of the hyoid. And in order for the mandible to be opened, a group of muscles which are known as the depressors of the hyoid have to be active and fix the hyoid bone so the elevators of the hyoid can depress the mandible. Consequently, the opening of the mouth is quite a complex proposition, because it calls into play the use of muscles which have other purposes than that of depressing the mandible.

Fig. 9 is the anterior view which shows the groups of muscles, concerned in depressing the mandible. This view includes a large number of the muscles of the neck. For purposes of relation the sternocleidomastoid is shown (Fig. 10) as arising from the sternum and the sternoclavicular articulation extends upward and backward, to be attached to the mastoid process of the temporal bone. This muscle is not concerned in the movement of the mandible, only in drawing the head downward and forward or when acting single in rotating the head. The sternocleidomastoid may be considered as a superficial muscle of the neck, along with the platysma, which has been removed.

The muscles indirectly concerned in the opening of the mouth because they are attached to the hyoid bone are the omohyoid and the sternohyoid. Also attached to the hyoid bone we have the thyrohyoid which becomes a depressor of the hyoid bone, because of the fact that the sternothyroid is inserted below it, and when the sternothyroid fixes the thyroid, the thyrohyoid becomes a depressor of the hyoid bone. We have four muscles which may be considered as active factors in the depressing of the hyoid bone or in fixing hyoid bones so the elevators of the hyoid become depressors of the mandible. The omohyoid as shown in Figs. 9 and 10 arises from the upper border of the scapula and is inserted in the outer third lower border of the hyoid bone, immediately external to the insertion of the sternohyoid muscle. This muscle is supplied by fibers of the hypoglossal nerve. The sternohyoid arises from the sternum and extends upward to the hyoid bone inserted into the hyoid at a point internal to the insertion of the omohyoid. This muscle and the omohyoid are the two long muscles which depress the hyoid bone and fix it in conjunction with the two short muscles, namely, the sternothyroid and the thyrohyoid. The lower portion of the sternothyroid is shown in Fig. 9, which extends from the sternum to the thyroid cartilage. The thyrohyoid is better shown in Fig. 10 where it extends from the hyoid bone at its insertion and has the origin at the thyroid cartilage. All of these muscles are supplied by branches of the hypoglossal or twelfth cranial nerves.

We have called attention to the fact that there are practically four muscles which are concerned in the fixation of the hyoid bone known as depressors of the hyoid which are also concerned in opening the mouth. In the region above the hyoid bone and between the mandible we also find four muscles, three of which again are directly attached to the mandible, while one is only active in elevating the hyoid. The digastric which is shown in Figs. 9, 10, and 12 is so

named because it is a double-bellied muscle, the posterior belly of which arises from the digastric fossa of the temporal, extends forward to the hyoid bone where it is bound down by the fascia of the stylohyoid muscle. That point is also the insertion of the anterior belly, the origin of which is the digastric fossa found on the internal surface of the mandible. While this muscle is named as a double-bellied muscle because of the insertion of the anterior and posterior belly into the hyoid bone, it is in reality the fusion of two muscles as shown by the nerve supply. The posterior belly of the digastric is supplied by a branch of the facial nerve, which therefore according to nerve supply is related to the muscle of expression. The anterior belly is supplied by the mylohyoid division of the inferior dental, which associates it more intimately with the mandible

