Treatment of fracture of the jaw : with critical remarks / by Thos. Brian Gunning.

TREATMENT

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Fracture of the Jaw,

WITH CRITICAL REMARKS,

BY

THOS. BRIAN GUNNING, D. D. S.,

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FRACTURE OF THE JAW,

With Critical Remarks.

BY THOMAS BRIAN GUNNING, D. D. S., NEW YORK.

I shall say very little of much that has been already well-told by others; but to prevent practitioners and students from being misled, I purpose to point out error when necessary.

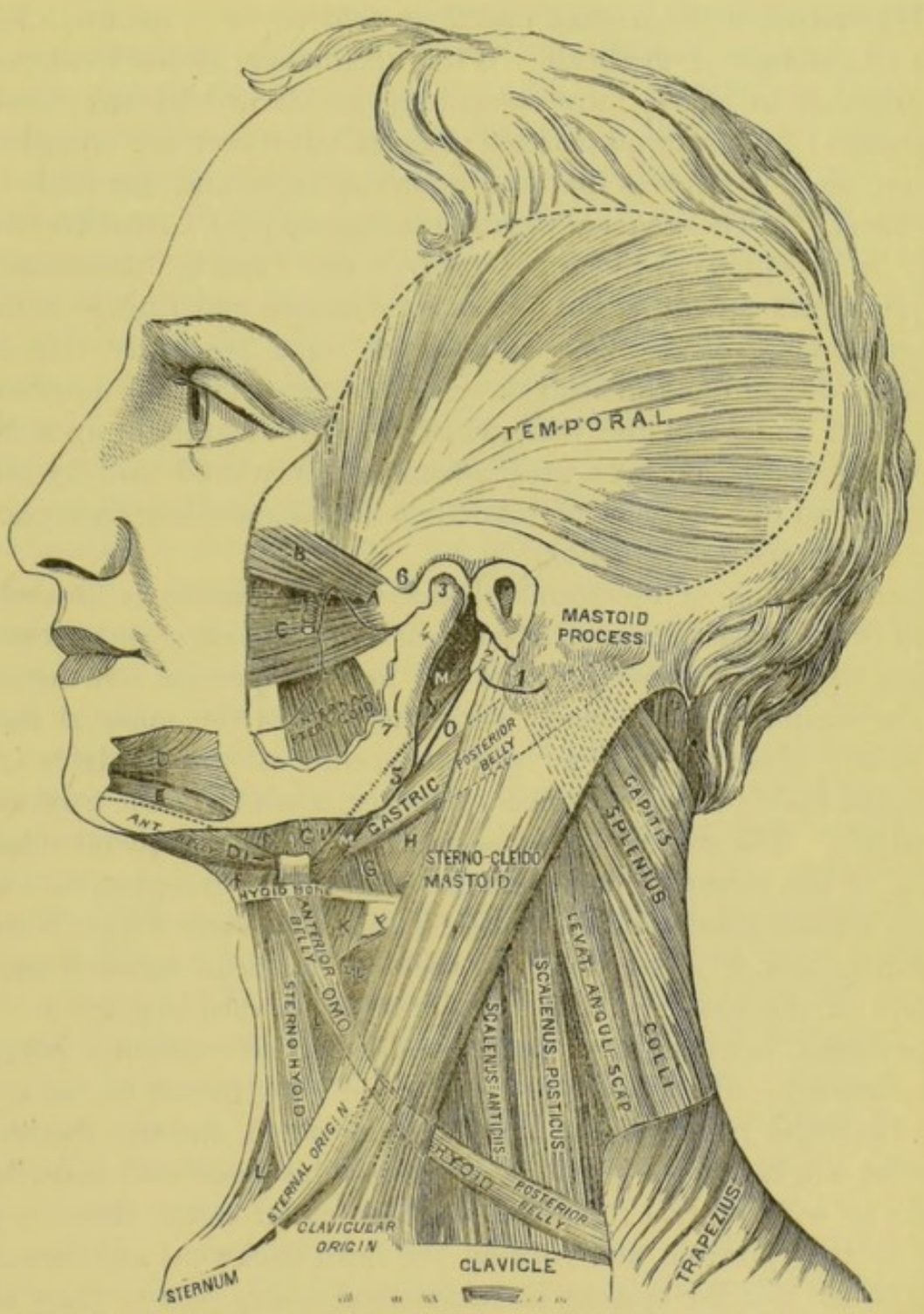
Knowledge of what a bone has to do, and of the muscles which affect it, is indispensable when judging of its injuries; and if it is fractured, to determine the best means of holding the fragments in place. This paper will, therefore, show the use of the lower jaw, and correct the mistakes held in regard to the muscles which control it, and in other particulars. Diagnosis of its fractures will receive attention, and my own methods of controlling them be clearly shown.

The changes in form and condition of the lower jaw, from infancy to old age, are so well known and described that little need be said here, beyond calling attention to its obtuse angle in the earlier and the later periods of life compared with its adult form, which last gives greater freedom to its movements, while the neck of the condyle is more liable to be fractured, through being less in line with the chin, the most exposed part of the jaw. The condyle and its inter-articular cartilage sit close up in front of the ear when the mouth is closed, but they are brought forward under the rounded projection (*eminentia articularis*) to open the teeth.

The mobility of this joint is singularly unlike in different individuals. In some the condyle appears to move very much as in the carnivora,

while in others it is so loosely attached that it is difficult to learn its proper position under unusual impressions. The jaw has, however, always more or less lateral movement in natural conditions, and its condyles always come forward to open the mouth. The variety and completeness of its action and movements fit it perfectly for the efficient use of its different forms of teeth and of those in the jaw above it. The human jaw has not, however, that extreme contrast of action to be found in that of some of the lower animals. In the beaver, neither this difference in its own movements, nor their approach to those of the human jaw, is, I think, in the least suspected. The rodents, according to Cuvier and Owen, have horizontal motion of jaw only from back to front and the reverse. Now this is true of the capibara, the largest rodent of South America, as its condyle moves in a groove which prevents lateral motion. But in the beaver, the largest living rodent of North America, the jaw in eating moves from side to side. In this rodent the temporal bone does not form any socket over the condyle, but it merely projects out in front of it, something like the *eminentia articularis* in the front of the glenoid cavity of the human temporal bone; while the auditory process of the beaver is very strong and curves forward so as to enclose the back of the condyle. By this formation, when the jaw is held forward, as in gnawing with the incisor teeth, the molars are well separated; whereas in eating with molar teeth the condyle is back against the bone of the ear, and the lower incisors being then clear of the upper, the muscles, by alternate action upon the sides of the jaw, work the condyles up and down on the temporal bone and thus swing the lower molars from side to side around the upper ones. Thus the beaver in eating moves its jaw at right angles to the movements in gnawing; the slight circularity of these motions being left unconsidered. It should be borne in mind that this rodent in eating, like other animals, including man, uses the teeth of one side only at the same time. In comparing the lateral movements of the beaver's jaw with those of the human maxilla, it will be seen that while the body of the beaver's jaw moves from side to side equally through its whole length, the lateral motion of the human jaw is greater at the canine and less in proportion as the part is nearer the condyle.

The use of the jaw can, however, only be well understood through acquaintance with the muscular action which affects it. This will now be fully explained.



1. Centre of the condyle upon which the head rocks. 2. Styloid process. 3. Condyle of lower jaw. 4. Neck of do. 5. Angle of do. 6. Eminentia articularis. 7. Curve upon which the jaw opens.

A. External pterygoid. B. Upper head of do. C. Lower head of do. D. Genio-hyo-glossus. E. Genio-hyoid. F. Mylo-hyoid. G. Hyo-glossus. H. Middle constrictor. J. Inferior do. K. Thyro-hyoid. L. Sterno-thyroid. M. Stylo-hyoid. N. Stylo-hyoid ligament. O. Stylo-maxillary ligament. P. Complexus.

The chin is thrown up, and the jaw, and also the curved line which indicates the position of the condyles of the head, are drawn small to show the muscles more distinctly. For the same purpose the Platysma-myoides and Masseter muscles are left out, and the insertion of the Temporal and the origin of the Trapezius cut away.

The sterno-cleido-mastoid muscle is said to be a rotator, a flexor, and an extensor of the head. What this flexing of the head means, in addition to lateral movement, may be learned by the following quotation: "The sterno-mastoid muscles, when both are brought into action, serve to depress the head upon the neck, and the neck upon the chest."* These views are also maintained by J. Cruveilhier,† and may be accepted as those not only of the French anatomists and physiologists generally, but also of the German and English with few exceptions. Professor Henle, however, says positively that these muscles do not flex the head down in front, and that the muscles lift the head and bend the neck when the body is brought up in rising from the back. This is a great advance upon what is said by others, but beyond this he gives no intimation of understanding their peculiar and most important function.

The insertion of the sterno-cleido-mastoid muscle is around the front of the mastoid process, and back along the superior curved line, about half the distance between the mastoid process and the centre of the occipital protuberance, while the front of the mastoid process is nearly always on a line with the centre of the condyles of the occipital bone (in rare instances, however, it is nearer the front of the condyle). The sterno-cleido-mastoid muscle is consequently inserted back of the centre upon which the head rocks (except in rare cases, when a small portion of the muscle is a little forward of it). Notwithstanding this, it is set down as rocking the head forward, and the action of the muscle in rising is brought forward to prove it. The experiment, however, if properly conducted and explained, will prove the contrary. If the experimenter, while lying flat on his back, with the forefinger resting in the interclavicular notch, and the thumb and second finger on the tendons, will raise his head and shoulders a little, he will find that the muscles are acting strongly; then, by staying in that position and rocking the head backward and forward, it will be felt that the muscles are unaffected in any part of their fibres, and that they pay no attention to the movement of the head, neither the tendons on the sternal portions nor those on the clavicles being relaxed for a moment. Then sit up, throw the head forward sufficiently to relax the tendons, and rock the head as before; it will now be found that the tendons remain relaxed, showing that tightness of the

*Gray's Anatomy. 2d Amer. edit., p. 256. Phil. 1865.

†Traité d'Anatomie descriptive. Troisième edit., tome deuxième, p. 173. Paris. 1851.

tendons did not conceal action of the muscles in the first experiment, and demonstrating that the *sterno-cleido-mastoid* muscles do *not* "serve to depress the head upon the neck." On bringing the head forward it will be found that it is assisted by the muscles only until the head comes to its centre of balance, when the tendons relax, and remain so even when the chin touches the breast. But if the head is obstructed in this downward movement, these muscles will then assist to bring it down in front and to hold it there. The sterno-cleido-mastoid muscles do not, however, in this rock the head upon the atlas, but bring the atlas forward. Neither are they "extensors of the head" in the sense indicated by the books, which seems at first sight to accord more with their insertions back of the centre of the condyles. But the insertion is so peculiar that it requires careful consideration to determine how the muscles affect the head when the sternal and clavicular portions of both sides are in action. The mastoid process is always below the superior curved line upon which the back part of the muscle is inserted. When the process is large it may be more than half an inch below it, although much less when the process is small, as in childhood before the cells are developed. Moreover, the uniformity of position between the mastoid processes and the condyles horizontally is not met with in their vertical relation, the condyles being on some skulls more than half an inch lower than the mastoid processes, while on others the processes are as much below the condyles, the large proportion being between these extremes. These variations go far to show that the sterno-mastoid muscles are not intended to rock the head backward; for when the mastoid process is much lower than the condyles, and especially when it is large and projects forward somewhat, to correspond to the direction of the muscle, it follows that as the head is pulled down by the *trapezii*, etc., the mastoid processes go upward and forward; consequently, if the *sterno-cleido-mastoids* were to act to bring the head down behind, the portion on the mastoid process—the strongest part of the muscle—would hold the head down in front, probably as much as that on the occipital bone would pull it down behind. But their action can be tested by lying down so as to remove the necessity for action of the muscles to hold the atlas. In this position (care being taken not to lift the atlas or neck) the *sternal* portion of the muscles will not act in concert with the other muscles to rock the head back, even if the whole weight of the body is thrown

upon the back of the head, and I have been unable to find any action in the clavicular portion, although the action of this part of the muscle is so delicate and prompt that it can be distinctly felt when the foot is raised in walking, the head and body being then thrown over to the other side to restore the balance. Further, when the *sterno-cleido-mastoid* and the *splenius* of the same side are acting in concert to pull the head down to the shoulder, no backward movement of the head is discoverable. *This* is conclusive, for both these muscles having similar insertions, if one rocks the head back the other must, and their combined action would be manifest if they exerted it.

It has been shown that this muscle acts as a lateral *flexor*, in connection with the *splenius* of the same side, but only when the head is obstructed, and then generally by its clavicular portion, the sternal acting only in extreme necessity. It is now seen that it does not flex the head down in front, that is upon the atlas at all, and that its action as an extensor of the head cannot be demonstrated. The proper function of the *sterno-cleido-mastoids* when acting in concert is to give anterior support to the top of the spine, the *splenii* muscles giving posterior support. This may be easily proved by sitting down and watching the tendons. When the head is back of its centre of support both the sternal and clavicular tendons are tightened, when rising they become tenser until the head is started, as it comes into balance they relax. On sitting down the tendons tighten to check the head as it goes back out of balance. Sudden forward movements tighten them until the head is in motion, they then slacken as the head is forward of the centre and the atlas supported by the *splenii* muscles. If the head is in balance any pressure upon the forehead brings the muscles into action to preserve it. The action of the muscles in these movements is but a modification of the service rendered by them in raising the head from the horizontal position, in doing which the muscles at first support more than the weight of the head; for in supporting the mastoid processes they support the atlas, and make it a fulcrum between the bulk of the head and the counterbalance at the other end of the lever; but as the body comes upright and the head into balance, the strain upon the sterno-mastoid muscles gradually diminishes, until the head is held by the posterior muscles, when the spine bears all the weight.

[A reference to the figure will render this explanation more apparent. The same figure also illustrates the action of the muscles of the lower jaw, and confirms the opinions expressed in the subsequent portions of this paper.]

The hyoid bone, in addition to the muscles which pass to it from parts above the lower border of the jaw, gives attachment to others which pass up the front of the neck below the jaw. Of these the *sterno-thyroid* arises close to the centre of the posterior surface of the upper bone of the sternum, and falling back somewhat as it passes up, is inserted into the side of the thyroid cartilage, from whence the *thyro-hyoid* (appearing like a continuation of the preceding) goes up and is inserted into the body and greater cornu of the hyoid bone. The *sterno-hyoid* arises from the sternum and end of the clavicle, and is inserted into the lower border of the body of the hyoid bone. It is separated considerably from its fellow at its origin, but crosses the sterno-thyroid and approaches it in the middle of its course; it leaves the front of the thyroid cartilage uncovered.

The *omo-hyoid* arises from the upper border of the scapula, and occasionally from the transverse ligament which crosses the supra-scapular notch. It passes across and up the side of the neck, to be inserted into the body of the hyoid bone. It crosses over the *scaleni* and *thyro-hyoid*, but under the *trapezius* and *sterno-cleido-mastoid* muscles. It is a doubled-bellied muscle, united by a tendon which is held down by a process of the deep cervical fascia. The first portion is nearly horizontal in its course; but underneath the sterno-mastoid muscle, where the cervical fascia passes around the tendon, it turns up so that the second portion is nearly vertical in its course to the hyoid bone. These are the directions of the muscle when at rest, but when active it approaches the line of its attachments, and the cervical fascia is drawn upward and backward.

The *digastric*, another double-bellied muscle, has peculiar relations with the preceding. It arises from the digastric notch, on the inner side of the mastoid process of the temporal bone, and passes downward, forward, and inward, to the side of the hyoid bone, where its rounded tendon (after passing through the stylo-hyoid muscle) is held by an aponeurotic loop in connection with the side of the body of the hyoid bone above the insertion of the omo-hyoid. The muscle then passes forward, and is inserted into a large depression on the inner side of the lower border of the jaw close to the symphysis. The tendon which divides the posterior and longer belly from the anterior gives off a large aponeurotic layer, which is attached to the body and great cornu of the hyoid bone; it is termed the *supra-hyoid aponeurosis*. It forms a strong layer of fascia between the

anterior portions of the two muscles, and a firm investment for the other muscles of this region. This muscle is peculiar in not being inserted into the hyoid bone, but attached to it by a loop; this allows the muscle to act without interfering too much with the hyoid bone. The *digastric* muscle has not, however, that freedom which is attributed to it as a reflected cord, for its aponeurotic connection with the hyoid bone and adjoining muscles prevents it from sliding through the loop which attaches it to the hyoid bone.

