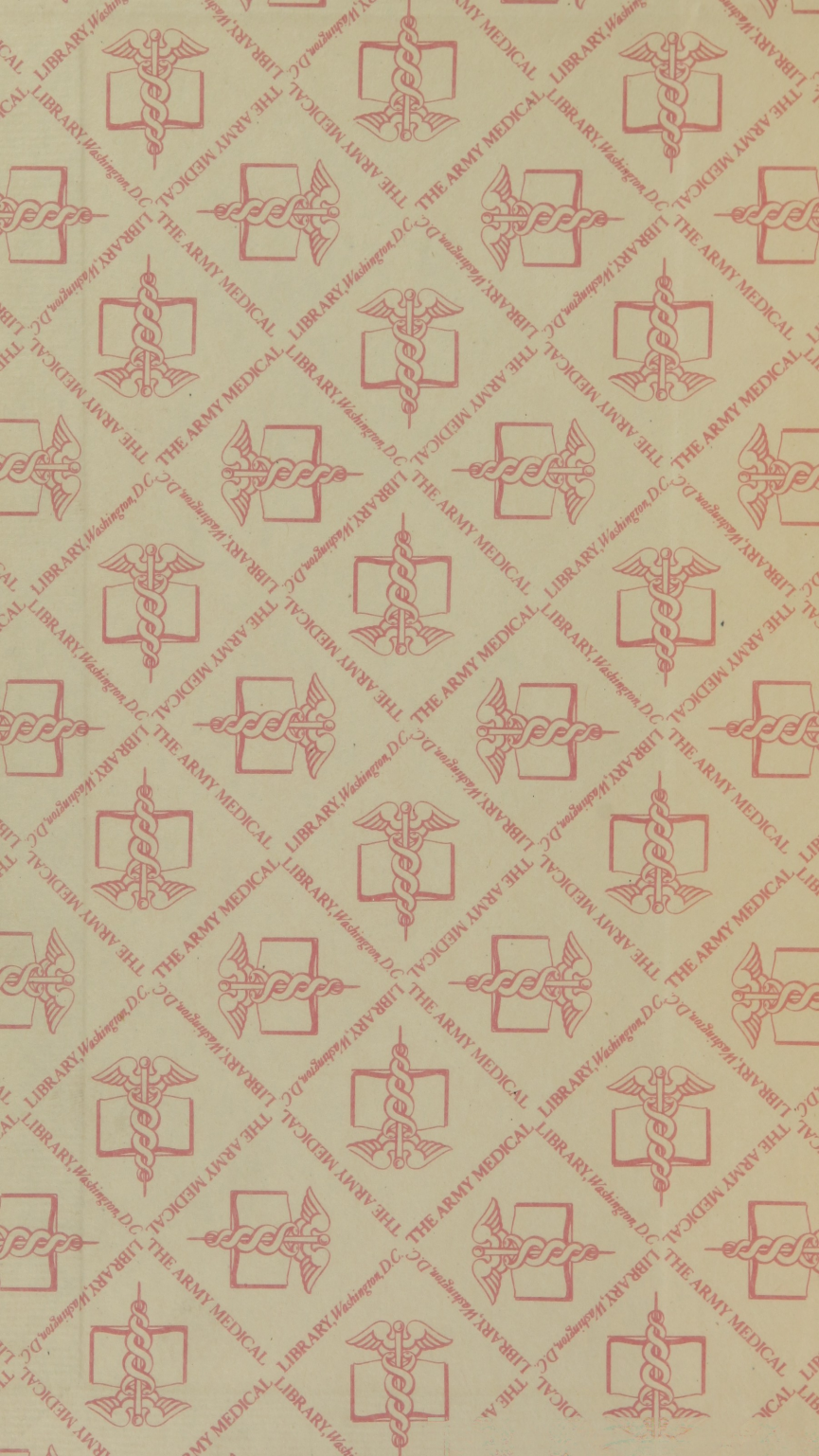