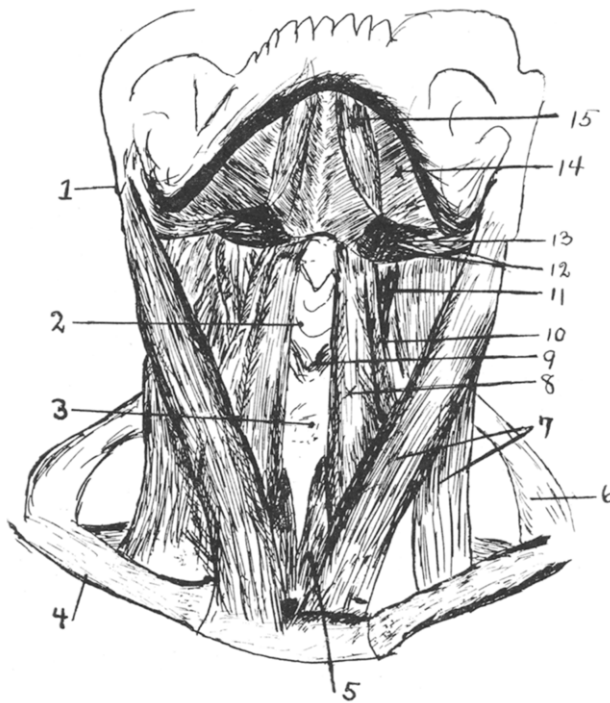


Fig. 9.—1. Mastoid process. 2. Thyroid cartilage. 3. Thyroid. 4. Clavicle. 5. Sternothyroid. 6. Trapezius. 7. Sternocleidomastoideus. 8. Sternohyoid. 9. Cricothyroid. 10. Omohyoid. 11. Thyrohyoid. 12. Stylohyoid. 13. Digastric muscle, posterior belly. 14. Mylohyoid. 15. Digastric muscle, anterior belly.

than with the hyoid bone, and while it is classed as an elevator of the hyoid, it is in more reality a depressor of the mandible, that being the direct action of the anterior belly as shown by the origin, insertion, and nerve supply. The stylohyoid muscle which is shown in Figs. 9, 10, 11, and 12, arises from the styloid process of the temporal bone and is inserted in the anterior surface of the hyoid at the junction of the body and great cornu. This muscle like the posterior belly of the digastric is supplied by the facial nerve and consequently more intimately associated with muscles of expression than that of the hyoid or mandibular group.

The third muscle of this group, the mylohyoid which is shown in Figs. 9,

10, 11, 12, and 14 is a double muscle, which is united at the median line to form the diaphragma oris. It arises from the internal oblique ridge of the mandible and is inserted into the anterior surface of the hyoid bone. The

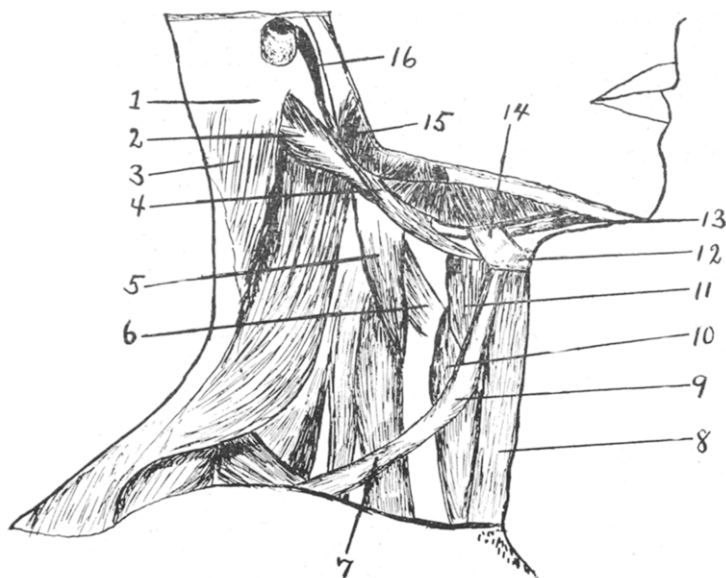


Fig. 10.—1. Styloid process. 2. Masseter. 3. Digastric muscle, posterior belly. 4. Stylohyoid. 5. Sternocleidomastoideus. 6. Trapezius. 7. Omohyoid. 8. Sternohyoid. 9. Omohyoid. 10. Thyrohyoid. 11. Hyoid. 12. Digastric muscle. 13. Ramus.