The digastric muscle is set down as drawing the hyoid bone backward and forward in deglutition, and as depressing the jaw by acting as "a reflected cord." These services are inconsistent with each other and with the anatomy of the parts. If it were fixed so as to draw the bone backward and forward, it could not slide and be of service as a "reflected cord" sufficiently to lower the jaw. To do the latter the anterior belly should be inserted higher up the jaw, while a long unrestricted tendon of the muscle should run through a fixed loop on the lower border of the hyoid bone, which last should also be freed from the styloid ligaments, and be drawn down half way to the sternum every time the jaw opened wide, and proportionally for less opening.

In respect to the united action of both bellies drawing the head backward, it is only necessary to say that the origin of the digastric is partly in front of a line drawn across just behind the condyles of the occipital bone; it could not, therefore, draw the head back appreciably even if its insertion were directly under its origin. It is consequently a mistake to suppose it can do so when its direction forward is so nearly horizontal. In fact this muscle is the great agent in drawing the head *forward*. The posterior belly slants down to the hyoid bone, but the anterior is nearly horizontal in its course, and when the muscle acts it tends to the line of its attachments by drawing or endeavoring to draw the hyoid bone upward, unless the jaw is much depressed, when, as the muscle is straight, or nearly so, it has no power to raise the hyoid bone. But in several important services the digastric acts in concert with the omo-hyoid. In this way the muscles passing from the hyoid bone to the front of the jaw, including the anterior belly of the digastric, are as effectually antagonized as if a powerful muscle passed from each side of the hyoid bone to the opposite cervical vertebræ, with the advantage of greater length of muscle to contract, and easier adaptation to the movements of the

jaw; and the muscles in front of the hyoid bone act, when necessary, in alternation with the omo-hyoid and the posterior belly of the digastric. Frequently, however, the anterior belly of the digastric acts with the posterior belly and the omo-hyoid, for they keep the head upright. In doing this the omo-hyoid muscle and the posterior belly of the digastric draw or hold the hyoid bone back, while the anterior belly of the digastric brings in the chin, and the *temporal* and other elevators of the jaw draw the head forward; in this way the digastric acts on a long lever, as the head rocks on a centre, but a little below the entrance of the external ear. These muscles are always active during forward or backward movements of the body or head. They do for the head what the sterno-mastoid muscles do for the spine, and their action can be felt easily with the finger, in sitting down or rising up, etc. They are also powerful rotators of the head, and the action of the omo-hyoid is singularly quick in sudden turns of the head (as with the sterno-mastoid muscles), the digastric being useful in assisting to keep the hyoid bone up in place, it being held laterally by the aponeurosis and probably by the mylo-hyoid muscle.

If the end of the finger is placed just behind the origin of the *cleido-mastoid* during these movements, the omo-hyoid will be felt rising above the clavicle, and carrying the cervical fascia upward and backward; and if a finger is placed behind the mastoid process so as to cover the end of the digastric notch, the digastric muscle will be felt acting in concert with the omo-hyoid, and the anterior belly can be felt between the jaw and hyoid bone. The peculiar attachment of the digastric can now be appreciated, as the hyoid bone is left sufficiently free in its various movements, although it is at the same time the centre of control and support to the head. The importance of this support to the head can hardly be overestimated, for the weight of the head beyond the atlas must be balanced. This the digastric and omo-hyoid muscles do effectually by acting upon the jaw, which is a lever in length below the atlas, of about one-third of the height of the head above it. The points from which these muscles act are the mastoid process and the shoulder; the vertex of their angle being in the hyoid bone, from which they draw in the chin; in this direction they are very active and powerful. They not only balance the head in locomotion and leave the other muscles free to act in deglutition, vocalization, and articulation, but give them important assistance.

The following quotations show the opinions entertained as to the action of the muscles which move the lower jaw:

Gray's Anatomy says: "The temporal, masseter and internal pterygoid raise the lower jaw against the upper with great force. The two latter muscles, from the obliquity in the direction of their fibres, assist the external pterygoid in drawing the lower jaw forward upon the upper, the jaw being drawn back again by the deep fibres of the masseter, and posterior fibres of the temporal. The external pterygoid muscles are the direct agents in the trituration of the food, drawing the lower jaw directly forward, so as to make the lower jaw project beyond the upper. If the muscle of one side acts, the corresponding side of the jaw is drawn forward, and the other condyle remaining fixed, the symphysis deviates to the opposite side. The alternation of these movements on the two sides produces trituration."*

Todd & Bowman's Physiological Anatomy, part iii. p. 539, says: "The *external pterygoid* neither raises nor depresses the lower jaw."

My own views as to these muscles differ materially on some points from those expressed in these quotations. The position of the *masseter* is too well known to need particular description. The fibres of the deep portion have a more perpendicular direction than those of the superficial portion, the last passing backward as much as downward. The deep portion draws the jaw upward and backward, the superficial portion upward and forward. The *internal pterygoid* has the same general direction as the superficial portion of the *masseter*, excepting that as it rises from the pterygoid fossa it passes considerably outward to reach its insertion on the inner side of the ramus and angle of the jaw. It has, therefore, not only the upward and forward motion of the superficial portion of the masseter, but also lateral power over the jaw.

These muscles not only raise the jaw and teeth, when cutting with the incisors and crushing with the molars, but are also the main movers of the jaw in trituration. In cutting they bring the jaw forward bodily, in triturating they exert more forward and lateral action on one side than on the other; by this the jaw is thrown over to the opposite side and then *drawn in and carried out continuously on that side*, and not carried over to the other side. It is a mistake to suppose that trituration of the food is effected by the alternate action of the muscles of both sides. When the jaw and teeth are perfect, the teeth of one side only are used, until the muscles tire, perhaps, and then those of the other side are resorted to. If the teeth are tender, badly

* Gray's Anatomy, Descriptive and Surgical. 2d American Edition. p. 252. Phila., 1865.

placed, or deficient on one side, trituration is performed on the other only.

The *temporal* muscle which covers so large a portion of the side of the head, and is strongly inserted into the inner surface, apex and anterior border of the coronoid process of the jaw, pulls its insertion upward and backward, and assists the *masseter* and *internal pterygoid* muscles in cutting, crushing and triturating the food.

The *external pterygoid* is a short, thick muscle, which arises from the pterygoid ridge on the great wing of the sphenoid, and the portion of bone included between it and the base of the pterygoid process, from the outer surface of the external pterygoid plate and the tuberosity of the palate and superior maxillary bones. It arises in two portions separated by a short interval; they both pass outward and backward and are inserted into a depression in front of the neck of the condyles of the lower jaw, and into the corresponding part of the interarticular fibro-cartilage. The separate portions join and form one muscle previous to their insertion, the middle fibres being horizontal; but as the origin of the muscle is very wide vertically, the upper portion descends in passing back, while the lower ascends. This strong and beautiful muscle has, from its peculiar situation, great influence over the jaw. The origin being more internal than the insertion, gives the muscle control over the condyles laterally, by which they are held firmly in the glenoid cavities, and the great strength of the muscle tends to keep the condyles from being driven back by falls, or blows upon the chin, which otherwise might occur easily, as the glenoid fossæ are very shallow.

A more prominent service of this muscle is when it brings the condyle forward either on its own side alone, as in trituration, or with its fellow of the opposite side, as in cutting by the incisors. In these movements it acts in concert with other motors of the jaw. To consider it especially the triturating muscle is no more correct than to suppose that when triturating with a pestle in a mortar the thumb and forefinger (which are further from the grinding surfaces) are the triturators rather than the fingers below.

The *external pterygoid* muscle controls the upper end of the jaw in concert with the *temporal*, while the muscles attached to the body have especial control below, and by the concerted action of all, power and steadiness are secured in the complicated movements of the jaw, and of the lower teeth against the upper. The *external pterygoid* muscles hold the condyles fixed in any part of the glenoid cavities to

which they may be drawn in forward movements of the jaw. For this service they are admirably fitted by the great width of their origin, which enables them to brace the condyles so firmly against the parts above and in front of them, that the jaw is fixed, even when wide open, as firm as if the condyles were hinged in that position.

The *eminentia articularis*, the rounded projection which forms the front of the glenoid fossa, is indispensable to this fixation of the condyle, and as the condyle in coming forward mounts this eminence, the jaw, while going down the front, is also carried down bodily, by which the back teeth of the lower and upper jaws are widely separated. These advantages are gained while the centre upon which the jaw turns is two-fifths down toward the angle. This may be tested by placing the hand and wrist around the back of the neck, applying the end of the finger to the back of the ramus and finding the point upon which it turns, which is probably near the insertion of the internal lateral ligament. By this arrangement the jaw is opened promptly and widely, without interfering with the parts behind, which would be injuriously pressed upon if the condyle remained still and the angle went back far enough to open the jaw wide.

The *external pterygoid* is now to be spoken of in a service in which the action of the muscle is greater in range, frequency and importance than in any other, and in which it has never before been recognized, *that of opening the mouth.* This muscle antagonizes the temporal, masseter and internal pterygoid muscles, and is, especially by its lower head, the *depressor of the lower jaw.* It does this alone when necessary, without assistance from any other muscle. This may be proved by bracing the arm against the breast and applying the thumb firmly to the chin; or better, by placing the jaw flat on the mantel or any fixed support, then on opening the mouth the head will go backward, being drawn back by the external pterygoids whose insertions in the condyles are fixed by support of the jaw.

The action of the external pterygoid muscles in opening the jaw is somewhat similar to their action when the jaw is brought forward to cut with the incisors, the difference in effect being produced by other muscles; the temporals relax in these movements only so far as to permit the jaw to move properly. It may thus be held that the temporals probably act similarly in both movements. The masseters and internal pterygoids, however, must relax in the opening of the jaw instead of assisting to carry it forward as in cutting, while the digastrics, which relax in the forward movement of the jaw, undoubtedly

assist to draw the chin back in gaping, vomiting, and in very wide opening of the mouth when voluntary. When not otherwise employed, it is probable that they always assist in opening the jaw, as they are admirably fitted for carrying the chin back when the condyle is going forward. It is, however, clear that they could not carry it back readily if the condyles were not at the same time pulled forward. For when the chin points down very much (as in some persons even with the jaw closed) the digastric muscle forms but a slight angle at the loop, and decided action of it in such cases would tend to keep the condyles of the jaw back in the glenoid cavity from the start, or soon after, and the opening of the jaw would straighten the digastric so much that it would have little or no power to carry the chin back. Even in cases where the anterior belly of the digastric ascends from its loop to the chin, so that it has some vertical direction to favor it, and supposing it to be assisted by strong back fibres in the mylo-hyoid muscle, it is not possible that the condyle could release itself from the pit behind the *eminentia articularis*, and unless it did so and came forward, the jaw could open only to a trifling extent, for it would act as if hinged in the glenoid fossæ. But with the external pterygoids drawing the condyles forward, the jaw opens, as upon a centre in the ramus, and the question arises as to what the jaw really turns upon.

The masseter and internal pterygoid muscles hold the angles very much as if a sling were passed around them, and if it were not for the angle going back it might be said that the jaw turned down upon this centre, supported by these muscles in connection with the *stylo-maxillary ligament*, which is also inserted into the angle of the jaw. Under all the circumstances, however, the insertion of the *internal lateral ligament* around the inferior margin of the dental foramen marks the centre upon which the jaw opens with sufficient exactness.

This will be more clearly understood by recollecting that with the teeth closed, the stylo-maxillary ligament *slants* down to the angle of the jaw; therefore, while the *temporal* muscle relaxes to allow the *external pterygoid* muscle to draw the condyle forward under the *eminentia articularis*, the angle is, at the same time, carried back by the ligament into the perpendicular of its attachment on the styloid process. This allows the jaw to go down bodily, as well as open in front, by which the back teeth of the upper and lower jaws are widely separated, and the size of the oral cavity much enlarged.

The shape of the jaw, whether congenital, or modified by age or accident, may also vary the location of the centre somewhat; but at

all ages the condyles must come forward to open the jaw effectually. This can be done only by the *external pterygoid* muscles, whose special office is to move and also fix the condyles, and in connection with the temporal and other elevators, the jaw also. In this way only can the digastrics and associate muscles act efficiently in their most important functions, otherwise they would be disturbed by undue movement of the jaw. In certain cases, however, these muscles, as before stated, assist in moving and holding the jaw.

When the *external pterygoids* throw the jaw wide open, the chin is much below the hyoid bone, but controlled by the anterior bellies of the digastric muscles, the hyoid bone being fixed by the posterior bellies and by the *omo-hyoid* muscles, which can now be felt in action. Consequently the three extremities of the jaw, the chin, the angle, and the condyle, have each diverging or converging muscular support. The *digastrics* go to the chin, the *internal pterygoids* go to the angles, and the *external pterygoids* to the condyles. This arrangement of the muscles in connection with its ligaments holds the jaw firm in all its complicated movements.

It has been shown that the *sterno-cleido-mastoid* muscles give anterior support to the atlas, while the splenii and other muscles give posterior support, and that in combination they support it laterally. This support is so complete that the head is held securely on the atlas in all positions.

These muscles, however, do not *rock* the head upon the atlas, but in all positions the lower jaw is the lever which controls it in its backward or forward movements. When the head is in line with the neck and body, it is controlled by power acting upon the jaw, at right angles to the neck. When the head is thrown back so as to be at an angle to the neck, the muscular power is applied to the jaw more in a line with the neck or in certain modifications of it. Thus the powerful muscles which are attached to the occipital bone, behind the condyles, and act upon the head vertically, are antagonized by muscles which act upon the jaw, principally in a horizontal direction, and the head is effectually controlled, notwithstanding the little power of the muscles attached to the occipital bone in front of the condyles.

The lower jaw is the great lever by which the head is held upright, that is forward, and also flexed upon the neck.

These explanations of the physiological action of the muscles which control and influence the lower jaw, prepare the way for the diagnosis of its fractures.

Diagnosis of fracture of the jaw will be easier after recapitulation of the muscular action in connection with the leverage afforded by the jaw, and also the base of the skull through which the muscular power is made effective.

The head, as generally seen, appears so firmly supported by the neck, that notwithstanding the extent of its movements, and the ease with which they are effected, it is difficult to realize the great flexibility of the cervical spine; unless this is done, however, it is impossible to understand the mechanical relations existing between the jaw, head, neck and body.

Although this flexibility of the cervical spine can not be precisely estimated, a sufficiently correct idea may be attained by letting the head *fall* in different directions and making allowance for the surrounding muscles, fasciæ, blood vessels, nerves, &c. It will then be felt that the cervical vertebræ and their ligaments could not protect the spinal marrow and support the head, even with the aid of the muscles which cleave to them, except for the assistance of the muscles attached to parts more removed from the centres upon which the head rocks and turns. These muscles, however, are not attached to the spine but to the skull, it follows that when they put the great weight of the head in motion, the spine goes with it, keeping the head extended in every direction and supporting it on the atlas when the body is upright.

The head, therefore, moves the cervical vertebræ, and its leverage must be considered.

Of the whole distance between the origins of the genio-hyoid and the digastrics inside the jaw to those of the *trapezii* on the occipital bone, or the distance between the most anterior muscles which act upon the point of the jaw, and of the most posterior which act upon the base of the skull; from $\frac{1}{7}$ to $\frac{2}{3}$ is in front of the centre, upon which the head rocks. The condyles of the lower jaw are, with the teeth closed on a line a little in front of this centre, and each condyle is separated so far from its respective coronoid process that they form of each ramus, which projects forward in front of each ear, a horizontal lever half as long as the distance between the centre upon which the head rocks and the inside of the chin. Thus the temporal muscle, which is inserted into the anterior end of this lever, in connection with the *external pterygoid*, inserted into its posterior termination can hold the jaw so firmly in any position, that it is virtu-

ally, when so held a part of the skull, or in other words it is the great lever through which the head is controlled by means of the muscles which pass to the hyoid bone.