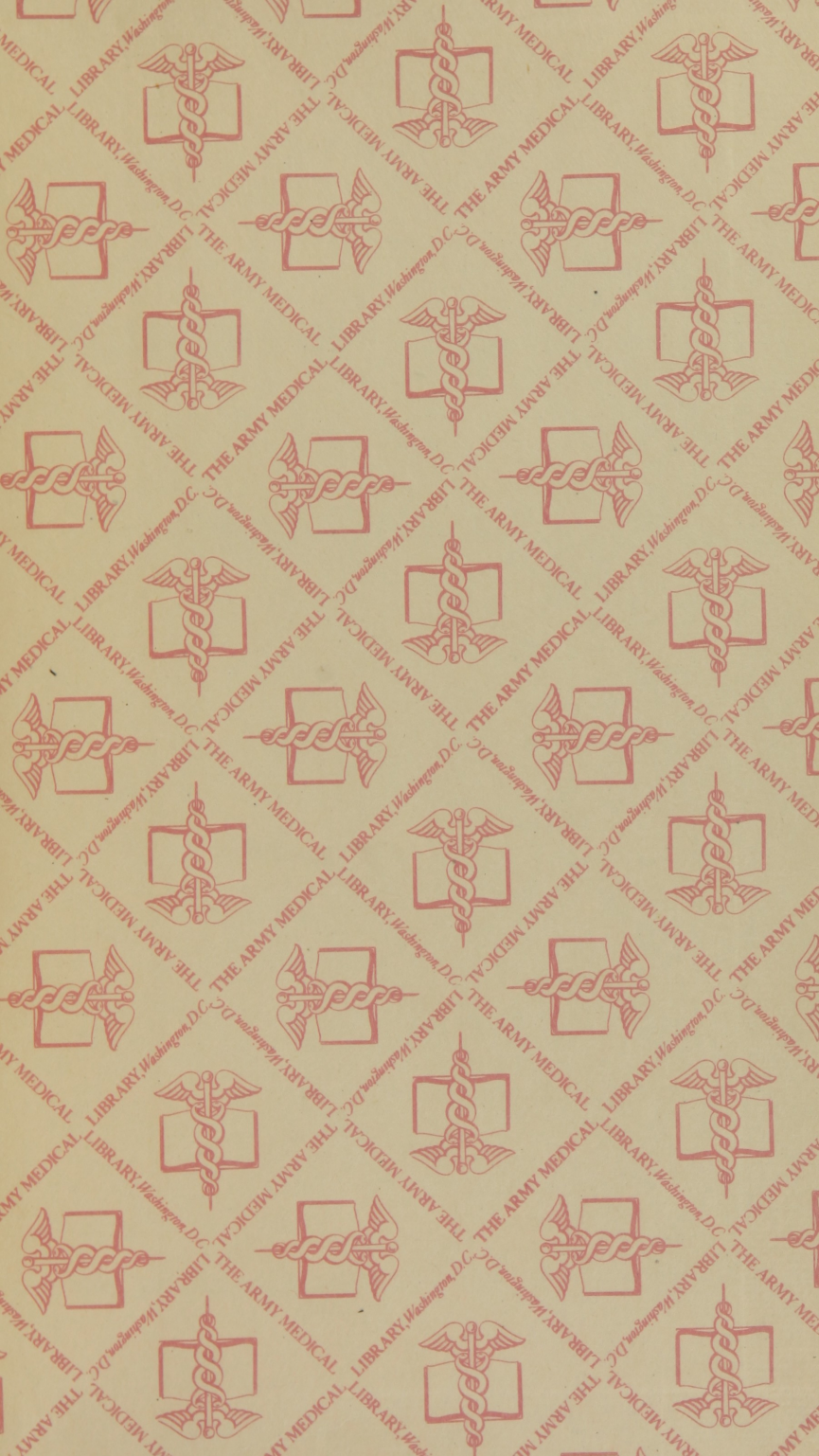