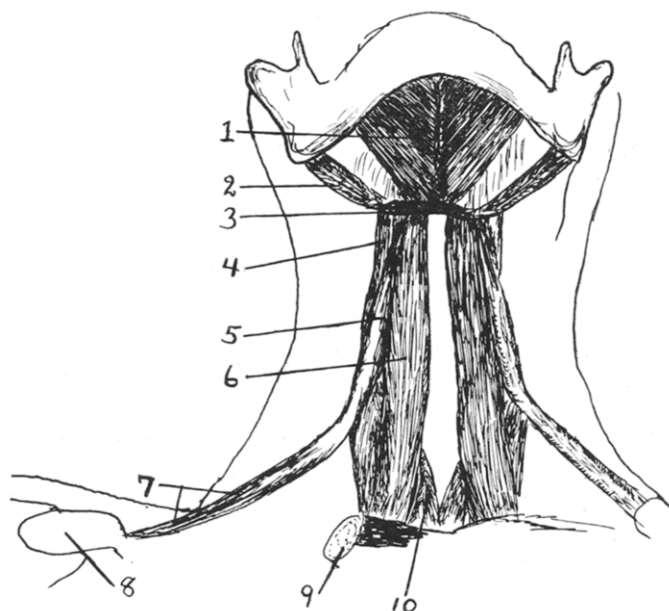


Fig. 11.—1. Mylohyoid. 2. Stylohyoid. 3. Hyoid. 4. Thyrohyoid. 5. Omohyoid. 6. Sternohyoid. 7. Omohyoid. 8. Scapula. 9. Clavicle. 10. Sternothyroid.

general direction of the fibers are downward and inward. The muscle raises the floor of the mouth and when the mandible is fixed, elevates the hyoid and

draws it forward. When the hyoid bone is fixed, it depresses the mandible. The nerve supply is the mylohyoid branch of the fifth.

Fig. 13 shows the manner in which the sternothyroid arises from the sternum and is inserted into the thyroid cartilage, the action of which is to depress the thyroid cartilage. This muscle is also a depressor of the thyroid bone and as such, also becomes a depressor of the mandible by the extension of the thyro-hyoid from the thyroid cartilage to the hyoid bone. Fig. 13 shows what might be called the deeper layers of muscles in the hyoid region, but also concerned as depressors of the mandible. Fig. 14 is made to show the arrangement and direction of the fibers of the mylohyoid and the geniohyoid from the mandible to the hyoid bone. These muscles also form the floor of the mouth and are influential in mouth-breathing.

Figs. 15 and 16 show the ligaments associated with the mandible, the purpose of which is to limit the extent of the mandibular movement as the result

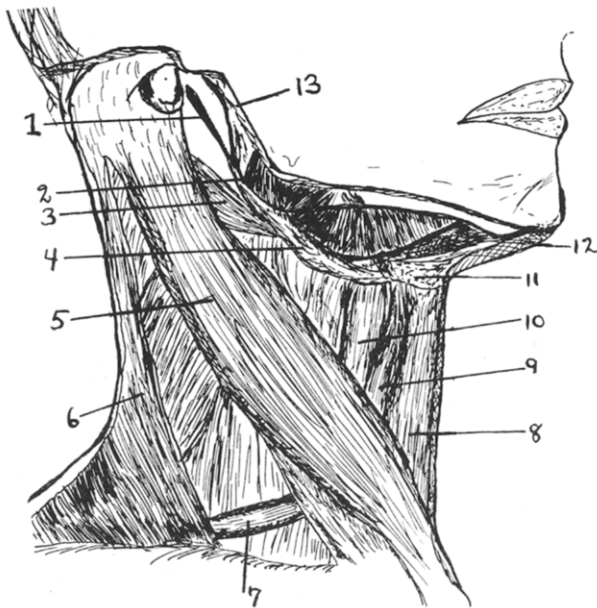


Fig. 12.—1. Mastoid process. 2. Digastric muscle. 3. Splenius capitis. 4. Stylohyoid. 5. Longus capitis. 6. Constrictor pharyngeus inferior. 7. Omohyoid. 8. Sternohyoid. 9. Omohyoid. 10. Sternohyoid. 11. Thyrohyoid. 12. Hyoid. 13. Digastric muscle, anterior belly. 14. Loop for digastric muscle. 15. Masseter. 16. Styloid process.

of the action of the various muscles. Fig. 15 shows the temporomandibular ligament or what is often called the external capsular ligament which is attached into the outer border of the glenoid fossa and inserted into the neck of the condyle below the articular cartilage. It completely surrounds the head of the condyle, attached to all sides of the glenoid fossa. The outer fibers are the stronger, the majority of which run downward and backward. This ligament limits the forward movement of the mandible as a result from the action of the external and internal pterygoids, and also limits the lateral movement of the mandible on the right side when the pterygoid muscle on the left side are contracting alone to shift the mandible laterally. When the posterior fibers

of the temporals contract or when the lower fibers of the temporal act during the act of incision after the mandible has been moved forward to place the edge of the incisors together, these fibers of this ligament also limit the backward action of the lower fibers of the temporal. Owing to the direction in which the stylomandibular and sphenomandibular ligaments run downward and forward, as the mandible is protruded by the action of the pterygoids there is necessarily a tendency for the condyle to move upward as these ligaments assume a different angle. When the mouth is opened to its extreme width by the action of the depressors of the mandible which include the anterior belly of the digastric, the geniohyoid and the mylohyoid; the mandible first starts