The hyoid bone gives insertion to the *genio-hyo-glossus*, and the *genio-hyoid*, which arise on the inside of the jaw near the symphysis, and to the *mylo-hyoid* which descends from around the side of the body of the jaw; while the *sterno-hyoid* which passes up from the breast bone completes the line of muscular control between the front of the trunk and the point of the lower jaw. Below the *mylo-hyoids* (or floor of the mouth,) the anterior *digastrics* also *arise* around the inside of the front of the jaw, but in going back diverge to their tendinous junction with the posterior bellies which come down from their origins on the head inside of the mastoid processes; and under the *aponeurotic* loops which hold the tendons of the digastrics to the *hyoid* bone the *homo-hyoid* muscles are inserted into its lower border; each muscle having passed on its own side of the neck from its origin on the scapula, &c., and after crossing the shoulder and by its tendon, which separates its two muscular bellies, passing through a loop of the deep cervical fasciæ which attaches it loosely to the cartilage of the first rib, ascends almost vertically to the hyoid bone. Thus the lower jaw (termed a floating bone from its facile mobility,) is held by these two pairs of double bellied muscles by means of the hyoid bone, in relation both to the back part of the trunk and to the least movable part of the head; while the muscles which pass from the sides and base of the skull to the *coronoid* processes and condyles of the jaw, control its movements so completely that the body of the jaw affords a base from which the anterior bellies of the digastrics antagonize or act in concert with their posterior bellies and with the *omo-hyoid* and other muscles. When the body is back out of the perpendicular, and even when the head only is over back, it is brought into balance through the great leverage of the jaw, by the muscles which pass from the sternum and shoulders. These muscles act upon the body of the jaw, the horizontal lever, which is on an average twice as long in front of the centre of the head's support as the vertical lever of the ramus is below it. The longer lever brings the head up and forward until it comes under the control of the vertical lever of the ramus; the head being controlled by the mixed leverage brought into use by going from one to the other and this whether the head is going back or coming forward.

The use of the jaw in controlling the head, or when acting as a part of the skull is now demonstrated.

The head and jaw will now be considered in the functions connected with food and speech, &c., in which, while the head is still, the jaw is active.

With the body upright and the head at rest upon the atlas, more than half the weight of the head is forward of its centre of support, and the anterior recti muscles, although so near the centre, effectually antagonize the complexi and other muscles behind the condyles. These muscles all act vertically upon the horizontal lever of the skull and control it in its *antero-posterior* directions. The lateral movements of the head not being considered in this paper.

It has been shown that in movements of the head its muscles control the jaw by means of the rami, and of course, this is also done in the special functions now under consideration.

In mastication, the muscular action between the head and jaw is increased in proportion to the resisting quality of the food, yet little or no movement of the head results, although the temporal muscles are active, nor even when the great force of the *masseters* is engaged in crushing the hardest substances, if the jaw is allowed to go down *unrestricted.* The supposed upward movement of the head in mastication has been speculated upon by many investigators, Monroe, Pringle, Bèrard, Ferrien, Hunter; but without finding a solution of the question. Dr. Austin Flint, Jr., says: "The movement of the head, however, does not ordinarily require any powerful muscular action, and is probably the result of the contraction of muscles too deeply situated to be explored experimentally."* In that year, however, my discovery that the *external pterygoid* was the depressor of the jaw was published;† and the support of the chin to demonstrate the action of the external pterygoid, solved the difficulty; the head moves up in mastication only when the jaw is prevented from going down, and this whether by a cravat or by the mantel-piece. The muscles brought into use in mastication including even the *internal pterygoid*, arise on the skull, in front of the atlas and move the jaw only. Deglutition brings other muscles into use, whose action is more complicated.

*The Physiology of Man, vol. 2, p. 148, D. Appleton & Co., N. Y., 1867.

†New York Medical Journal, vol. vi, p. 211.

In this function the jaw is so held that its teeth nearly touch the upper ones, and in order that the tongue may make air-tight contact with the roof of the mouth, there is upward movement of the hyoid bone and its attachments; this is effected by the palate and other muscles which depend on the skull, not by those which arise on the jaw. If the mouth is opened wide and the tongue drawn up to swallow, even the point of the *thyroid, cartilage* will be above the lower border of the jaw; the *external pterygoid* holding the latter down and thus demonstrating its power to open the mouth. The muscles which arise inside the front of the jaw antagonize the constrictors of the pharynx and those muscles which arise on the styloid process of the temporal bone and in the digastric notch. These all act in a horizontal direction and most strongly when the hyoid bone is drawn up within the body of the jaw. In respect to this horizontal action of the muscles upon the skull, it may be concluded that its influence is very slight, and is such as counteracts the vertical action, for the inferior and middle constrictors arise on the spine below the axis, while the styloid processes which are virtually on a line with the centre upon which the head rocks, extend downward, so that the effect of the styloid muscles, as with the constrictors, if any, must be to throw the head upward, or rather to neutralize the downward action of the palate muscles. With mastication there is more or less suction to get the food into the mouth, between the teeth and under control of the pharyngeal muscles. This is effected by the *digastrics* and *omohyoids* whose action on the jaw is somewhat like that which it meets as the head passes from the control of the horizontal lever of the body to the vertical lever of the ramus. The great weight of the head, however, is moved but little in the transient movements of suction, while the action in the floor of the mouth affects the jaw considerably.

In speech the vocal utterance may be said to affect the head similarly to the upward movements of the hyoid bone in deglutition and while the tongue in articulating the lingual consonants, is unaided by special movement in the jaw, during any particular vowel-sound of one continued pitch of tone, yet in changing the vowel the jaw alters its position, and this so much in tones of high pitch that the mouth is opened very wide, but this does not act on the head more forcibly than deglutition, nor does it require stronger action of the muscles behind the atlas.

These remarks are sufficiently explicit; they suggest the effect of

the muscular action, rather than estimate it precisely; this last being impossible. For in addition to the difference between the muscles of different persons and of the same person under the changes of age and condition, the form and size of the jaw and of the skull vary so much that the most careful estimate of their leverage can give but approximate ideas of any special case.

It has, however, been demonstrated that the *sterno-mastoid* muscle does not flex the head upon the atlas and neck, but that this is done by means of the lower jaw.

It was necessary to make the foregoing views clear, even at the expense of so much attention, for my paper in the New York Medical Journal in 1867, showed that the *external pterygoid* was the depressor of the jaw and that the *sterno-mastoid* muscle does not rock the head upon the atlas.

It also maintained that the *sterno-mastoids* do not usually rotate the head; this being necessary, although the supposition that they did was declared by Dr. John Barclay to be a "vulgar notion," nearly sixty years earlier. Again,

Professor Harrison Allen, M. D., in his Studies on the Facial Regin,* says:

"The massive internal pterygoid and the masseter act together in directly raising the lower jaw. But before it can do this, the condyloid process, which has been tilted out of the glenoid fossa, must be replaced. This is done by the external pterygoid; the larger slip operating on the jaw, the lesser one adjusting the capsule and the inter-articular disk." This absurd statement, for to do so the external pterygoid must push the condyle and cartilage back, was first published in November, 1873,† so that ample time had been given for criticism and correction to have prevented it from being again sent out to mislead. Yet it was re-published in the eighth year after I had demonstrated that the external pterygoid is the depressor of the lower jaw.

In the same year, 1875, "The Leverage of the Lower Human Jaw, by John Gorham, F. R. C. S., in Medical Times and Gazette," was re-published in Philadelphia.‡ The author elaborated his views very scientifically; he speaks of the jaw as a lever of the third kind, because the muscular power is applied between the condyle and the part which

*J. B. Lippincott & Co., Philadelphia, 1875. †Dental Cosmos, Vol. XV, p. 568.
‡Dental Cosmos, Vol. XVII, pp. 212, 267.

holds the teeth, the weight of which and their positions being carefully laid down, but no consideration is given to the other parts attached to the body of the jaw, although the effect of their action in function is attributed to it.

It may be admitted that, although the condyle moves back, it is still the fulcrum upon which the weight of the teeth and jaw, &c., are carried up, as they go back with it. The paper, however, as a whole, is radically defective and misleads. The frequent reference to the leverage of the jaw in its upward movement without remark upon the backward and forward movement of the condyle to shut and open the teeth, leaves no place to hope that the author had any idea that the jaw was depressed as a lever of the first kind, the power being applied at the condyle the end of the rod, the fulcrum being between the power and the teeth, the weight; and this whether the fulcrum is held to be at the insertion of the stylo-maxillary ligament on the angle or at that of the internal lateral ligament, around the inferior dental foramen. This omission effectually shuts out all idea that the external pterygoid depresses the jaw. Further, so much trouble to estimate the weight of the teeth, leaves no reason to suppose that the jaw is the lever by which the head is controlled. Mr. Gorham's paper, however, is a pleasant assurance of his industry and unusual ability for scientific investigation. It also deepens the conviction that my own remarks upon the muscular action of these parts will be of service to many. Concluding summary. The muscles which give form to the neck and support and move the head, and through it the cervical spine, are so arranged as to leave the fronts of the vertebræ free for the tongue, hyoid-bone, larynx and trachea, with their special muscles. These organs being attached to and in part surrounded by the body of the lower jaw, from which also many of their muscles act to move them in their functions—deglutition and vocalization, &c., while its own movements are made to co-operate in these functions and in mastication and articulation by muscles which arise on the head and are inserted into the superior terminations of the rami. In these functions the front of the jaw is a base from which the muscles act to antagonize those which arise on the skull and the back of the pharynx, while in all motions of the head the jaw is the great lever through which the muscles give anterior support to and exert control of the head. The radical importance of the lower jaw and of the integrity of its leverage is now demonstrated, and due allowance can be given in judging of and treating its fractures.

DIAGNOSIS OF FRACTURE OF THE JAW.

That this, the foundation of correct treatment, may be placed in its most simple features before the reader; little will be said of gun-shot fractures as they are often so anomalous as to confuse rather than assist the student to comprehend the principles which lead to correct views regarding fracture of the lower jaw.

This accords with my presentation of the Treatment of Fracture of the Jaw by "Interdental Splints," in 1866, when severe injuries, brought under my observation during the war, were left out. The EIGHT cases then taken to show the use of the *splints*, were selected to give a clear and full view of all which I considered essential to hold any broken jaw in place; several other cases being referred to. The experience of fourteen years which have since passed justifies me in republishing these cases, together with others now selected to assist in giving clear ideas upon the diagnosis of fracture of the jaw.

The jaw may break in the symphysis, in any part of the body, in one or both angles, necks of its condyles, or in its coronoid processes, and in several different places at the same time. Enumeration of the position of these fractures, or rather the proportion which fractures in a particular part bear to those in any or to all other parts gives but little assistance. Age, however, is suggestive, for in very young children the symphysis or the body gives way easily compared with the parts back of the teeth; the symphysis not being ossified until some time in the second year, and later, the body in its upper, the alveolar border is excavated for the germs of the permanent teeth as well as the teeth of the infant set, which last at three years of age are fully developed and standing in the mouth. As this temporary set gives place to the longer teeth of the adult, the bone below the alveolar process grows deeper and stronger and its obtuse angle gradually becomes more vertical by which the neck of the condyle is more exposed to fracture from blows upon the front of the jaw. But, notwithstanding the comparatively greater risk to the neck of the condyle in adult life, its fracture is very rare compared with those in the body of the jaw. The exposure of mature life is of course followed by a large increase in fractures of the jaw, and this although the body of the jaw, is so fully developed both in the true bone and the deep sockets of the teeth.

These sockets, however, seem to offer a starting place for fracture, the greater proportion being found in the alveolar when holding

teeth. The singular immunity of the lower jaw, when without teeth is shown in the fact that Malgaigne says: *"Duverney has suggested that the jaw might be broken when completely destitute of teeth. This case seems never to have presented itself." My own observations reach back to 1840, but no case of a lower jaw fractured when destitute of teeth, has come to my knowledge, although I have seen the jaw so absorbed under the use of very heavy lower plates of artificial teeth that the body was only a quarter of an inch deep in the parts where the first permanent molars had stood. In April 1879, however, a farmer 70 years old fell down stairs and broke his jaw in the socket of the right canine, which was knocked out, and the mouth left without a tooth or root in it.† Therefore, M. Malgaignes' exception has presented itself as he referred to treatment; but although no jaw is yet known to have broken that was destitute of teeth; there should be no doubt that lower jaws without teeth will break in the body much easier than in any other part.

The fact that fractures are met with precisely in the symphysis, suggests distrust as to the completion of ossification of this part in some jaws; with its two halves firmly united it seems much more likely that the bone would break in the socket of a tooth.

It is necessary to bear in mind that the *position* of the lower jaw is *peculiarly* dependent upon the muscles attached to it. Neglect of this has caused great mistakes, both in diagnosis and treatment; patients having been put to much suffering by the endeavors of surgeons to set fractures which did not exist; the displacements supposed to indicate them being the result of fracture in another part of the jaw (the latter being drawn out of shape by the muscles through laceration, contusion or severe swelling) and *thereby prevented from going into proper atriculation with the upper jaw*, while the surgeon supposed that the ramus or neck of the condyle was broken! This also occurs when there is no fracture of the bone.

With only incomplete fracture, in which the bone retains its shape so perfectly that treatment is unnecessary; weeks or even months may elapse before the muscles are able to bring the jaw into place so that the lower teeth will close against the upper as before the injury. In fact, this inability may be present *without any* fracture of the bone.

*J. F. Malgaigne, TREATISE ON FRACTURES. Translated from the French by John H. Packard, M. D., p. 321. J. B. Lippincott & Co., Phil. 1859.

†The case was successfully treated by Dr. J. A. Bishop, and is reported in Johnstons Dental Miscellany, VOL. VII, p. 63.

Malgaigne† maintains that muscular action cannot of itself induce displacement, even in cases where the violence has dis-connected the fragments by tearing the periosteum and the surrounding tissues. This is opposed to the views of other observers, and is disproved by the action of the muscles. M. Malgaigne's position made it necessary to notice his radical mistake at this time. Cases 4, 6, 7 and 8 show conclusively the influence of the muscles and confirm the views of their action as explained in the preceding pages. Other cases treated and seen by me also demonstrate that the opinion expressed so decidedly by Malgaigne and entertained by other writers, as to the effect of the impulse given by the cause of fracture upon displacement, is erroneous. For the impulse being exhausted in deciding the position, direction and extent of the injury to the bone and surrounding tissues, the bone is then *surrendered* to the muscles which affected it before and at the time of fracture, and still continue to do so, according to the *condition in which it and they are left.*

If pain and swelling, or either, set in after the jaw has been subjected to a shock, to a blow, or to compression, it may still be unfractured; reliable details as to how the injury was received in connection with the age and condition of the patient, are quite important, but to all this there must be superadded careful examination before the nature of the injury can be known. When the surrounding tissues, periosteum, gum, &c., are torn by the separation of the fragments of the bone, the muscular displacement is likely to be great, unless, as sometimes seen, the fragments are, by the impact which broke the bone, driven into such positions as to remain in contact in opposition to the muscles; *the displacement of the accident being maintained.* This impacted condition of the fragments is, however, rarely seen.

The fracture of the bone is generally *compound*; that is, the broken bone is through a tear, cut or other opening in its investing tissues exposed to the air, this being mostly the case in fracture of the body, as the fibrous coat of the periosteum tears readily and the mucous covering is very thin; but the bone is seldom exposed though the external parts are frequently contused.

The muscular displacement will be proportioned to the separation of the parts at the time of fracture, even if the fracture is *simple*, that is, without any tear of the periosteum and investing tissues, the effect of the muscles is present, although it may not always be apparent.

† Malgaigne, op. cit.

If the anatomy of the parts involved and the muscular action which controls and effects the lower jaw were well understood, very little need be said at this time; unfortunately, however, some who undertake to instruct as clinical surgeons, or as authors of formal treatises, fail to set the matter correctly before the student.