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TREATMENT

OF

FRACTURE OF THE LOWER JAW

BY

INTERDENTAL SPLINTS.

BY

THOMAS BRIAN GUNNING,

NEW YORK.

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TREATMENT OF FRACTURE
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nts were described in a paper read before the New York Academy of Medicine,
June 1st, 1864.)

In the year 1840, when treating the first fractured lower jaw placed in my care, I found treatment by bandages, etc., 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 reunited and the teeth become firm. Meanwhile the motions of the jaw are in most cases unrestricted and the cheeks and lips always left free.

The best time to commence fitting a splint is immediately after the injury, if the condition of the patient will allow. If the fracture is old and has been treated by bandages, and there is much displacement of the fragments, with swelling of surrounding parts, it may be advisable to leave it *free* for several days.

When the fracture is not quite recent, pain and stiffness may prevent the patient from opening the mouth sufficiently to apply a splint, in which case the operator should force the jaw steadily downward with his fingers, assisted by wedges of wood, etc. This may be very painful to the patient at the time, but the movement of the parts, will be followed by great amelioration of the pain and stiffness. Hooks, forks and strings, applied to the teeth, will manage the fragments with less suffering to the patient than handling the inflamed muscles. The fragments of the jaw should be set and held by wire, pack-thread or silk, passed around the teeth. If the teeth are so formed that the ligature slips off, it may be carried through the gum with a needle. When a fragment of the jaw falls below the one next to it, a ligature of wire should be fastened around the neck of the lower tooth, two eyes being made by twisting the wire, before applying it. Another wire should be fastened around the neck of the elevated tooth, and both ends brought up on the side furthest from the fracture, over the crown, down through the eyes before mentioned, and then tightened until the bone is in place. Or the wire may be fastened to a tooth further back, and then pass over the crown, etc. On this principle, ligatures may be applied to the teeth laterally to bring the fragments into line. A jack-screw, furnished with points, forks and collars, is frequently necessary to extend the fragments, but in some cases it can be done by a piece of wood. The jack-screw should be made to turn by its centre, and the points, forks, etc., fitted into sockets, that they may be left still when the screw is turned. This instrument may be used across the mouth to keep out any back fragment that falls in, or more in front to extend oblique fractures. In fractures behind the canine when the back fragment comes forward over the front—being allowed to do so by the absence of teeth and the direction of the fracture—the jack-screw, with a point in

the front fragment and a fork in the back one, will be found very useful in making extension. One fitted with hooks, to draw in the jaw by inserting both hooks near the external oblique lines, or in any required positions, will be found indispensable in some cases. A piece of hard wood forced in between those teeth which fall toward each other, and to which it must be fastened with fine iron wire, will frequently give the needed extension. When the jaw is broken between the canines, with the fragments smooth and the parts around allowing them to go in any direction, there is frequently a front tooth absent, through the fracture, or by shedding, etc. In this case a piece of moderately hard wood may be fitted in the vacancy. It should be so wide that the adjoining teeth will press into its sides, when they are wired tightly. If this is well done the bone will be firmly set. Should the teeth in question need support, they may be wired to those adjacent.

An impression of the parts should be taken in pure yellow wax, warmed by *dry* heat. But in comminuted fractures there may be portions of the jaw and teeth for which plaster of Paris would be better, but it must be applied in sections. The wax should be applied in a mouth-cup adapted to the jaw. No. 4 splint is precisely what is required for this purpose. (Some useful hints may be found under that head.) If fracture should occur in a jaw without teeth, plaster would be much the best. It should then be applied in a cup to all parts of the jaw at one time. If possible (and it is rarely otherwise), an impression of all the teeth and gum, *properly set*, should be taken at one time. The wax in coming off will then draw or enlarge in the right places, and the plaster-cast from it will be precisely what is required to mould the splint, excepting the addition caused by the ligatures.

If the bone cannot be held in place, an impression of each fragment should be taken separately, and the casts from these impressions united by plaster in their proper relative positions. A cast of the upper teeth will sometimes guide in doing this. The united cast must be enlarged under those parts of the teeth which overhang. But when the pieces of the jaw can be held *nearly* in place, an impression of all may be taken at

one time, the cast separated where necessary, and then adjusted as above.

By adopting this method, when there is little displacement, the jaw may be left unset until the splint is applied. When adjusting the cast, care must be taken that it is not made too small for the jaw and teeth as a whole, or for any tooth individually. There is little chance of getting it too large, as far as the teeth are concerned.

On February 12, 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 have 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. But a severe fracture may occasionally be met with, which will require either a specialist or an accomplished dental surgeon.

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 on both sides of the fracture, except those with *obstinate* vertical displacement.