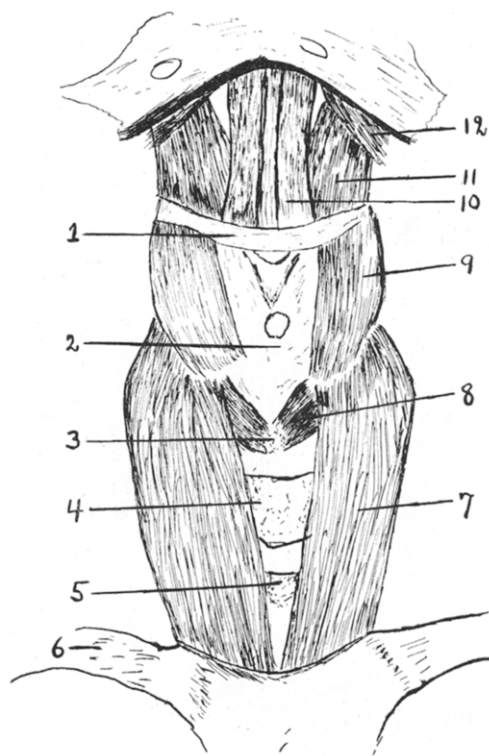


Fig. 13.—1. Os hyoidei. 2. Thyroid cartilage. 3. Cut cricoidea. 4. Thyroid gland. 5. Trachea. 6. Clavicle. 7. Sternothyroid. 8. Cricothyreoideus. 9. Thyreohyoideus. 10. Geniohyoideus. 11. Hyoglossus. 12. Styloglossus.

to open with the temporomandibular articulation as the hinge point after the stylomandibular and sphenomandibular ligaments become tight: then the opening movement of the mandible is continued by the attachment of the stylomandibular and sphenomandibular ligaments on the mandible becoming a limiting point. The condyle then moves forward as far as allowed to by the temporomandibular ligaments, at which point the opening of the mouth is stopped.

We have called attention to the different groups of muscles attached to the mandible, of which there is a group of four, all of which are concerned in the acts of mastication. The group of four is located in the suprahyoid region, three of which are depressors of the mandible and one of which is only an

elevator of the hyoid bone; namely, the stylohyoid. We have four infrahyoid muscles which connect the hyoid bone to the suprahyoid region and depress the mandible, two of those muscles extending from the sternoclavicular region to the hyoid bone, one extending from the thyroid cartilage to the hyoid bone, which, however, becomes a depressor of the hyoid, owing to the fact that the fourth muscle in the group extends from the sternum to the thyroid cartilage. The four muscles of mastication, which are supplied by the fifth nerve and are attached to the ramus, are the least affected by maldevelopment or environmental changes and conditions. Of the various types of malocclusion that we encounter, with over- and underdevelopment of the mandible, we find that region to which the muscles of mastication are attached more often normally developed than any other part of the mandible. The action of the muscles of mastication is nearly always normal, in fact they are always normal in regard to the direction, but

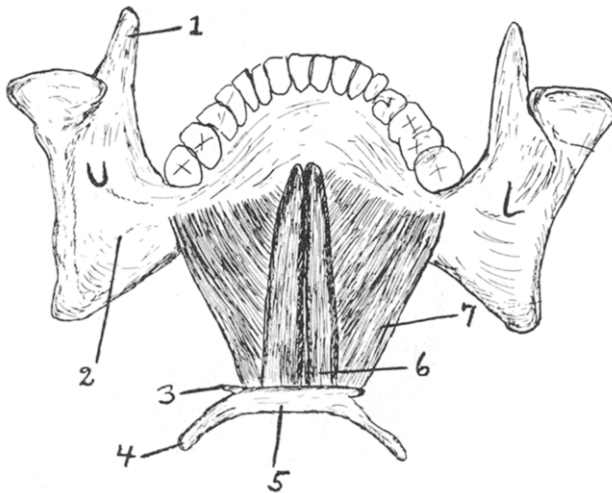


Fig. 14.—1. Coronoid. 2. Ramus mandibulæ. 3. Cornua minora. 4. Cornua majora. 5. Hyoid. 6. Geniohyoideus. 7. Mylohyoideus.