When the body of the jaw, which supports the hyoid bone and its appendages, is fractured vertically in or near the front, the shorter fragment will rise if the muscles are unhurt, and this even if the fracture is at the upper border precisely over the symphysis and only shortens one side by passing down at its expense. In the first instance the longer fragment bears most of the weight of the larynx and trachea, and the shorter one will be drawn up by the muscles which pass down from the skull to the ramus, and in the second the short fragment will also ride up to the slant of the other, and in both cases the teeth will show it. These conditions will be more marked in proportion as the one fragment is longer than the other, but should the fracture pass down at the expense of the longer fragment, the teeth may be level, though perhaps a little separated, as the shorter fragment may by its projecting end support the longer. If the fracture is in the thickness of the bone, that is as if the break should commence in the outer line of the symphysis and pass back on one side so as to come out near the canine tooth, which is perhaps more frequently seen near the angle at the back of the teeth, or in parts where they have been lost, the short fragment is generally outside. This was so in case 4 in which the fracture was in the left lateral socket and passed back on the outside of the left fragment. In case 5 however, in which the break was in the body behind the right canine and passed down in the depth of the bone at the expense of the back fragment its sharp, upper, bare edge pointed inward to the symphysis. The muscular action was consistent in both instances, the difference in the positions being the result of the direction of the fractures, and the sound in the left masseter of case 4.

Fracture in and near the angle, or in the ascending ramus is readily detected, according to my own observation they are apt to be very painful. I cannot agree with Professor D. Hayes Agnew, who says:* "When the ramus of the lower maxilla is the part implicated, there is generally not much disarrangement of the fragments, in conse-

* The Principles and Practice of Surgery, vol. 1, p. 843; J. B. Lippincott & Co., Philadelphia, 1878.

quence of the two planes of muscles, the masseter and the pterygoid, covering the part of the bone, and acting as splints." The internal pterygoid muscle passes from its origin so much outward to reach its insertion on the angle that the *external pterygoid* separates it from the upper part of the ramus ; its action is therefore likely to draw the angle in if this is broken clear of the body. In case 4, this displacement would have probably resulted had the jaw been broken where the masseter was cut so deeply. In case 7 the bone was so split that the inside was a part of the body, and kept the angle out. If fractures in the *ramus* is seen early or when there is little swelling it may be often felt in the mouth. When looking along the range of the teeth and no indication of fracture is seen in the body of the jaw, if the finger is laid against the outside of the back tooth, its end will feel the anterior edge of the ramus which, when the mouth is opened wide may be explored up to the sharp edge of the *coronoid process.* Any displacement along this ascending border could be felt, unless the parts were swollen, and if so, crepitus and pain on proper manipulation, would indicate the seat of the fracture which in any part of the ascending ramus would generally not be on the same side with a fracture in the horizontal body of the jaw.

Professor Agnew also says : *"Fracture of the *coronoid* process is an accident of great rarity and is difficult to diagnose. It may be conjectured when a finger placed over the temporal region fails to detect any movement of the temporal muscle when the mouth is opened and closed."

From my own experience it is likely that the *coronoid* process is broken from the ramus as frequently as the *condyle.* Its fracture, however, interferes with the use of the jaw so very little, compared with a break in the neck of the condyle, that it easily passes unnoticed, especially as it probably occurs only when the jaw is broken on the other side.

The blow or pressure which falls upon one side of the jaw and breaks it, may easily drive it over to the other side and fracture the coronoid process against the inside of the malar bone.

Attention has been called to the facility afforded by the mouth to examine the anterior border of the ramus, which commences with the upward curve of the exterior oblique line near the outer side of the back tooth. Now if the finger is turned down over the inside of this

*Op. Cit., Vol. I p. 843.

tooth so as to reach under the *internal* oblique ridge, it will be felt that the alveolar process ends very abruptly, both the basilar portion of the body, and the ramus of the jaw, passing outward, and leaving the sockets of the teeth overhanging and projecting in. It follows that when a fracture passes through the socket of the back tooth, it as in case 7 before referred to, is apt to leave the outer side of the ramus whole, that is, break the body and ramus apart, except, perhaps, a scale of the inner surface of the ramus, which may separate as far back as the mylo-hyoid groove, or even up to the inferior dental foramen, and project from the body while the ramus retains a part of the external oblique, at the expense of the outside of the body, this sharp portion frequently rising into the tissues and causing much pain.

When, however, the back tooth has been lost so long that the socket is filled up, the bone is very strong at this part, and fracture in the ramus is more likely to be found higher up, and across the bone, rather than splitting it. In which case, the anterior border will be the most likely place to find displacement, for even admitting that the masseter muscle should, as suggested by Professor Agnew, act as a splint, still there is the external pterygoid to pull the upper part of the ramus forward, and the muscles attached to the body of the jaw to pull the lower part of the ramus backward, and it is hardly possible that the anterior border should remain from the displacement and pain, even if not displaced laterally. In fact, I have seen in both sexes, and with the back teeth present, fracture in the ramus which passed back through the bone so that the portion below was separated from the part holding the condyle and the coronoid process.

Now, of the precise direction in which the fracture passes back in the ramus, no exploration can be made back of the rounded, upward continuation of the internal oblique ridge, as beyond this, the palate and superior constrictor muscles with the tonsil, &c., block the way. The direction of the fracture may, therefore, be looked for outside of the mouth.

The external surface of the ramus gives attachment to the masseter muscle, and the internal surface at the angle and at the front part respectively to the internal pterygoid and the temporal muscles, but there is a large central portion weakened by the inferior dental foramen and canal which is not protected by muscular adhesion, and a

blow on the outside may not only fracture the ramus but also displace the fragments.

In examination of the external surface, the masseter muscle is in the way but it does not reach to the posterior border of the ramus, except at the angle, from which up, the portion of the bone covered only by the skin, etc., gradually widens, so that the condyle and the ramus also, is free of muscular adhesion to the centre of the sigmoid notch.* Thus the posterior border which is clear of muscular adhesion, affords the best place for examination outside the mouth, and. as before shown, the anterior border inside. This comparatively uncovered condition of this condyle is important.

It has been seen that the condyle moves forward and the angle backward to depress the jaw and open the mouth, but it is now advisable to closer attention to the relations of the condyle. Its movement is clearly felt if the finger is pressed into the ear. With the teeth of both jaws closed against each other, the finger, if placed in front of the ear, will rest upon the condyle, and if this is drawn forward by opening the teeth, the finger will sink into the hollow left behind, or with the finger placed under the ear it will at once be felt that the part of the ramus then on a level with it, neither moves backward nor forward.

Now with one hand taking firm hold of the jaw, by means of the teeth and chin, while the fingers of the other are on or near the condyle, it could be felt whether movement of the body of the jaw, take the condyle with it, if it does, the bone is sound; if it does not, crepitus, pain and displacement will indicate the seat of fracture. The natural motions of the jaw in opening and shutting, and in the forward and lateral movements, as in cutting with the front teeth and in grinding the food, also give, when intelligently studied, clear indication of the position and character of the injury.

This displacement caused by any muscular action is of course modified by the direction of the fracture and the condition of the surrounding tissues. The facility afforded by the open jaw to examine the anterior border of the ramus even up over the curve of the coronoid process is little more than is afforded by opening the lips only when the jaws are shut together, in regard to injury below the coronoid process. The fracture of this process, as indicated in the

*The parotid gland enfolds the neck of the condyle, but need not be considered here.

mouth, having been remarked upon, we now pass to its external symptoms, as these also require examination in connection with those indicating fracture in other parts of the bone, especially in the ramus.

The cheek affords a good place for examination, for when the mouth is open the point of the coronoid process is somewhat below the border of the malar process, and with a finger on each side, comparison between the suspected coronoid process and the opposite one, would indicate more clearly than the finger over the *temporal region.*

The *masseter* muscle will, it is true, tighten somewhat when the jaw is depressed, but this will not mislead so much as the movement of the temporal.

Professor Agnew is mistaken in supposing that if the coronoid process is fractured, the temporal muscle is still when the mouth is opened and closed. In health, movement of this muscle may be as distinctly felt in opening the jaw as in closing it, and this can be felt also when the coronoid process is fractured. If the jaw cannot be moved, still examination on or near the coronoid process would be more likely to lead to correct understanding of the injury than if made over the temporal region. I present one case in illustration:

On May 28th, 1864, a boy eleven years old was crushed by a pile of lumber falling on him, and received two fractures in the thigh, one in the left clavicle, and one in the lower jaw between the left canine and bicuspid teeth, while there was much pain and swelling in front of the right ear and along under the zygomatic and malar processes.

The injury was six days old when I first saw it by the request of Dr. Freeman, and the jaw moving pretty well on the right side. I decided to leave it free to move during the treatment of the fracture on the left side.

The splint applied was the original of fig. 4. He used it in eating from the time it was first put on, and in six weeks from the injury his jaw was well, and the splint left off, but the coronoid process had not united, the corner left by the fracture on the ramus being felt, but the coronoid process was gone.

The boy had lost his mother, and his father being absent all day he by screaming, compelled his sisters to keep him supplied with crackers, which he crushed between the top of the splint and his upper teeth.

The temporal muscle is inserted into the ramus as well as into the coronoid process or his jaw would have been more crippled.

This case shows conclusively that fracture of the coronoid process

is not indicated by the temporal muscle, also that the inside of the mouth is the best place to look for injury of this process.

Hamilton, without having seen a fracture of this process, says: "It is probable that an examination by the finger within the mouth, would readily detect mobility and displacement."

The persistent action of the temporal muscle is equalled by its antagonist, the *External Pterygoid.*

With recent fracture in the body, the angle or the ramus, or in any part below the neck of the jaw, and in injuries where any of these parts are absent, the *external pterygoid* at ouce pulls the condyle and cartilage forward when the jaws are separated. The pain of recent injury may prevent movement, but I do not recollect an instance in which the *external pterygoid* was in fault.

In one case, through injury from a shot, the left angle and ramus above, was destroyed, except the condyle from which a short spine of the back border of the ramus still projected downward; these being in substitution of the bone, lost only a fibrous connection between this spine and neck of the condyle and the body of the jaw. The condyle, however, was in its normal position and came forward with its fellow of the other side to open the jaw. Now, in this case the ball which passed through the ramus shattered it so much that the necrosed pieces which came away left the condyle and its interarticular cartilage under control of the external pterygoid, without any part of the ramus to interfere with it. The result confirmed my explanation of the muscular action which depresses the lower jaw and opens the mouth, while it confutes the statements made respecting the effect of the external pterygoid upon the condyle, when its neck is fractured.

In respect to fracture of the neck of the jaw, Malgaigne says: "This fracture is exceedingly rare, and for my own part I have never seen it. It appears to have been observed by Soramus, after which no more mention of it occurs until the time of Desault, and I know at present of but eight published instances."*

Malgaigne, after referring to the fact pointed out by Ribes—that in laxation of the condyle, the chin is carried to the opposite side, while in fracture of its neck the chin deviated to the same side, says: "The displacement of the condyle, induced by the cause of the fracture, increased and maintained by the action of the external pterygoid

* Packard's edition of Malgaigne, vol. 1. p. 342.

muscle, is a main point in the history of this fracture. The condyle itself remains in relation with the glenoid cavity, but the pterygoid muscle makes it execute a movement of rotation, carrying the fractured neck upward, forward and inward, so that the fractured surface of the inferior fragment is in relation only with the posterior surface of the neck and of the condyle."

"The diagnosis is generally easily deduced from the symptoms pointed out; we can, moreover, explore the fracture at once, externally and internally, by passing a finger into the mouth." *

Professor Frank Hasting Hamilton, whose treatise appeared one or two years after Dr. Packard's translation of Malgaigne, in speaking upon the reduction of the displaced condyle by Ribes, says: "The case of a cannonier whose jaw was broken through the neck of the condyle on the right side, and through its body on the left, afforded him an opportunity to determine the practicability of a method of which he had as yet only conceived the idea. Malgaigne thus describes his procedure. "With the left hand seize the anterior portion of the jaw, for the purpose of drawing it horizontally forwards, while you carry the index finger of the right hand to the lateral and superior part of the pharynx. You will meet at first the projection formed by the styloid process, but moving your finger forwards you will find soon the posterior border of the ramus of the jaw; and following this border from below upwards, you will arrive at the inner side of the condyle, which you will push outwards in such a manner as to engage it upon the other fragment.

"This manœuvre cannot be made without causing nausea, as the finger always does when carried into the posterior part of pharynx; but this is slight inconvenience. The redнction obtained, bear the jaw upwards and backwards in order to press and fix the condyle between it and the glenoid cavity, then fasten it in place with the sling."

The fragraments were thus early brought into apposition in the case reported by Ribes, and the patient was cured without any deformity."†

This quotation from Malgaigne is to show the method by which the displaced condyle may be reduced and held in place; it has, however, been referred to as a means of diagnosis, and I therefore take it into consideration in this connection, especially as the sooner

*Packard's edition of Malgaigne, vol. 1, p. 324.

†F. H. Hamilton: Fractures and Dislocations, second edition, p. 129.

such nonsense is eliminated from our text books the better both for practitioners and patients.

In the first place Dr. Packard's translation puts this case before the reader in quite a different aspect to that presented by Professor Hamilton, who omits the last paragraph, in which Malgaigne says:

"Ribes, to whom this plan is due, had occasion to apply it in the case of a cannonier who had a fracture of the neck of the right condyle with a wound of the corresponding cheek, and another fracture on the left side of the body of the jaw. The destruction of the soft parts gave him the idea of carrying the finger to the inner side of the condyle in order to replace it, which he did easily; and the patient recovered without deformity at that portion of the bone."*

Now the true sense of Malgaigne's report is that by the destruction of the soft parts a way was open for the finger, which in the ordinary state of the cheek does not exist.

But by the omission of this part of his report, Professor Hamilton's readers are led to suppose that the condyle can be reached and set from the inside of the mouth in the usual condition of the parts, and it must be shown why it cannot.

Before doing this it is necessary to correct the erroneous statements in respect to the condyle remaining still in the glenoid cavity while the pterygoid muscle makes it rotate and carry its fractured neck upward and forward. It has been shown that in health the condyle with its crowning interarticular fibro-cartilage moves forward to open the mouth, while the back border of the ramus opposite the lobule of the ear remains still, and that the lower part of the ramus passes back during the descent of the front of the jaw.

Further, the case recently spoken of, in which part of the ramus was lost through necrosis following gun shot wound, shows the same effect of the muscular action, the condyle making the forward movement, or turning upon a point below in the spine of the back border of the ramus. It follows that if, after fracture of the neck of the condyle, the inferior fragment is in contact with the back of the condyle, it is owing either to the displacement at the time of fracture or the direction of the fractured surfaces, or both, and this displacement maintained by the temporal, masseter and internal pterygoid muscles, etc., drawing the inferior fragment up and back; *not*, however,

* Packard's Edition of Malgaigne Vol. I. p. 325.

by the action of the external pterygoid bringing the condyle and its neck into a horizontal position, as stated.

It has already been shown that fracture in the ramus cannot be explored in the mouth beyond the ascending curve of the internal oblique ridge. This of course does not prevent the entrance of the finger beyond the fauces, it being well known that its point can reach the back of the pharynx and also into the extreme upper back corners; but the back wall of the adult pharynx is less than two inches across from side to side, while the styloid process of the temporal bone is about twice this distance from its fellow on the opposite side, and each one about half an inch *back* of the condyle. This is so far, that the finger could hardly reach the styloid process even if it were not covered in by a mass of muscles and other tissues, including the internal caroted artery, and internal jugular vein, with important nerves, etc.

In brief, the directions of both Malgaigne and Hamilton for finding the styloid process are all erroneous and impracticable.

We now pass to consider the feasibility of reaching the condyle with its fractured neck turned upward and forward as stated in the directions now under review. When the finger is carried along the gum on the inside of the upper third molar, if its point is pressed into the commencement of the soft palate, it will feel the hamular process on the lower end of the *internal pterygoid plate* of the sphenoid bone, this hamular process being distant from its fellow on the opposite side about one inch and a half.

Now the ramus just behind and above this process is naturally a full inch outside of it, and if the neck of the condyle, or any part lower down, were fractured, but not displaced, no decision could be arrived at from examination inside the mouth; and if the condyle were broken loose at its neck, it might be from an inch to an inch and three fourths from this point of the soft palate, and even much more, if it were forced up into the zygomatic fossa by the lower fragment. Therefore exploration could not determine any thing as to the injury, for the mucous membrane, soft palate, constrictor, stylo-hyoid digastric, and internal pterygoid muscles, ligaments, internal maxillary and other nerves, otic ganglion, eustachian tube, etc., are in the way. Nor can inspection of the teeth determine as to fracture in the neck of the condyle, as shown by Case 6, in which, judging by the teeth alone, the neck would appear to be fractured, whereas the injury was in the inter-articular fibro-cartilage.