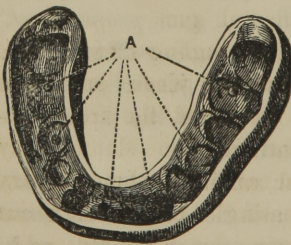


Fig. 1.

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

should be quite thick, so that they may be well rounded.

When the gum on the inside is so overhung by the back

teeth as to afford but little bearing for the splint, the latter may be cut off, generally at or just below the edge of the gum, for there is rarely any tendency of the jaw to fall in at its lower border. The splint should not extend into the muscles unnecessarily in any part.

When the jaw is fractured in or near the front, the digastric and other muscles, inserted on the inside near the symphysis, draw the bone backward and downward. This splint neutralizes the first by holding the sides of the jaw *in*, which prevents the arch in front from falling back.

The tendency of the jaw to widen at the angles and to fall in at its upper border, so that the points of the canines approach each other, is also counteracted. The splint goes down about half way (on the outside) from the points of the teeth to the lower border of the jaw, and all the surfaces of the teeth and the outside of the gum are held by it, while the condyles and their interarticular cartilages are so far above the lower edge of the splint that their leverage prevents the sides of the jaw from being turned outward by the muscles inserted near the symphysis.

This must be effectual so long as the splint is down in its place; and even when the fracture is back of the canine, and the four pairs of muscles are acting upon the front of the jaw, there is little chance that they will draw it down out of the splint, as they act in sympathy with the elevator and other muscles attached to the bone, when the *splint is on and the jaw allowed to open and shut*.

There is also, in recent fractures, a roughness of surface, which prevents the fragments from moving when held close together. But if the fracture is so old that the fragments slide past each other, especially if the back one slants away and affords no support to the forward one, it *may* be necessary to hold the latter up by a screw passing through the splint into the canine or some other tooth, near the depressed end of the bone. That horizontal displacement which frequently follows fractures near the canine and lateral incisor teeth, in which the front of the jaw is drawn back by the muscles inserted near the symphysis, leaving the end of the short fragment in determined projection, and in which the treatment by

bandage and ligature is not only useless but pernicious, is effectually overcome by this splint, without screws. A large proportion of all fractures may be successfully treated in this way. When a *very* loose root or tooth is present, it may be advisable to remove it before application of the splint. Rarely so before the impression is taken, as they are frequently of use in holding the jaw.

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

Fig. 2. *In cases with obstinate vertical displacement*, the 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.

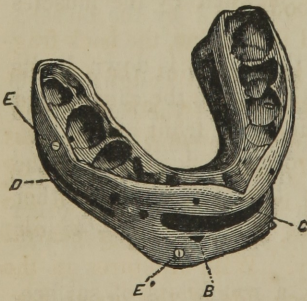


Fig. 2.

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, etc. 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 ramuses, or their terminations. In these cases the splint may be cut away in front, and extended across the 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. In frac-

ture of the ramuses no difficulty would arise from this course. If a coronoid process were broken, this plan would give as good a chance for union as any. In fracture of the angle, this process would be likely to hold the parts in contact. If it did not, a wing could extend out from the splint and pass back from the corner of the mouth to hold a pad, etc., against the part requiring support; it could rest on the zygoma, or the mastoid process, if necessary.

In cases where enough of the front teeth are lost to afford room for food to enter, the jaws need not be opened more than will just give room for the rubber to pass through to hold the parts of the splint outside the teeth to the parts inside. A separation of a line would be sufficient, or *even less*, if any back teeth were absent to give room for pillars of the rubber to hold the upper splint to the lower.

As a rule, the splint should be fastened on both sides, above and below. Fractures back of the teeth are frequently less troublesome, so far as application of the splint is concerned, than those which are broken in the body.

When the body is fractured behind the canine, the back fragment requires no support to keep it in the splint, the muscles doing that effectually. But that portion of the jaw which includes the symphysis, whether separated on one or both sides from the parts behind, must be *firmly held* up in the splint by one or two screws, according as it is fractured. When the fracture is between the lower canines, one firm upper central incisor will hold the splint up firmly. With fractures in the *back* of the lower jaw, a tooth on each side of the upper jaw, back of the canines, would be sufficient for any case. Teeth which have lost much of their supporting alveolar will *bear great strain* in the *direction of their sockets*, but the firmest teeth will suffer from slight lateral pressure; consequently ligatures are of little use, except temporarily. The thread must be removed from the screws on the ends which enter the teeth. The holes drilled to receive them should be from half a line to a line in depth, according to the size of the tooth. This will not injure the teeth, but they should be filled, however, after the jaw has united.