they may not exert as much pressure as is desired in certain types of malocclusion. The muscles of mastication have long been accused of producing deformity of the mandible in rachitic individuals, which statement has been doubted by Dr. Hatfield.² The writer is still of the opinion that mandibular deformity in rickets does occur from the action of the mandibular muscles. Hatfield contradicts the theory upon the basis that physiologic use of an organ tends to produce normal development, therefore the action of the muscles of mastication would tend to produce a normal development of the mandible. This theory would be true if Hatfield did not forget that in rickets there is a pathologic condition of the mandible in extreme cases, which results in an abnormal development or a failure of response to the mechanical stimulation such as would obtain in a normal individual. Consequently with the mandible in an imperfectly calcified state and the individual attempting to masticate on the teeth, we find the mandible assumes an obtuse angle between the ramus and the body.

Rogers has also stated that the pterygoid muscles should be exercised in

distoclusal cases with the idea of moving the mandible forward. This theory is open to criticism upon the grounds that it must first be proved that in distocclusion cases the mandible needs to be moved forward. In other words, if a distocclusion case is a result of posterior position of the condyle in the glenoid fossa, then the action of the pterygoids in moving the mandible forward would be a desirable condition. But, it must be further remembered that muscular action does not hold the mandible in position; so, no permanent results could be expected from the action of the pterygoids in keeping the mandible in a new position. The mandible is held in position by the force of the inclined plane and the atmospheric relations, not by muscular activity. The beneficial results which occur from the exercising of muscles in cases of malocclusion do not result from the fact that the muscles hold the mandible in position, but the use of these muscles simply create physiologic growth and development which becomes beneficial through the inclined planes of the teeth performing the functions in their proper positions. Rogers has recognized this factor because he states that in no disto-



Fig. 15.—1. Temporomandibular ligament. 2. Stylomandibular ligament.

clusion case should exercise of the masseter and the temporal be employed until the cusps of the teeth are in proper position. As a result of this muscular exercise, instead of the mandible assuming a different position, it produces a growth and development which overcomes the deformity and thereby gives a beneficial result which Rogers seems to think has been obtained by changing the position of the mandible.

The muscles most concerned in the direct movement of the mandible are the four muscles of mastication; namely, the external and internal pterygoid and the temporal and masseter. The various movements which these muscles are capable of producing upon the mandible can be analyzed by remembering that the external pterygoid running from the external pterygoid plate to the head of the condyle (Figs. 6, 7, and 8) moves the mandible forward, and also provides for a lateral motion. When the right and left external pterygoid acts jointly, the mandible is protruded and the incisal edge of the incisors is placed in position. The mandible is then guided to a position of rest by the cusps of the teeth as the

result of the action of the lower fibers of the temporal muscles. By a careful study of the lower fibers of the temporal muscles and the direction of the fibers of the external pterygoid, it will be found that those muscular fibers run practically parallel to each other, or rather run in a parallel direction. The fibers of the external pterygoid run from the external pterygoid plate backward and outward to the neck of the condyle, and the lower fibers of the temporal run forward and inward on practically the same plane to the coronoid process. We may then say that the lower fibers of the temporal have a directly opposite action to the fibers of the external pterygoid. If the pterygoid on the right side act, the mandible is swung to the left and is brought back into position by the reverse action of the right temporal muscle, especially of the lower fibers. The masseter and internal pterygoid are useful in closing the mouth or bringing the teeth to occlusion when the teeth have been separated by the action of the anterior belly of the digastric and the geniohyoid. Fig. 4 shows the general direction of the fibers of

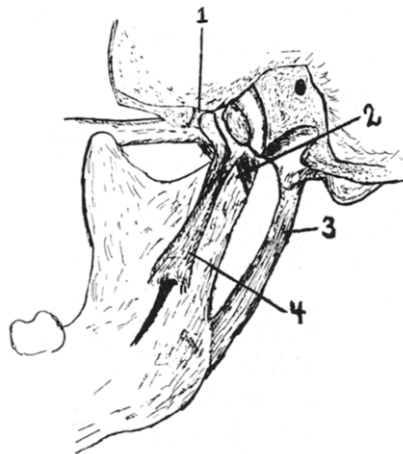


Fig. 16.—1. Temporomandibular ligament. 2. Temporomaxillary ligament. 3. Stylomandibular ligament. 4. Sphenomandibular ligament.