It is therefore indispensable to examine carefully upon the outside of the jaw around its body, and on the ramus near the ear and zygomatic process to complete the diagnosis.

The following cases are conclusive, not only in respect to the necessity of further information of these parts being placed before surgeons, but also of the advisability of correcting Professor Hamilton's translation of Malgaigne's report on fracture of the neck of the condyle.

C. B., 24 years old, was run over by a steam fire engine Oct. 11th, 1865, and after several wounds on his scalp and chin were dressed, his jaw being fractured, he was sent to the City Hospital, Brooklyn; on arriving there, he had recovered sensibility, but was unable to swallow.

Oct, 12. The pain in left ramus and angle of the jaw being so severe, the patient could not lie on his left side, and could scarcely speak so as to be understood. The front of the jaw had gone back very much, and the surgeons endeavored to bring it into place, but could not keep it forward.

Oct. 13. With assistance of other surgeons attempts were made in various ways to hold the jaw in place, but without success. Swelling and pain undiminished.

Oct. 14. Several other surgeons were present, but on examination it was decided not to do anything until it could be discovered where the jaw was fractured, as the swelling still continued.

Oct. 15. Patient could, with difficulty, swallow water or wine in small quantities, To this time he had been fed through a small tube, by the House Surgeon.

Oct. 16. Swelling and pain abated somewhat, and patient discovered two of his teeth out of place, and called the House Surgeons' attention to their condition, who said they had not discovered *that* before.

Oct. 17. Patient's condition improved but attempts to bring the jaw into place were still unsuccessful. The chief surgeon remarked that the jaw was broken in three places.

Oct. 18. Patient went to the College of Physicians and Surgeons, New York, and in clinic was advised to get his teeth wired by a Dentist, and that, in nine cases out of ten, it was unnecessary to set the jaw at all.

Oct. 19. At the City Hospital, Brooklyn, nothing was done, and the patient left for home, where he was attended by the chief surgeon and assistant, who attempted to hold the jaw in place by gutta-percha

moulded to the upper and lower teeth, assisted by a bandage supporting the chin and fastened over the head. This, like all previous attempts to bring the jaw into place, was insupportably painful, and patient was requested to return to the hospital to have it tried again under chloroform.

The application of gutta-percha in the hospital was, however, unsuccessful. The patient afterward made a second visit to the College of Physicians and Surgeons, N. Y., and was told that it was only necessary to wire the teeth to prevent the jaw from going farther back. The Surgeon in Brooklyn finally as a *dernier ressort* sent him to me to be treated for three fractures. "Fracture neck of both condyles—also fracture of body of bone."

When he presented this memorandum, his chin was supported by a bandage over the head. I found the condyles of his jaw, their necks, and his ears in good condition, but the parts under the angle of each ramus were still swollen and tender. He was very muscular, his neck being unusually large; and while the swelling caused by the accident moderated, it was superadded to by the efforts of the surgeons to pull the rami forward, in order that the lower front teeth should come to their place against the upper ones; from which they were now over ⅜ of an inch back. But if the falling back had arisen from injury in or near the articulation of the condyles in the glenoid fossæ, it could result only from the condyles being forced into the ears after crushing the auditory process, which gives form to the front of the meatus; or by fracture in the neck of the condyles. Each condyle, however, as before intimated, was in its right place in front of the ear, and both came forward without pain to open the mouth; the movement being felt distinctly by the finger back in the ear and in front of the tragus. The back border of each ramus could be followed down from its condyle to its angle; while in the mouth the front borders were found perfect from the outerside of the back teeth up to, and including, each coronoid process.

In fact there was but one fracture, that which loosened the two teeth as discovered by the patient on the fifth day after the injury.

This break through the socket of the canine tooth, so near the centre of the arch of the jaw, allowed his swollen muscular neck to push the angles of the jaw out, thus as the imposts of the arch of the jaw spread apart, its crown, the chin, fell back, and this receding was increased by the muscular action brought to bear on the chin in

controlling the head. The jaw held at the time of the accident fifteen teeth, all except the left molar, and, although the right canine and bicuspid were lost by the fracture, there still remained four strong teeth in the right fragment.

A stiff rubber splint was applied on November 5th, which inclosed all the teeth of both fragments, the angles being drawn in so as to bring the front teeth forward. The splint held the parts in place, by its fit on the teeth, without any other fastening, it being on the same principle as that applied to the patient in the Bellevue Hospital in January 1864, described in Case 4.

The food was masticated between the top of the splint and the upper teeth, throughout the treatment, as the jaw was allowed its natural movements, no bandage or anything external to the mouth being used, the patient attending to his business as before the accident. The bone united well.

The result confirmed my diagnosis that there was only one fracture—that in the body of the jaw, and that there was no injury whatever in or near the condyles.

Early in November, 1865, I was called upon by the medical attendant of a patient 62 years old, who had, in getting out of a stage, fallen on the curbstone, and received on the chin, a cut an inch and a half long. After this was dressed, a well known surgeon was called in, who, on examination, said the jaw was fractured through the neck of each condyle, and applied a bandage to hold it against the upper teeth. The patient was enjoined not to talk or open his jaw even to eat, his communications to be made in writing. The bandage soon caused great suffering, and turned the parts beneath it purple, so much so, that various contrivances, such as pads of lint, cork, and pasteboard were resorted to, but proved unserviceable, while the bandage required constant attention.

After hearing the Doctor's description, I felt assured that the diagnosis was incorrect. The accident occurred October 23rd, and the bandage had been applied at once, yet during about two weeks, while much suffering had resulted, no bad symptoms had been manifested in the ears, nor in the brain, although the man had struck on his chin. Even at sixty years of age, a blow on the side of the face might break the neck of the condyle, but I was not prepared to believe that the necks of both condyles had given way, through a blow directly on the front of the chin, without injury to the meatus of

the ear, or to the glenoid cavity, or some other part of the temporal bone. My visitor, however, seemed certain that his eminent surgical colleague could not be mistaken. A second interview, some days after, made no special change in our respective opinions.

The patient's friends, however, felt so much concerned, that they were determined to have me called in consultation. The result was that I met the gentlemen having charge of the case at the patient's house on Nov. 16th, 1865.

In talking over the injury, before seeing the patient, the surgeon told me that the necks of the condyles were broken.

I asked as to their position; he replied that they were in their right places; that they had been drawn forward and inward, but that he had set them with his finger from the inside of the mouth. I told him he must be mistaken, as the condyle could not be set in that way. He said it was so given in the books.

We then saw the patient, who handed me a slate, on which he had written, among much other information, that before the accident his lower front teeth on one side had projected beyond the upper, while on the other side they were even.

I found his head and jaw surrounded by a bandage sixty feet long, beneath which on each side a splint of lint and plaster extended from the ear down over the ramus under and outside the body of the jaw to within half an inch of the corner of the mouth. These splints had been on four days. For the first twenty days he had worn ninety feet of bandage, but as the crepitation continued, it was thought necessary to apply the splints, and thirty feet of the bandage was left off. The patient's jaw was over to the left of its usual place, and he held it firmly closed, as if he feared it would fall off. The left lower front teeth were an eighth of an inch back of the upper, while the cutting edges of the lower right lateral incisor and canine teeth, with the front of the latter slanting to nothing at the gum were broken off.

This was done in the fall, as the chin struck so as to drive the jaw back, and the inside of these teeth struck against the outside of the upper ones.

The bandage and splints being removed, I passed my finger up the front of each ramus, and found them all right; then around the body, and found it unfractured. I then examined the necks of the condyles externally, and they with the parts around were in good

condition. I told the patient to open his mouth; this he did without any pain, and he bit at my finger in front, and on the right, and the left naturally, the forward and lateral movements being unrestricted. The crepitation continued as heretofore, but it did not arise from any part of the bone, there being no fracture whatever. On the back border of the left ramus there was a very painful swelling about $\frac{5}{8}$ of an inch above the angle, extending up about three quarters of an inch; this perhaps arose at the time of the fall from the sudden strain of the back fibres of the masseter muscle. The condition of the muscles was now such as prevented them from holding the jaw forward in its former position. Its usual position, however, was not normal, its condyles having been held a little forward in the glenoid cavities to suit the irregular position of the teeth. Now with the muscles irritated by the bandage and splints, and held under unnatural strain by the fears of the patient that the condyles would get out of place, and this dread kept up by the noise made by the muscles and ligaments in their strained and unnatural condition being wrongly attributed to the friction of the fractured surfaces of the bone, it was hardly possible for the jaw to come into place, especially as the points of the teeth which had controlled the jaw were now broken off.

I advised that he wear the bandage slack until he acquired confidence; told him to use his jaw when eating, to walk and ride out when he felt disposed, and to talk as much as he pleased. On the second night his bandage getting out of place as usual, he slept without it. In the morning, November 18th, he went down town to his office without any thing on his jaw.

It grew rapidly strong, and came into place without anything further being done to it, except that one or two teeth were rounded off a little with a file.

The left ramus above the angle was tender to the touch for several months.

On November 19th, these two men, each treated for fractures through the necks of both condyles for more than three weeks, were in my office, rejoicing over their deliverance.

The only fracture which ever existed of the five they had been treated for, that in the socket of C. B's. right canine tooth, was even then so united as to leave no apprehension, the splint being removed at pleasure.

In the first case the one fracture misled the surgeons; in the second case the blow on the front of the jaw was stated to have caused an injury which at the best is very severe, and sometimes irreparable. Thus these patients were made miserable, and their sufferings very much aggravated, by those who were called in to cure them.

The importance of all this detail is now seen; it is not merely to show how the very few cases of injury in the superior terminations of the ramus of the lower jaw are to be diagnosed and treated; but also to open the way for the very much more serviceable qualification of being able to decide intelligently between very trifling injuries, and those of grave character; that is to make a correct diagnosis.

Now of the score of practitioners whose efforts caused so much anxiety and suffering to those two patients, many were of the highest standing and the results of their treatment demonstrate the propriety of the publication in 1867 of my views on the "Muscles Concerned in the Movements of the Lower Jaw." Of course, ignorance in respect to the action of these muscles was not confined to the surgeons of New York and Brooklyn; nor to those in Philadelphia who were connected with the University of Pennsylvania, for in Professor S. D. Gross' System of Surgery, Vol. 1, page 894, published in 1866, we read: "A fracture of the *neck* of the bone is easily detected, unless the subject is very fat, by the crepitation produced on moving the jaw, by the preternatural mobility in front of the ear, and by the manner in which the body of the bone is dragged forward by the action of the external pterygoid muscle. Similar symptoms will characterize fracture of the condyle of the bone."

Here this muscle which opens the mouth by pulling the condyle forward, and thus throwing the body of the bone down, is said to drag this last mentioned part of the jaw forward after it, the muscle is, by fracture of the neck of the condyle, separated from the body of the bone.

Thus with the surgeons mistaken as to the muscles which open their own mouths, they necessarily blunder in many cases far simpler than these now presented; and nearly all who, at this period, write with the professed object of instructing them show no better knowledge of the muscles involved than those of twenty years ago.

It has been shown that, as late as the year 1875, erroneous views were sent out by those undertaking to instruct specially upon the face and jaws; and the following quotation from a book published as "the embodiment of the latest knowledge upon the different subjects treated," prove that this is done even in the present year.

In a treatise on Oral Deformities* on page 366, under "Displacement" it is written, "Garretson says: If the freed portion be the anterior or chin part, it will be dragged downward and backward by the action of the genio-hyoid, hyo-glossus, and digastric muscles.

If the neck of the bone is broken, the body is dragged forward by the action of the pterygoid, crepitation and mobility will be very apparent, and much pain will attend the movements of the jaw, produced by the displacing action of the temporalis."

This is quoted by Dr. Kingsley from a work by Professor James E. Garretson† so long known as Oral Surgeon and Clinical Lecturer to the University of Pennsylvania and now as Dean of the Philadelphia Dental College, in which he is Professor of Anatomy and Surgery, and Surgeon to the Oral Clinic. These erroneous views may therefore, mislead so many that it is very necessary to correct them. Now, however free the anterior part of the jaw or chin may be through fracture, the hyo-glossus muscle cannot displace it, for this muscle neither touches the jaw nor affects the muscles attached to this bone.

Again, if the neck of the condyle be broken, the pterygoid muscle cannot drag the body of the jaw forward any more than when unbroken; but on the contrary it is dragged *backward* by the muscles attached to the inside of the chin; assisted by the omo-hyoid, all of which act in eating and in speaking, and those especially which control the head pull the jaw strongly back.

We then read, "Bertrandi states that, when the fracture is near the angle, the smaller fragment is drawn backward by the pterygoid and masseter, the sterno-hyoid and digastric not having power enough over the lower fragment."

Bertrandi wrote, say a hundred years since, that this statement is presented at all is indefensible, it would be difficult to give one more

*A Treatise on Oral Deformities as a branch of Mechanical Surgery, by Norman W. Kingsley, M. D. S., D. D. S.: D. Appleton & Co., New York, 1880.

†A treatise on the Diseases and Surgery of the Mouth, jaws, and Associate Parts, By James E. Garretson, M. D., D. D. S.: J. B. Lippincott & Co., Philadelphia, 1869.

inconsequent. In fact, the uselessness of these quotations is only equalled by their tendency to mislead the student in respect to the physiological and pathological anatomy of the parts referred to. The remainder of this section does not redeem it. I have remarked upon these extracts as "Displacement" has much in common with Diagnosis," under which heading Dr. Kingsley says,* in the two-fifths of a page which he gives to this important subject, several other things that require correction.

Now, fracture is not, as he says, generally accompanied with "a good deal of salivation." This flow of saliva may be associated with other injuries and it is not at all diagnostlc of fracture.

It is incorrect to say, "there is also displacement of fragments which the irregularity in the line of the teeth shows readily, together with contusion and laceration of integuments." Fracture may exist without any one of these symptoms; and all these, except displacement of fragments, may be present without fracture.

I now quote the whole section before remarking further.

"DIAGNOSIS.—The symptoms attending a fracture are rarely obscure. There is always unnatural mobility, generally crepitation, more or less pain, particularly at the seat of fracture, a good deal of salivation, with but little hæmorrhage. There is also displacement of fragments, which the irregularity in the line of the teeth shows readily, together with contusion and laceration of integuments.

"Where the diagnosis is difficult, particularly if fracture of the coronoid or condyloid process be suspected, the surgeon by passing the index finger into the mouth well back can, in conjunction with the other hand, so manipulate the parts as to detect the fracture should any exist. This examination should be further extended to determine if there be any dislocation, particularly if from the nature of the blow such a result would be likely to occur.

"In such cases there is almost always dislocation, or at least displacement. Should this occur, Ribes has described an excellent mode of reduction; in fact, it is the only way it can be successfully accomplished. The index finger of the right hand is carried into the mouth, and the displaced fragment searched for. With the aid of the left hand, applied externally, the piece is to be replaced and held in its normal position by forcing the jaw upward against the superior maxilla."

*Op. cit. p. 368.

I have already shown that within the mouth no exploration can be made back of the anterior border of the ramus; therefore, to "so manipulate the parts to detect the fracture, should any exist," or "to determine if there be any dislocation;" the body of the jaw whether it contains teeth or not is, in addition to the ramus, the only part which can be manipulated, and to do even this, a finger or thumb must generally be under the jaw outside the mouth to oppose the finger or thumb which rests within upon the teeth, etc.

In this way the front of the jaw is so held that the ascending rami can be moved readily in any direction, and if fracture exists, crepitation between the ends of the fragments will indicate it with more certainty than muscular movements, in which the friction of the soft parts frequently misleads.

It has taken some space to point out the errors in Dr. Kingsley's twelve lines on diagnosis, between which, and the close of the section which in fact, is devoted to the *reduction* of fracture, there are suggestions as to dislocation of the condyle which he intimates is likely to result from blows of some sort. These require attention especially as in the last two lines on page 363, when speaking of the special sources of protection from fracture of the ramus, he says, refering to one, "and by the case with which the fracture might slip, and thus break the force of the blow."