This splint can be made very thin, a shelly covering being

all that is necessary in many parts. Openings should be cut in the sides 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. Small openings should be made opposite particular teeth, to observe how the jaw stands in the splint. This is important in all splints.

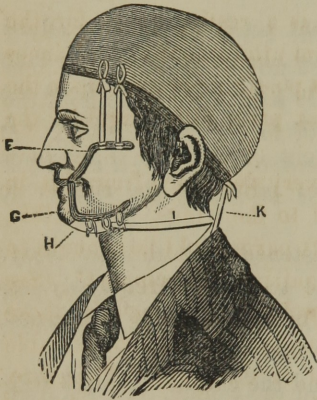


Fig. 3.

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.

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 (see figure), which keep the strings from slipping to the cap whence they started. The mental band passes up between the sides of the lower jaw and the wings where it is tied by the strings, which pass through the holes. (See figure.) 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

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 may be quite light. They should have fine teeth along the edges where the band and tapes bear to prevent slipping, and 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

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 inclines 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.

Should the band fail to keep a very depressed fragment in place, a metal loop may be fastened to the wings. From this, a metal point going through the soft parts could be brought to bear on any portion of the bone requiring firm support. (See Malgaigne.) But no external appliances, especially those which rest upon the muscles, can give the firm and comfortable support afforded by splints fastened to the teeth. Therefore, with suitable teeth in either jaw, the cap, or the mental band and corresponding wings, should be dispensed with.

When getting the articulation, or relative position of the jaws and teeth, 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, etc. (suffering from laceration, contusion or severe swelling), and *thereby prevented from going into proper articulation with the upper jaw*, while the surgeon supposes that the ramus, or neck of the condyle, etc., is broken.

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.

These injuries are frequently aggravated by bandages, and the displacements increased and caused by them in the broken jaw, and also in its relation to the upper, are sometimes irremediable by any subsequent efforts, even in cases which correct treatment in the outset would have cured perfectly.

In consideration of these facts, it is important to discriminate between displacements which can be reduced by art and those which should be left to nature.

The fragments of the lower jaw having been set in their proper places relatively to each other, the whole must be put in normal relation to the upper jaw, *as near as the condition of the muscles and ligaments admit.*

If the jaw is allowed to move during treatment, it will generally go into place before the bone is firmly united. When held still, it may not do so until some time after.

(Remarks upon displacement are given only so far as they are directly necessary to a proper application of the splints, and to an appreciation of their efficacy—the object of this paper. Correct diagnosis, however, is the foundation of proper treatment, and will be dwelt upon hereafter.)

Fig. 1 is the representative splint for the treatment of cases in the first class, or those in which the jaw is left free. Fig. 2 for the second class, or those in which the jaw is held still.

The articulation in each class is obtained by a method differing from the other. Consideration of these methods has been postponed until now, that they may be more easily understood. The reason for getting the articulation in different ways will be seen distinctly by recollecting that the fractures in the first class can be so *well* held together that the gutta-percha and wax have a firm resting place to carry them against the upper teeth. In the second class, however, it is frequently difficult, and occasionally impossible, to set the fragments in place, although it is desirable that *the splint* should hold them precisely so as regards each other, and, as a whole, in the best possible position relatively to the upper jaw. Now, the upper jaw, being uninjured, affords a proper basis for the gutta-percha and wax. The lower jaw can, therefore, be pressed *carefully* up in place, and any fragment *specially* directed into the best attainable position in the wax. The wax, with its support of

gutta-percha, may then be put upon the cast of the upper jaw, and the adjusted cast of the lower jaw placed in it precisely where required, as there is now a second opportunity to overcome any imperfection in the bite made by the teeth in the displaced fragments.