the masseter extending from the zygomatic arch downward to the lower border of the ramus. Figs. 9 and 10 show the direction of the anterior belly of the digastric from the hyoid bone to the base of the mandible, which is downward and backward from the mandible and very nearly parallel to the direction of the fibers of the masseter and internal pterygoid. It is the anterior fibers of the mylohyoid which are the most functional in opening the mouth. The geniohyoid is shown in Figs. 13 and 14 and also runs parallel to the anterior belly of the digastric and it may be considered that these three muscles, the mylohyoid, the geniohyoid and the anterior belly of the digastric are directly concerned in opening the mouth and work in an opposite direction to the temporal, the masseter and internal pterygoid. This belief is further strengthened when you consider that the four muscles of mastication attached to the ramus are supplied by the fifth nerve, and also those three of the suprahyoid group; namely, the mylohyoid, the geniohyoid and the anterior belly of the digastric are supplied by the mylohyoid branch of the fifth nerve. This group therefore may be considered depressors of the

mandible more than elevators of the hyoid, because they are supplied by the mandibular nerve.

Attention should also be called again to Figs. 15 and 16, which show the attachment of the three ligaments of the mandible which limits its various movements. It must also be remembered that the action of the muscles in mastication, as well as the muscles of expression, on the mandible, the teeth, and the supporting structures is that of stimulating physiologic development. The limitation of the movement of the mandible is governed by the ligaments, the temporomandibular, the stylomandibular and the sphenomandibular. When at rest the position of the mandible depends upon the occlusion of the teeth, upon the inclined plane of the teeth, and atmospheric conditions. As a result of the second statement, we have the solution of the beneficial results which have occurred in muscle training as outlined by Rogers, for the cusps of the teeth have been brought into play by the muscular action, which has resulted in the development of the parts supporting the teeth, and the mandible has assumed a certain relation because the cusps have been arranged to make that position possible; and, secondly, that position has been made permanent because the exercise of the muscles of expression has established the force of occlusion known as harmony in muscular action and atmospheric pressure. This harmony in muscular action has no influence upon holding the mandible, but simply of maintaining the buccolingual diameters of the dental arches as a result of the action of the tongue and the muscles of expression.

Rogers has likened the pterygoid muscles, especially the external pterygoid (which is the principal one to move the mandible forward) as the elastic rubbers of nature. This statement, while to a certain extent correct, is liable to misinterpretation, because the action of the external pterygoid does not produce such a movement as we hope to get with intermaxillary rubbers. If we admitted that in treating distocclusion cases we move the mandible forward instead of developing the body of the mandible, and that our results depend upon holding that mandible forward, then Rogers' statement would not be so liable to misinterpretation, but it would still be faulty. In the beneficial results which he cites in distocclusion cases where he has expanded the maxillary arch, and by the action of the external pterygoids placed the teeth in their proper position, those mandibles are not held in that position by the pterygoids. He follows the action of the external pterygoids in moving the mandible forward, by exercise of the masseter, internal pterygoid and perpendicular fibers of the temporals; which being attached to the ramus pull the cusps of the teeth into position, and stimulates growth of the body of the mandible in such a manner that the body of the mandible lengthens until a harmonious condition is again produced between the ligament holding the mandible in the region of the condyle and the cusps of the teeth.

In studying the musculatures of the mandible, one must consider the various groups of muscles and their nerve supply, and as a result of the knowledge of occlusion will arrive at the following conclusion: First, that various groups of muscles have certain movements which are again counteracted by other groups of muscles. Second, the mandible is not held in position by the muscles of mastication, but by the cusps of the teeth, atmospheric pressure, and muscular

harmony. Third, the limitations of the various movements of the mandible when the cusps of the teeth are separated is limited by the mandibular ligaments. The forces of occlusion, namely, the inclined plane of the teeth, harmony in the size of the arch, atmospheric pressure, and muscular pressure (and by muscular pressure we mean the pressure of the muscles of expression and the tongue) maintain the shape of the arches and the inclined plane and atmospheric pressure, when the other forces of occlusion are normal, hold the mandible in a definite position.

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