But the ease with which the articulation *might* slip, affords no protection, and if fracture of the ramus ever has been averted by the laxation of the condyle, which is very doubtful. I do not know a case which justifies such an opinion.

A blow upon the front of the jaw could hardly fracture the ramus, as the neck of the condyle would break from the sigmoid notch, rather than the wider part of the ramus below it. The ramus is therefore protected from fracture through blows from the front by the neck of the condyle, not by dislocation. The effect of a blow on the side of the ramus cannot be averted by the dislocation, for the condyle and cartilage, are prevented from going in by the depth of the glenoid cavity in this part, to which is superadded the descending spine of the sphenoid bone and a strong supporting ridge which springs from the temporal bone, and which also protects the internal caroted artery, as it enters the skull. Therefore, while dislocation cannot be caused by blows on the flat side of the ramus, its fracture

is very probable, for as before shown the bone is likely to give way near the inferior dental foramen.

Even if the mouth were open when the blow fell upon the ramus, although fracture might follow, dislocation could not; for the condyle would still be firmly supported against the lateral blow; while if the chin were struck, the temporal and other muscles would draw the condyle up and back into place. Luxation of the condyle which occurs in yawning and vomiting, is caused by contraction of the external pterygoid and digastric muscles in function; when it follows upon opening the jaw wide, for operations in the mouth, etc., the relaxation of the muscular action is voluntary, or if under ænesthetics, it is suspended. But when the jaw is exposed to fracture through blows or other violence, the muscles are on the alert and rarely fail to draw the condyle into place.

These explanations show that the articulation of the condyle with the glenoid cavity is not so weak or unprotected that it gives way and saves the ramus from fracture; it is, however, proper to say, that it is rather in connection with fracture that Dr. Kingsley says: "There is almost always dislocation or at least displacement." He, however, does not clearly show in what class of cases "there is almost always dislocation or at least displacement."

The fact is that dislocation of the condyle of the jaw is very rarely associated with fracture in any part of the bone; I have no recollection of seeing it. In case 6, the right condyle was dislocated outward and backward, but it was put in place before I was called in. Now dislocation occurs in connection with fracture so seldom, that Mr. Christopher Heath, F. R. C. S., in his admirable work, "*Injuries and Diseases of the Jaws*," could present only four, including this one which he quoted from my paper on "Interdental Splints," (New York Medical Journal, 1866). Those displacements of the condyle which are associated with fracture of its neck or of the socket, cannot, in my judgment, be properly classed as dislocations.

Dr. Kingsley's sweeping endorsement of Ribes' proceedure in the case of the Cannonier, whose cheek being shot away, no obstacle prevented the finger from reaching the pharynx without movement of the jaw, recalls the fact that he is President of the Board of Censors of the State of New York, and those asking permission to practice are examined by him on the treatment of fracture of the jaw. Notwithstanding that this special duty calls for full knowledge of the parts in-

volved, and affords many opportunities for acquiring experience, he gives directions in his book in respect to the condyle which are impracticable for reasons given in correcting Malgaigne and Hamilton, and more especially through the *action* of the *external pterygoid* muscle which *pulls* the condyle forward and holds it displaced, while the mouth is open in order that the finger may get into the pharynx. Consequently, even if the condyle could be examined from the inside it could not be controlled, for the muscular action would displace it the moment the finger was removed to force the ramus up against the fractured surface.

In the case of C. B., fracture in the socket of the right canine tooth allowed the jaw to fall back so much as to lead the surgeons to suppose the necks of the condyles had given way; and in the case which follows, the displacement of the jaw bodily, through strain of the ligaments and injury to teeth was followed by treatment for fracture in the necks of the condyles; although the jaw was not broken in and place. Again, in case 4, a cut in the left masseter muscle caused displacement, which led the surgeons in the Bellevue Hospital to suppose the neck of the condyle was broken. To these three causes of error in Diagnosis, I give one more abnormal condition, which might easily mislead.

A patient under my treatment for 40 years, whose teeth in both jaws were unusually regular, and the lower teeth articulated to the upper ones perfectly for the whole of 39 years, was then attacked by rheumatism so severely that it was supposed she would remain helpless, like her mother through the last years of her life. Ten months after, however, I was agreeably surprised by seeing her recovering so far as to get up into my chair without assistance. On looking at her teeth I found the lower front incisors could not be brought forward and up against the upper incisors. They were kept apart nearly three-eighths of an inch by the back teeth meeting to soon, the condyle going up too far into the glenoid cavities, through alterations in their articulations. The patient was 57 years old and very deaf. The parts in front of the ears however, had never given any trouble, but there was marked shrinkage of the integuments and loss of plumpness generally. This change in the jaw came in a few months, and if associated with a fall or blow might be misunderstood. The jaw had never been dislocated nor its movements interrupted in the least. A fracture in the symphysis will allow of much spreading

of the angles, but on looking into the mouth the injury might be undiscovered. In one case I saw the symphysis fractured so exactly that the adjoining teeth remained firm ; while the gum was healthy. The patient 24 years old had lost one central incisor to give room, but the other stood out in front of the lateral precisely in the symphysis. When the man fell on his chin, this small wedge shaped tooth struck against the upper teeth with such force that it was driven into its socket; this split the halves of the lower jaw apart, and the tooth was removed by the fingers.

Fracture in any part of the jaw between the canine teeth, and in or near the socket of either will allow the jaw to be carried back by the muscles and especially if the patient is robust. If no injury can be seen within the mouth and the angles are thrown out so far, that on closing the teeth up, those in the front will not reach out to their usual place against the upper teeth, firm pressure upon each angle of the jaw, may reveal the seat of fracture by causing pain even when crepitation is absent and if the injury is so recent that adhesions have not formed the angles by going in will force the front of the jaw forward and bring the teeth into place.

If the injury is not quite recent the condition of the patient from concussion of the brain, or other injury ; even debility alone may have been such that the displaced bone is firmly united, and the case presents a serious complication of the first injury. This displacement may be the result of sleeping on the side ; whether the jaw was bandaged or not ; any one of these conditions may counteract the muscular displacement, or on the other hand increase it. The suggestions in regard to the effect upon recent fracture of the displacement of the injury being maintained through impractition of the fragments, and also of any injury to the muscles or ligatures, are of course pertinent when examining those of older injuries, and should be borne in mind. These varied conditions however, only require intelligent and careful examination to prevent them from misleading the surgeon.

These remarks upon diagnosis of fracture of the jaw are not given as complete or exhaustive, they have been called forth rather by the apparent need of information upon special aspects of the subject which is clearly shown in the works of the several writers, who, within the last twenty years have been foremost as instructors in the surgical and dental schools of the United States. In their writings much is given that may assist the student, while in my own views of

treatment of fracture of the jaw to which I now pass, those which I have submitted will be fully sustained by the results in well known cases.

TREATMENT OF FRACTURE OF THE JAW.

The surgeon called to any injury of the head or face should, if the jaw is hurt, see whether it will move properly and close the lower teeth against the upper ones as before the accident; and this even when it is at once seen that the teeth are displaced. When the muscular action does not adjust the parts, he should assist or do it with his fingers; for if this is tried soon after fracture of the body of the jaw the parts should go into place temporarily, at least. If, however, this does not reduce the fracture it is impacted, or the first displacement is in some other way maintained, and the fragments should be taken firmly by the thumb and fingers of each hand and so forced apart as to allow the broken surfaces to be set right. A dry towel held between the hands and the wet tissues will give firmer hold. Muscular action should be avoided by the patient.

The relief afforded when the sharp fragments are in place is always marked and often singularly great.

The surgeon should therefore release the parts at once from the displacement of the accident, unless the patient's condition is so bad that fatal consequences might ensue from any increase of suffering before partial recovery from the shock.

Insensibility from concussion affords a most favorable opportunity not only to set the fracture but to apply the splint.

It is, however, sometimes very difficult to replace the fractured parts, especially if they have been left unset for several days.

In August, 1873, a girl about ten years old when running in the Bath road, Newport, came in contact with a horse, and her jaw broke between the left incisor teeth. Several physicians were called and two saw the case on different days, but accomplished nothing. One formerly attached to the New York Hospital spoke of it to Dr. Austin L. Sands, and he advised that I should be called In. I saw the patient late in the second day after the accident, and to my surprise found the left fragment within and above the right, and firmly held the soft parts, having partially united.

The child was suffering terribly, whereas, had this displacement been reduced immediately after the accident, she would have been comparatively easy, even if nothing had been done to keep the bone

steady. It required all the strength of my fingers to wrench the parts asunder. During this minute or two of extreme suffering the child made no resistance, feeling assured that now she was going to be relieved. A pad was placed between the teeth of the left side, to keep the elevated fragment down, and a four-tailed bandage worn around the chin and head until the next morning. The patient was then much relieved, and impressions of both upper and lower teeth were taken, as the growth between the fractured surfaces made it advisable to set the fracture by means of the splint. The upper plaster cast was therefore required to set the lower cast right, in order that it might mould the rubber splint.

I had no apparatus in Newport to make the splint, but Dr. C. A. Bracket kindly allowed it to be made in his laboratory.

The splint was a simple shell of hard rubber which fitted all the teeth of the lower jaw, and was tried to an infant molar on each side. The top of the splint took the place of the lower teeth in eating, the jaw moving naturally.

Dr. Brackett was much interested in the treatment, having seen nothing like it before. He had graduated from the Dental School of Harvard University where Garretson's Surgery of the mouth was used, but this book, although showing my cuts, leads the reader to suppose my splint is used with a bandage around the head ; whereas, my splints are intended to obviate the use of these vicious appliances.

I returned to New York on September 1st, but left the case in Dr. Brackett's care.

The splint was applied August 18th ; by September 8th the fracture had united well, but as the two incisor teeth were still weak the splint was worn without ligatures until October 1st.

The unaided fingers are sometimes unable to bring the fragments into place ; in case 6 I found it necessary to pass pack-thread around the teeth, with a piece of wood to draw by, yet the fracture was but four days old.

The following case shows that recourse must sometimes be had to the surgeon's knife. In the terrible stage accident at the White Mountains in August, 1873, when so many passengers were killed and injured, one received a compound fracture in the lower jaw, between the right canine and the lateral incisor teeth, and for several days remained insensible through concussion of the brain. Professor Charles E. Buckingham of the Medical School of Harvard University

had charge of this patient, assisted by physicians of the vicinity, and a dentist who had attended the Philadelphia Dental College. On the sixteenth day, Dr. T. M. Cheeseman, of New York, was called in consultation, but as the surgeon in charge expressed the opinion that it was safe to leave the jaw without any mechanical appliance, Dr. Cheeseman retired from the case; and through his advice it came into my hands on September 3d, the patient bringing letters to me from both surgeons. Dr. Buckingham said that three separate attempts had been made to force the fragments up into place by bandages, but pain in the left articulation and masseter muscle was so severe that the bandages were given up. He had thought it best to leave the whole to itself, that nature would do the best for this particular patient. The fracture was now firmly united.

The gentleman also brought a hard rubber splint made for the chin and jaw, and two small caps for molar teeth. I found his front teeth down five-sixteenths of an inch below the right canine, the wisdom teeth a full quarter of an inch too close together, and the tonsils which lie inside the angles of the jaw still closer.

The lower right canine was the only tooth which touched the upper when the jaw closed, and this tooth, with those behind it, being so much above the front incisor teeth, in fact, all in the left fragment, the mouth was not only unsightly but the teeth useless in eating; while the tongue was restricted by the closeness of the angles of the jaw. This condition was evidently brought about through muscular inaction of the parts during the patients' insensibility, when by lying on his side probably, the left fragment holding ten teeth was pressed in and the back ones impinging against the upper back teeth, threw the front of the jaw down below the right fragment in which position they united. After this, attempts to force the parts up by bandages, of course failed, and as time went on the union grew stronger until the case came under my treatment about twenty-four days after the accident.

The patient was but twenty years old, and his jaw having united so strongly, it was clear that if broken again and set right, the bone would again unite; therefore, after taking wax impressions of both upper and lower teeth, I cut the bone apart as follows. A powerful gum lancet was passed through the new growth at the junction of the lip with the front of the lower jaw and one upward cut separated all above; then the sides of the jaw were pulled apart, the left by an

assistant; this separated the canine and the lateral incisor teeth enough to allow the knife to stand vertically between them, and from this position the point of the lance gradually cut down through the new growth until the fragments of the bone were so loosened from each other that the teeth in both were easily brought to the same level.

The splint should have been put on while the patient was insensible, but as the surgeons left the fracture until it united, they should have cut it apart before they applied the bandages, in order to allow the bone to go into place.

I found it necessary to cut the fragments apart before making the splint, to find out whether they could be brought precisely into their original relations. A plaster cast can be sawed apart precisely where the jaw is fractured, but if the parts of the bone cannot be put back exactly, the cast should also deviate as the splint must be made to fit. These two fragments, however, came into exactly the same relations, and a splint covering all the teeth and fastened by screws to the left canine and right first molar, was worn for thirty days; the screws were then left out and the teeth filled, but the splint worn thirty days longer, although removed at pleasure; the jaw was then strong and in its old place and was used in eating and speaking throughout the treatment.

No trace of the separation by the knife was seen, except a fine line on the gum, as I had taken care not to cut into the lip, nor into the soft parts under the tongue, and not to allow the point of the lancet to touch the skin after it had passed through the whole depth of the jaw.

Had the break between the bone passed off to either side, that is, had it, instead of being straight, turned from its first direction, a bent blade could have followed unless the angle were very sudden. If a fracture were bent too abruptly to be followed, and it could not be wrenched apart, it should be sawed off on a line with the first part of the fracture; a small saw could be used with a dental engine. But if an opening in the skin were required it should be cut under the border of the jaw so as not to appear in front.

Certainly no such operation can now be justifiable as that quoted by Professor Hamilton as follows:

"In the case of the fracture of the inferior maxilla, reported by Dr. Buck, to the New York Pathological Society, and already referred

to, the bone was broken between the two incisor teeth of the left side; the part of the bone on the left of the fracture was driven in, and interlocked behind the end of the right portion, so as to be separated by a finger's breadth. Finding it impossible otherwise to reduce the fracture, Dr. B. dissected off the under lip, so as to expose the fracture. He found that the right anterior portion of the fractured bone terminated in an angular projection as far as on a line below the left angle of the mouth. The lip was then divided to the chin, and the soft parts holding the fragments together incised. A chisel was then insinuated behind the projecting angle of the bone, while it was being excised by the metacarpal saw. When the bone was restored to its natural position, it was found so apt to be displaced, that holes were drilled at the lower angle of the fracture, and adjustment maintained by wiring them together, the wire passing out through the lower angle of the wound. Sutures and adhesive straps, with a bandage, were employed to maintain the adjustment of the parts. So far, the patient has done well, being supported by liquid nourishment introduced through a tube, passed through the space left by one of the incisors, which, on account of its looseness, was removed.*

In many cases much trouble is experienced in attempting to set fractures of the lower jaw *after adhesions* have set in.

In the case of C. B., in which so much trouble was experienced by the surgeons in Brooklyn, I feel assured that the *springing* of the jaw back and the angles out was kept up by the early union of the soft parts around the fracture. The man was young and robust, and as the swelling of his neck pushed the angles out and his strong muscles drew in the front of the jaw, adhesion set in and held the fragments which were well in place at the fractured surfaces, except having a little too much new growth between the inner part of the bone. This *elastic* union in and through the socket of the right canine tooth resisted all their attempts to hold the angles of the jaw in, and bring the front of the jaw forward. On the second day the parts were sore and the man too weak, and as he became better able to bear pain, the union of the soft parts grew stronger, and resisted the misdirected efforts of the surgeons.

Notwithstanding these proofs of "immediate union," (Dr. Macartney's term,) in the soft parts, it is clear that the surfaces of these ragged wounds do not fit closely but in some of their fibres require

*Opus cit. p. 118. Also New York Journal of Med., &c., March, 1847, p. 211.

lymph or other intervening substance and unite more gradually; never so quickly as in a case of immediate union, completed in four or five hours.*

In compound fractures where the fragments of the bone and their surrounding tissues move freely, this inconvenient union or adhesion of misplaced parts is not found, except in old injuries.