In the first class, a piece of dentist's gutta-percha should be warmed by *water*, and moulded to the plaster-cast of the lower teeth, etc. Upon this sufficient wax should be placed to give a bearing for the upper teeth and the proper thickness to the splint. When cold it must be placed on the *lower teeth*, and the jaws closed until the upper teeth press properly into the wax, then replaced upon the cast and trimmed into the shape required for the splint. The indentations made by the upper teeth should be cut down, so that only their points may touch the splint. The whole should then be set in a vulcanizing flask, to form the mould for the rubber splint.

But in the second class, as indicated before, the gutta-percha, etc., should be placed upon the *upper teeth* or *gum*, and the lower teeth or gum brought up in place. A case, however, is sometimes seen in which the articulation must be obtained in a radically different way.

When the upper teeth are so marked by the lower ones as to indicate the relative position of the fragments clearly, they do this for the jaws also; and by placing the adjusted cast against the upper cast, and setting them in an articulator, the normal relative position of the jaws, whether open or shut, may be obtained more accurately than from the mouth, *in some fractures*. A model of the splint can therefore be made of gutta-percha. When quite cold from immersion in ice water, it should be put upon the upper jaw, and the fragments of the lower pressed up into it, to test the accuracy of the adjustments. This model might be used to form the mould for the splint without the original cast, if it were found that either were incorrect, for the gutta-percha could be made to fit by a little heat and pressure. As a rule, it should only be used to set the casts.

This plan is less painful to the patient in extreme cases, as it avoids the setting of the fragments and taking the bite. But it requires considerable care, as allowance must be made for

any altered condition of the fractured surfaces, and also for any inability of the fractured jaw to go into proper articulation with the upper.

The gutta-percha or wax, when taken from the mouth, should be placed between the cast representing the lower or broken jaw and that of the upper jaw, then cut into shape, the female screws, or the wings, imbedded, and the whole set in a suitable flask.

The nuts for the screws should be about an eighth of an inch square, and a little less than a line thick, thus giving sufficient length to the female screws in the centre. The nuts should be beveled down, inside and out, on three sides, but the fourth only down to the middle one of three gold strips, of which the nuts are formed. This strip, being left long, should be turned over a short distance from the nut and its edges notched—it will then act as a standard to hold the nut in place in the mould. Each nut must also have a piece of tough wood screwed into it. To set them in position, bore a hole in the plaster tooth exactly where the screws are to enter the natural teeth. Place one end of the wood into the hole with the *nut* against the plaster tooth, and bring the wax up close around it. In this way the other end of the wood will stand out and be imbedded with the gold strip in the plaster forming the mould, and the nuts held firmly while the rubber is packed.

Dental works give full directions for the vulcanization of rubber, and also as to many things necessary to a successful application of these splints.

Before applying the splints, all the projections caused by air holes, or other imperfections in the plaster-cast, must be cut away, especially in the parts covering the teeth. The rubber may also be beveled off where it fits close on the festooned edges of the gum. This will give more room for the teeth to enter in applying the splint, and leave the gum unpressed while the splint is worn. The latter should be well oiled inside before application.

A piece of packthread or silk, about a foot long, placed around the neck of one or more teeth, is frequently useful to draw a fragment into the position suitable for entering the splint. It should be tied at the ends, but not around the teeth,

so that it may be easily cut and drawn away before the splint is on tight. Although the fragments of the bone may not have gone completely into place before taking the impression, little anxiety need be felt as to their going up into the splint if the latter has been properly adjusted, as the muscular displacement frequently yields to the more normal condition produced by the splint, even when it is only partially in place.

If the jaw should not go well up in the splint, it may be worn loose for a day or two, to allow the muscles to relax. This, however, is rarely necessary.

A tube, just large enough to slide into the female screws, should be inserted, to protect them while the teeth are being drilled to receive the ends of the screws. The tube must be made of thin plate, and should be set at a right angle in the end of a thick piece of plate, that the latter may serve as a handle to keep the tube from turning with the drill.

Rubber splints are neat and comfortable. They can be kept free from food and all unpleasant odors, if frequently cleaned externally with a tooth-brush, and on the inside by means of a small sponge on the end of a crooked probe. They should also be frequently syringed with warm water, etc.

Fig. 4. This splint is made of tin. Six or eight sizes might be cast (and kept ready for use), from which one could be selected suitable for the jaw. The wings are of malleable iron, tinned to prevent rusting and for more readily soldering. Three sizes would be sufficient to select from.