These views upon the union of the tissues which surround and cleave to the fractured bone are in accordance with those of standard writers on pathology. I cannot, however, agree with them so far as to admit in respect to the maxillary bone that there is so long a period of delay of the reparative process as they suppose to be usual in compound fractures of human bones. Mr. Paget thinks that the period of inflammation with seeming inaction and recovery, *previous* to the production of reparative material to be from eight to ten days.†

Now, with the fragments of the jaw moving, and their fresh broken surfaces out of sight, no judgment can be formed of the process of repair. But when, as in case 2, the parts were tied together in an hour and a half from the fracture and did not again separate; while in C. B.'s case the fragments united so soon, and in view of the firm union by the 24th day of the fracture of the White Mountain case; I must claim for the jaw an exceptional position and place it, especially when promptly controlled by a splint, in the category of those where union commences very soon, as in animals.

Case 2 gives a brief statement of a fracture in my own jaw, in which after the ligatures had held the fragments for several hours, the parts were then controlled by the thumb and fingers four and a half hours more, when the splint was applied, and worn when the jaw had been held *in all*, twenty hours. The splint was then taken off, but not with difficulty, as it fitted tightly, and after a hole was sunk in each first molar, it was again put on and screwed fast. During all this I felt nothing like movement of the fractured surfaces. Yet the fragments were by the accident, only 21½ hours before, displaced to a very great extent, and the soft parts much lacerated. They, however, were soon placed exactly together, and the splint covered them so, that with the saliva, etc., the fracture was shut in completely from the

*Lectures on Surgical Pathology, by James Paget, F. R. S., D. C. L., Oxon. Third Edition, p. 144. Philadelphia, 1871.

†Opus cit. p. 193.

air; while the splint by means of the teeth held the bone in place at once firmly, much sooner and more firmly than the ensheathing or provisional callus so early formed around the fractures of the lower animals; but which in man is rarely formed except in fractures of the ribs, where movement cannot be entirely prevented; and, as Mr. Paget thinks, perhaps in the long bones of young children.

It is thus shown that when a splint is properly applied to a fractured maxillary bone with the gum and periosteum torn open, this compound fracture is at once placed virtually in the condition of a simple fracture, and that the splint, by means of the teeth, holds the fractured surfaces of the bone precisely and firmly in place against each other. Referring to such rare cases Professor Paget says:

"The union o fracture is commonly affected by the organization of new material connecting the fragment. Sometimes, indeed, immediate union occurs. When portions of the bones are placed and held in exact apposition, they may be united without any new material being formed for their connection; a continuity of tissues being restored, as in the cases of healing by immediate union of soft parts. But this is rare, and has not yet been sufficiently studied."*

Thus, what was rare to Professor Paget, my splint has made easily attainable and frequently accomplished in respect to the upper and lower maxillary bones; the last mentioned being, next to the ribs, the bone most imperatively called into service.

In the prompt setting of my own jaw, and early application of the splint, the first ever used without being supplemented by external appliances, there being consequently nothing to press upon the soft parts, nor impede the nervous and vascular circulation, nor limit the muscular action I found, as I thought, that the bone had within itself and the tissues which cleave to it, reparative power which at once set to work to repair its fracture. In the paper which I read before the New York Academy of Medicine on June 1st, 1864, after fully describing the case, I said:

"After making due allowance for the interlacement of the fragments, would the bone have held together, unless assisted by some reparative process even then going on?"

The experience of sixteen years which have passed since I asked that question, has confirmed me in the opinion that repair in the human jaw bone commences as early as in the soft parts which surround it.

*Opus cit. p. 181.

This conviction has been forced upon me by the results of treatment in fractures of the jaw under the use of interdental splints, which reflection assures me were the simple consequences of efficient assistance by which the *natural processes* of repair were protected from interference.

I believe, also, that could the other bones be held as well, that the healing processes would set in very early.

These remarks are not intended to intimate that I claim to have made any progress through personal observation of healing processes beyond the discovery that they are simultaneous in the bones and in the tissues cleaving to them.

I have otherwise simply learned from able and indefatigable men whose writings have so enlarged our knowledge of physiological processes and pathological conditions. It would hardly be decorous to them or just to myself to leave this unsaid.

PROGNOSIS depends so much upon the treatment that I deferred speaking of it until some remarks upon the latter should in a measure prepare the way for its consideration.

M. Malgaigne's section upon prognosis, in fractures generally, precedes that on treatment, but his remarks clearly justify my arrangement and they are, while concise, so comprehensive and withal so fitted to my purpose that in a later page I quote the opening and closing sentences of the section. To take more would be unjust to the translator. Malgaigne's admirable work published in 1847, was translated into English in 1859, and Professor Paget's "Lectures on Surgical Pathology," from which I also quote, were printed in 1853, and repeated editions have followed. Now, with such great sources of information open to all engaged in Medicine and Surgery, when giving my views in 1866, upon the treatment of Fracture of the jaw by interdental splints fitted accurately to all the teeth of the broken bone, I merely said in respect to their effects.* "These splints hold the fragments so well together that I have seen badly lacerated gums heal up in from two to three days, so perfectly that the fractures were then only simple.

"No bad effects are produced by splints covering the teeth and gum. On the contrary, teeth that are so much loosened by the injury as to be beyond recovery in the usual treatment, are securely held by the splint and become firm again. The gum looks red and soft while

*New York Medical Journal, Vol. III, p. 447.

the splint is worn, but a short period suffices for its complete restoration, even when it has been covered up for months. I generally leave the splint on long enough to feel assured that temporary removal will not endanger the union, which is very delicate for some time. How soon this will be, after the first application of the splint, and how long before the splint can be dispensed with, depend upon the gravity of the injury, and the state and the age of the patient."

These explanations seemed at the time quite sufficient, especially as they were complemented by cases carefully selected to illustrate the use of the several splints and also to show the results which had been observed in the six years since the first splint was called into use through the explosion on a Spanish frigate. These results of treatment were the surest guide to the surgeon in his prognosis on these injuries when treated on the same system, and on his comparison with those treated by other methods.

For twelve years nothing appeared to raise the belief that any well informed practitioner, even if without personal observation of the splints in treatment, would be unable to comprehend and estimate those pathological conditions which they were devised to meet, so far, at least, as to judge intelligently to what extent a patient's condition admitted of relief by surgical art. But in March, 1879, an article was published in the New York Medical Journal, which indicated a disregard of fair consideration of the pathological conditions and of the facts involved, and which in other respects required correction. The publishers, Messrs. D. Appleton & Co., in replying, said:

"We write to-day further, that not being members of the profession, it is impossible for us to form any opinion of the matter in dispute, or to judge of the merits of any article on a medical topic." They, however, promised a correction by the editor, and the following appeared in the May number of the journal.

"Correction.—On page 281, of our March number, statements were inadvertently admitted, which disparaged the treatment of the late William H. Seward, whose injury, it will be remembered, was so severely complicated by the subsequent attempt to assasinate him."

JAMES B. HUNTER, M. D., *Editor.*

At the request of the publishers, this statement was drawn up by me, and upon their pleading disability, I suggested the "Medical Editor," instead of the publishers, should make the correction; in the correction, however, as above, the word "*unjustly*" was omitted

before the word "*disparaged*" as well as the words "*Dr. Gunning's*" after it, and the following sentence of my statement was entirely ignored, viz.: "The report of this case first appeared in Vol. IV, of this journal, and shows conclusively that Dr. Gunning's treatment was eminently successful." Thus Dr. Hunter further misled the readers of the journal by calling attention to the false statements without adequately correcting them.

These statements are now quoted, viz.:

*"The late Wm. H. Seward, when traveling around the world, and when at Tokohoma, Japan, required the services of a dentist. Upon examination it was found that the inferior maxilla was comparatively useless for masticating purposes, there being a false joint at the seat of the original fracture, no union having taken place. This case will be remembered from the world wide notoriety of the circumstances attending the injury, as well as the reports, which have been universally believed that the patient was benefited by the treatment he received for the cure of his fracture."

It is thus intimated that Secretary Seward's jaw was broken only in one place, and that my report, founded on personal observation of the case, and the subsequent statements of the patient, which led to the belief that he was benefited by my treatment, were false.

The report, case 8, was quite circumstantial, and it shows that there were two fractures in the jaw, that I set them and applied the splints, that one united by bony union, and the fibrous union of the other, grew firm enough to do without a splint, and continued to improve so that in March, 1866, Mr. Seward wrote: "Thus at last I begin to regard my cure in that respect complete." The report was first published in the "New York Medical Journal," when edited by Doctors Hammond and Dunster, the predecessors of Dr. Hunter; and it remained uncontradicted until the article was published, entitled "Gun-Shot Wounds of the Mouth;" which contained the slanderous reference to Mr. Seward's case. His case having no relation to the subject of the paper nor to the case put in comparison with it. Dr. Hunter in alleging oversight, gave no reason for the singularly limited wording of his "Correction," nor is it necessary to suggest any at this time, except to admit that it may have arisen in part from inability to comprehend the very serious character of Mr. Seward's case. But as editor for 8 or 9 years, he must be held to know of much that has

*New York Medical Journal, Vol. XXIX, p. 281.

been written by Howship, Stanley, Malgaigne, Paget, and many other observers of pathological conditions and results. It is thus proper to assume that Dr. Hunter's difficulty was in the unparalleled complications which surrounded Mr. Seward's case. As many have been misled by the improper course pursued in respect to his treatment, it is advisable to explain its special difficulties and make them clear.

The report of 1866 is quite full, but the time which has since passed, while showing the necessity of its being supplemented, has also cleared the way for some instructive explanations which could not in the first report be entered into. Now, however, it is proper to make them in order that surgeons and physicians may have the fullest experience of the past to aid in prognosis in future cases, and at the same time show them that the treatment by interdental splints effectually controlled Secretary Seward's fractured jaw.

Without full assurance of the efficiency of these appliances, prognosis in fractures of the maxillæ must continue uncertain, and the most experienced surgeon might find his patient had passed into the care of another whose use of a splint resulted in a successful cure. Or worse still, being misled in respect to the splints, keep his unfortunate patient suffering under the old treatment for months, and then perhaps deformed for life.

M. Malgaigne says:

*"Our prognosis should have reference to several points, viz: the favorable or unfavorable termination of the case; its simple or complicated course; the influence of each complication; the duration of the treatment; and lastly, the result as to the functions of the limb." Then after two pages of important suggestions, he says:

†"On the whole, then, to form a judicious prognosis, the surgeon should take into account the age of the patient, the sex, the state of strength or debility, of health or sickness, the circumstances of the fracture, as regards its seat, its nature, its recent or ancient date, its complications; and lastly, the plan of treatment already pursued, as well as that proposed for the future."

Sir James Paget says: ‡"Doubtless the conditions necessary to the normal nutrition of parts are very many; but the chief of them are these four:

1. A right state and composition of the blood or other nutritive material.

*Op. Cit., p. 140. † Op. Cit., p. 142.

‡Lectures on Surgical Pathology, p. 11.

2. A regular and not far distant supply of such blood.
3. (At least in most cases) a certain influence of the nervous system.
4. A natural state of the part to be maintained."

Sir James Paget in referring to the deprivation of nerve force, says:

*"A man with nearly complete paraplegia, and distorted feet, the consequence of injuries of the spine, in whom some tendons were subcutaneously divided and appeared to be healing; but a bandage being applied rather tightly, sloughing ensued at the instep, on which the chief pressure fell, and extended widely and deeply to the ankle joints."

Again, in asking through what class of nerves is the nutritive process influenced? He says:

†"Indirectly, it is certain that the motor or centrifugal nerves may influence it, for when these are paralyzed the muscles they supply will be inactive, and atrophy will ensue, first in these muscles, then in the bones, (if a limb be the seat of the paralysis,) for the bones in their nutrition observe the example of their muscles; and finally, the want of energy in the circulation, which is in some measure dependent on muscular action, will bring about the atrophy of the other tissues of the part."

Further, in his approximate estimate of the time taken by the several parts of the reparative process in fractures of adult human bones, he says:

‡To the second or third day after the injury, inflammation in and about the parts; thence to the eighth or tenth, seeming inaction, with subsidence of inflammation; thence to about the twentieth, production of the reparative material, and its gradual development to its fibrous or cartilaginous condition; thenceforward its gradual ossification, a part of the process which is, however, most variable in both its time of commencement and its rate of progress, and which is, probably, rarely completed before the ninth or tenth week; although the limb may have long previously recovered its fitness for support or other use. From this time the rate of change is so uncertain, that it is impossible to assign the average time within which the perfection of the repair is, if ever, accomplished."

The Hon. William H. Seward, Secretary of State, met the injury on April 4th, 1865, through jumping from his barouche while the horses were running away. The heel of his boot caught and threw him over so that his right arm struck the ground and his face was bruised. He was insensible from concussion for a short time, and on

*Op. Cit., p. 34. †Ibid, p. 35. ‡Op. Cit., p. 193.

examination, his right arm was said to be broken. The lower jaw was also found to be fractured on the right side, as the edges hurt his tongue. The attempts to hold the fragments of the jaw in place, failed entirely; and on the tenth day I was called to the case.

The patient, 65 years old, had been without teeth in the upper jaw for several years and the alveolar process, which is only an appendage of the teeth, had with much of the gum been absorbed, so that the roof of the mouth was flat and very far from the lower front teeth. Yet attempts had been made repeatedly to hold the fragments of the jaw together by drawing the teeth up to the roof of the mouth by means of bandages around the chin, face and head; on the principle practiced by Hippocrates and Soranus of making the upper teeth a splint for the broken lower jaw, except that this patient had no upper teeth for the lower ones to rest against, consequently, the fragments of the bone and the adjoining soft parts were so distorted as to cause great pain. In the language of the patient: "Coals of fire could not have hurt me more, and when I could bear it no longer I would tear the bandages off."

Yet the patient had an upper set of artificial teeth, which could have been placed in the mouth so that the lower teeth would have had a resting place when the bandage was around the jaw and head. This would have held the parts less displaced than without the plate; and if the four front teeth had been removed from the plate, the space left between it and the edges of the lower teeth would have sufficed to allow food, etc., to enter the mouth. Had any difficulty prevented the surgeons from doing this, Dr. H. N. Wadsworth,* dentist of Washington, was but a few minutes distant, and as he was the first to use gutta-percha on fractures of the jaws; having applied it on the teeth in 1847, and outside the mouth around the lower jaw in 1850, he could have arranged matters temporarily, at least, so that the patient would have suffered much less, the parts have been less injured, and the patient's life less jeopardized.

Ligatures had also been used on the teeth to hold the fragments together, but I saw but one, this was when I examined the jaw on April 16th, it was of wire which had passed around the two right bicuspid teeth, but the movement of the jaw had fortunately released one tooth and the wire hung on the other. Had the wire been fastened around each tooth singly and firmly and then have been twisted so as to hold the two bicuspids close together, one must have

*American Journal of Dental Science, new series, Vol. I, p. 171.

been pulled out, for the jaw was broken between them, and in swallowing even the saliva, the back fragment went up and the front of the jaw went down. Had the wire been passed around the wisdom tooth as well as the second bicuspid and also fastened to three or four teeth in front of the fracture it would have held the bone together on that side for several days, but such control is only temporary. This, however, in a young and vigorous patient, might allow the gum to form adhesions and limit the movement of the parts while more efficient support was prepared.

The wire ligature, however, as used in Mr. Seward's case, was not only useless but dangerous, and probably led to the loss of the second bicuspid tooth. Now, there were a dozen dentists in Washington who could have applied the ligature safely as a temporary support.

These mistakes were made four years after my splint had cured the jaw of the Spanish seaman in the Naval Hospital at New York, and his case was well known for the Spanish Government was very complimentary in regard to it. Further, it was more than two years after, my treatment was brought before the " New York Academy of Medicine," and the " Medical Society of the State of New York," and published in their journals. The splints had also been applied by me in the Civil and the Military Hospitals in many difficult cases. In addition to this, the splint had been used for nearly a year in the Confederate Army Hospitals, with astonishing success.*

It received marked attention from their surgeons, and Surgeon-General Samuel Preston Moore,† with his usual judgment, ordered Dr. Bean to Richmond, in order that the splint might be laid before the Army Medical Board.

It was under these circumstances that Dr. Whelan, Chief of Bureau of Medicine and Surgery for the Navy, after assisting and advising in Secretary Seward's treatment, felt it necessary to insist that I should be called to Washington. The fracture was then into that period when according to Paget and other observers, the reparative process should be at work to unite the fragments of the bone, whereas they were still moving about, even the soft parts having no opportunity to form adhesions.

When I saw Mr. Seward on the twelfth day of the injury, his condition was gravely complicated by the terrible events which had

*E. N. Covey, Richmond Medical Journal, Vol. I, No. 2, February, 1866.

†American Journal of Dental Science, 3d Series, Vol. I, p. 187.

passed since I was sent for. The patient had been free from bandages on his jaw for several days, but he was suffering from the loss of blood through the cuts in his neck and face on the night of the 14th, and also from the pain of these recent wounds. I found upon examination that his chin, the front of the jaw, was moving on the compound fractures on each side between the bicuspid teeth. The right fracture, the one discovered by the patient, being so loose, that it allowed the back fragment to rise high above the front one; thus the end of the back one was much exposed, while the separation between the fragments of the left side was so great that it was hardly possible that the blood vessels in the dental canal were not cut off like those on the right side; and the bone also exposed to the air. This, together with the general condition of the patient, left room for fears of necrosis; but as the patient thought he could not bear his artificial teeth in his mouth, I could not set the bone in place without annoyance to him, so he was left to rest until the next day; as shown in case 8.

Enough has already been shown to prove the need of other assistance, in the light of those views before quoted from Malgaigne and Paget; but to afford every possible help to the student to become an adept in prognosis so far as this is attainable without investigation into the views of these authors in their own works, I present some additional remarks upon the graver complications of Secretary Seward's case.

The report, case 8,* made in 1866, shows, without the amplification now given, that Secretary Seward suffered from two compound fractures of the lower jaw which were uncontrollable by the surgeons in Washington, that his right arm was useless (being under treatment for a fracture near the shoulder) and further that on the tenth day, after I had been sent for, but before I reached him, he was subjected to several cuts on the face, jaw and neck, one of which left the right fragments of the jaw unconnected except by the soft parts under the tongue and that he lost much blood. I found him on the twenty-fourth day also suffering from paralysis in the head, face and lip on the right side, and with the fragments of the jaw still left to move about. The duct of the right parotid was severed and the saliva

*See N. Y. Med. Jour., Vol. iv; Dental Cosmos, Vol. viii, p. 529; American Jour. Dental Science, 3d series, Vol. 2; British Jour. Dental Science, 1866; and Heath's Injuries and Diseases of the Jaws.

flowed through the right fracture. He was sixty-five years old, and was mentally overworked especially during the war. At the time of the accident (April, 1865) the state of the country was critical, and the transfer of the executive power, through the death of President Lincoln, to Andrew Johnson, greatly increased his responsibility as Secretary of State and this while his son, the assistant Secretary lay in imminent danger through the wounds inflicted upon him. Mrs. Seward was seriously ill at the time I removed the Secretary's first splint, and when I took off the second he had buried his wife. In view of what I have already quoted from Malgaigne and Paget, it would be superfluous to explain further, for the mere tyro in surgery may see that going into Mr. Seward's case, as I did, it would not be fair to charge even an unfortunate result to the insufficiency of my treatment, for everything was unfavorable. The fact is, however, that my splints held the fragments of the jaw perfectly. That the jaw united in both fractures although the right did not ossify, but the jaw was used from the time the first splint was removed, and continued to improve so that in a letter to me dated March 29, 1866, Secretary Seward, after speaking of the removal of the loose tooth, said "Since I had the pleasure of seeing you in New York, the soreness of the part has diminished and the whole jaw moves quite well and firmly. Thus at last I begin to regard my cure in that respect complete."

In April, 1867, Baron Gerolt, the minister of Prussia, in writing to me in reference to my pamphlet and the electrotypes explaining my treatment of fractures of the jaw which he had forwarded to his Government; and also to medical authorities in Berlin, closed his letter as follows; "Mr. Seward's lower jaw seems to work admirably well for all purposes."

Mr. Seward's case was never used by me except in connection with others to illustrate my treatment with *Interdental Splints* consequently all these cases may be found with his by any one who wishes to consult them in reference to the splints, of which the illustrations and explanations are now submitted to the readers of the Independent Practitioner.

INTERDENTAL SPLINTS.

In the year 1840, when treating the first fractured lower jaw placed in my care, I found treatment by bandages unreliable. For, while the muscles tend to displace the bone, bandages frequently increase the

difficulty; especially when swelling sets in through their pressure. They also, by interfering with the circulation, tend to prevent union. Teeth, loosened by the injury, are left unsupported, and the motions of the jaw, cheeks and lips painfully restricted.

Of the contrivances invented to supplement bandages, many were even more objectionable, and little improvement has been made in general treatment up to the present time. Having successfully used interdental splints, in many cases which had proved unmanageable under the usual treatment, I am convinced that they are superior to all other appliances.

When a well adapted splint is on the teeth and gum, the other parts around the bone are, to a great extent, a counter support to the splint. Thus the broken jaw, together with any teeth loosened by the injury, is held securely in place, until the fractured bone is re-united and the teeth become firm. Meanwhile the motions of the jaw are in most cases unrestricted and the cheeks and lips always left free.

On February 12th, 1861, I applied a "hard vulcanized rubber splint" to the fractured jaw of a seaman in the United States Naval Hospital, and from the vulcanite splints used by me since that time, I selected three which show all that is essential to hold any fractured lower jaw in place.

The fourth, a metal splint, is sufficient for the treatment of most cases, and can be applied by surgeons and country practitioners, who can also treat most cases of fracture with rubber splints, if assisted by the neighboring dentist.*

The radical and distinctive feature of these splints is, that, when suitable teeth are in the mouth, nothing is required on the outside, and the patient may move about. In the use of these splints fractures of the lower jaw are divided into two distinct classes; first, those in which the teeth and gum of the fractured jaw are alone used to control the fractured bone, and the jaw is allowed to move naturally; second, those in which the splint is fitted to both the upper and lower teeth, the jaw being held still; but no bandage is used around the head.

To apply these splints the fractured jaw should, if possible, be set and held by ligatures around the teeth while an impression of the

*The splints were described in a paper read before the New York Academy of Medicine, June 1st, 1864.

teeth and gum is taken in pure warm wax confined in a cup like No. 4 splint; the plaster cast from the impression will then be precisely what is required to mould the splint. If the bone cannot be held in place an impression may be taken of the teeth in the best attainable position, the plaster cast then separated where necessary and the parts set in place; a cast of the upper teeth will guide in putting these parts of the lower cast in place.

Fig. 1 represents the inner surface of a splint which incloses all the teeth and part of the gum of the lower jaw, and merely rests against the upper teeth when the jaws are closed. This splint is adapted to the treatment of all cases which have teeth in both fragments.

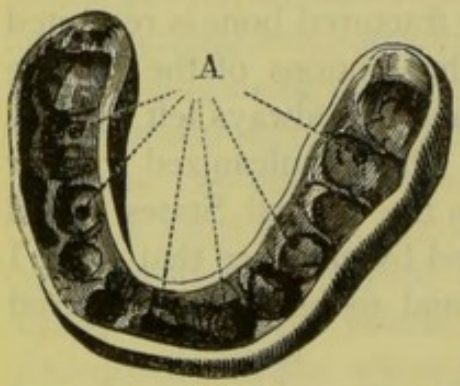


FIG. 1.

The holes marked A go through the top of the splint for the purpose of syringing the parts within with warm water during treatment. The dark round spots in all the cuts represent holes for similar purposes.

The angles of the jaw tend outward, when the jaw is fractured through the body. It is therefore necessary that the splint should go down and extend back as far on the outside as the muscles admit, especially on the short fragment, if there is much difference between them. The parts near the external oblique line are so formed that the splint can be fitted to them perfectly. The outer ends of the splint can be fitted to them perfectly. The outer ends of the splint should be quite thick, so that they may be well rounded.

I have generally used this splint without any fastenings, but in children or even adults it is sometimes advisable to secure it by packthread or wire, or by screws passing into or between the teeth, or by the wings and band of Fig. 4.

When screws are used to hold any rubber splint fast on the teeth, metal nuts must be imbedded in the splint, for the screws to work in.

Small openings should be made opposite particular teeth, to observe how the jaw stands in the splint. This is important in all splints.

Fig. 2 Shows a splint for cases in which it is found impracticable to hold the fragments together, except by keeping the fractured bone still; this splint, in addition to fitting the teeth and gum of the lower jaw, must also inclose the upper teeth, as shown in the cut, where screws may be seen opposite both lower and upper teeth.

By this arrangement the fragments of the lower jaw are secured not only relatively to each other, but also to the upper jaw.

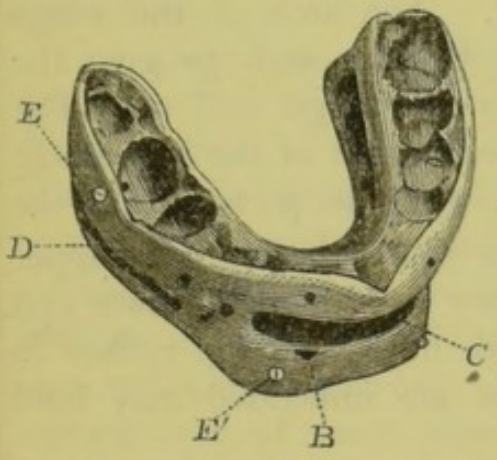


FIG. 2.

B, triangular opening, of which one side corresponds to the cutting edge of the lateral incisor, which tooth stood in the end of the fragment most displaced before the splint was applied. C, opening for food, speech, &c. D, channel for the saliva from parotid gland to enter the mouth, its fellow being seen on the other side of the splint. E, screw opposite lower canine tooth, head of the left screw being just discernible. E, head of screw opposite upper first molar tooth, end of its fellow being seen on the other side.

This splint is therefore adapted to the treatment of *all fractures back of the teeth*, whether in the body, the rami, or their terminations. In these cases the splint may be cut away in front, and extended across roof of the mouth, when there are upper and lower back teeth to fasten to, and thus give as much room as possible to speak and eat through. Opening the teeth a quarter or three-eighths of an inch would not have any bad effect on the position of the fragments, even if the jaw were broken through the necks of both condyles, as the parts near the fractures would move but little and the back of the jaw could be raised high enough to keep the broken surfaces in contact. Even if the neck of one side only were broken, the lower part could be kept firmly up against the fragment above.

When the jaw is held fast to the upper teeth, especially when wings project through the lips, passages should be cut through the sides of the splint, where the absence of teeth or separation of the jaws gives a chance for the saliva from the parotid glands to enter the mouth, otherwise it may overflow at the lips.

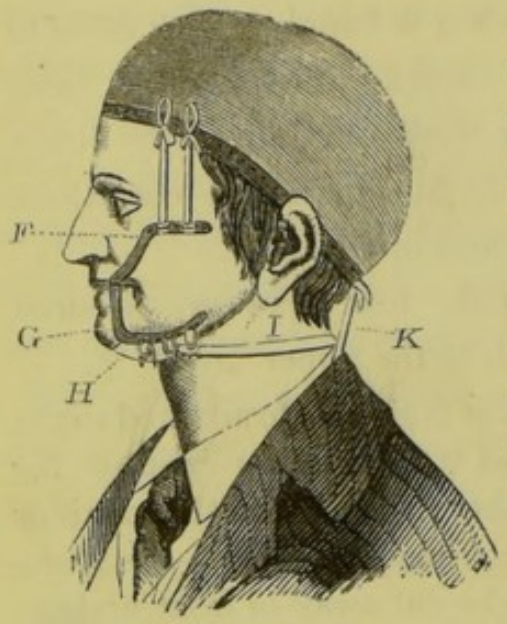


FIG. 3.

F, upper wing. G, lower wing. H, mental band to hold the jaw up in the splint. I, neck strap to keep the band back. K, balance strap to hold the cap in place.

Fig. 3 shows the wings for cases having no teeth in either jaw—the ends of the wings within the mouth being imbedded in a vulcanite splint similar in principle to that of Fig. 2.

Wings made of steel or of iron may be quite light. They should have small holes every half inch to hold the strings, lacing, etc. The arch of the wings should be high enough to give the lower lip room to go well up. The wings for each side of the jaw are in one piece, and the parts within the mouth pass back in the line of the upper gum. They are thinned down and pierced with holes, that the rubber in which they are imbedded may hold them firmly.

The tape strings pass from the cap inside and under the upper wings, then up between them and the tape lacings which keep the strings from slipping to the cap whence they started. The mental band (which is only one thickness of linen,) passes up between the sides of the lower jaw and the wings where it is tied by the strings, which pass through the holes. The band is cut off to show this; but when worn it should be turned down on the outside and pinned just below the wings. The neck strap should be sewed to the mental band on one side and pinned on the other, and worn tight enough to keep the band from slipping forward over the chin.

The jaw and splint are supported by the cap forward of its centre. This is counterbalanced by the elastic strap which passes from the back of the cap down around an unelastic and much heavier strap, extending across and fastened to the shoulders by elastic ends. The balance strap returns to the cap and is buckled tight enough to hold the jaw up. At night it may be slackened to do this, with the neck flexed. It slides on the shoulder strap as the head incline to either side.

By this arrangement the splint is a resting place for the broken, jaw, while the wings give firm attachment to appliances which hold the jaw up with the least possible pressure upon the external parts, as the wings need not press either against the jaw or the zygomas.

Fig. 4 represents a splint devised in 1863, for the use of practitioners out of the reach of a dentist, and for hospital use. This splint is made of cast tin, and is applied with a lining of gutta-percha. It is in the shape of an impression cup, and seven sizes are kept ready for use from which one can be selected for the broken jaw. The wings are of malleable iron, tinned to prevent rusting and for more readily soldering. Three sizes are sufficient to select from.

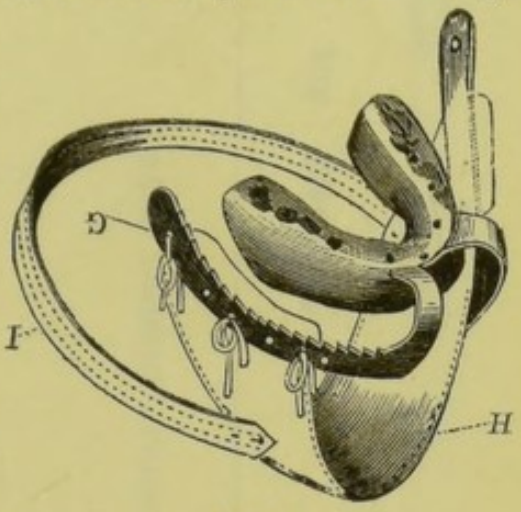


FIG. 4.

G, wing of malleable iron, projecting, with its fellow, from the splint to which they are soldered. H, mental or splint band, with the end left up to show the manner of tying it. I, neck strap. The mental band is made of linen or any thin material.

The splint has a handle in front, that it may be used as a cup to take the impression of the jaw—the holes being useful to allow a small probe to be pressed through the wax down to the teeth, thus allowing air to enter to facilitate the removal of the impression, and when in use as a splint giving entrance to warm water, thrown from a syringe, to keep the parts clean.

The splint should be made to fit well by bending, cutting off the edges and rounding them up smooth. When a tooth projects so as to keep the splint from fitting, a hole may be cut to let the tooth through, if the metal cannot be hammered out. This should all be done before taking the impression, as a well fitted cup assists greatly in this important matter.

After the *cast* is obtained, the handle in front should be cut off, and the wings, *if needed*, soldered on, care being taken that their edges are clear of the corners of the mouth, when *open*. Warm gutta-percha should then be placed in the splint, pressed down on the cast, and, after cooling in water, dig out the softened plaster.

This splint has the advantage of being easier of application, and can be applied in much shorter time than a rubber splint, especially if the fractured bone can be set and held by ligatures firmly enough to bear the pressure of the warm gutta-percha, for the splint can then be at once applied to the teeth and the gutta-percha closing around them, the bone will keep in place without other fastenings.

When the fragments of the jaw cannot be held firmly enough to bear the pressure of warm gutta-percha without displacement, plaster of Paris would hold the jaw securely in the splint for a long time. In these methods the ligatures are left on.