The splint should have 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.

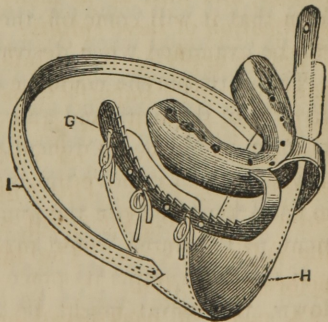


Fig. 4.

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 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.

(The adaptability of this splint is shown in the fact that the one from which the cut was taken had been used successfully on two different jaws, so unlike that the first was a quarter of an inch wider, where the ends of the splints rested, than the second. When fitting it to the second jaw, it was necessary to cut off a part of the right wing, to keep it clear of the corner of the mouth. This accounts for the difference in the width of the arches as seen in the cut. The indentations on the top of the splint were made by the boys in eating.)

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 it in water, dig out the softened plaster.

If the splint is found to rock on the teeth, it should be removed, a *little warm* (not hot) *water* be poured into the lining, then carefully replaced upon the teeth, and slightly pressed down. It will then fit perfectly. This lining will be of such form that it will come off the teeth readily, therefore the jaw can be examined when desirable.

The gutta-percha could be placed in the splint and applied *directly* to the teeth and gum, if the jaw is set *sufficiently firm*, as there would be no difficulty in drawing the lining off before it was cold, to remove the ligatures. But if they are put on so as to keep clear of the gum, they might be left during treatment, as the lining would prevent them from moving the teeth.

If the jaw retains its place when the gutta-percha is pressed down, the splint might be *left* on. In this way the gutta-percha, by embracing the teeth, and fitting in between them, would hold the fragments of the jaw firmly in place.

It is, however, much more difficult to apply gutta-percha than wax, as it requires more heat and pressure.

When the jaw can just be held in place, but will bear but little pressure, hardly that of warm wax, plaster of Paris might be used as a lining. In many cases it would hold the fragments in the splint for a long time.

This splint can be used without wings, in any way that Fig. 1 will answer.

The mental or splint band must be used when there are no teeth suitable to fasten to. This is frequently the case in children. This band may be removed for washing when necessary, care being taken that the patient keeps the jaws closed during the removal, in the earlier stages of treatment.

The splint has so far been spoken of in its adaptation to fractures in which the jaw is allowed to *move*. It can also be used instead of Figs. 2 and 3, by soldering suitable portions of another splint on the upper part, to hold the lining for the upper teeth. When the teeth are not fit for screws, the cap of Fig. 3 could be used, with long tapes to reach down to the wings beside the lower jaw, if a ready-made lower wing could not be fitted so as to act in place of an upper one.

No care will keep this splint as pleasant as one made of rubber. Gutta-percha absorbs, and becomes very offensive, but the small quantity used for lining the splint is protected and covered so that, with great cleanliness, it may be worn with little annoyance.

This splint has the advantage of being easier of application, and can be applied, if ready made, in much shorter time than a rubber splint.

In fractures treated with either kind of splint, the trouble and anxiety are over when the splint is on, as there is then no chance for the jaw to get misplaced.

In ordinary cases the splints may be removed during the first three days, if any edge is pressing so much into the gum as to be painful. With proper care in the fitting this will be unnecessary.

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 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 or 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 age of the patient.

With the fragments held in place, little apprehension need be felt of those painful abscesses, exfoliations and other complications so often present in the usual treatment. The advantages of splints over bandages are so great that nothing but experience will give a full appreciation of them to any one. I am able to speak positively upon this point, as nearly all the cases treated by me had been found unmanageable by the old methods, before coming under my care, and some of them were gravely complicated.

The following are examples:

CASE 1.—A seaman, senseless from explosion of powder on board a Spanish frigate, was sent to the U. S. Naval Hospital. A comminuted fracture of the lower jaw was found between the canines, a piece of the bone loose in the mouth, the teeth of both jaws much shattered, with face severely burnt and lacerated. The case had been carefully treated for over four months without producing any union, when, by the advice of Surgeon Bache, Director of the Naval Laboratory, I was requested to treat it. The jaw was contracting from loss of bone, and pieces were coming out through the chin. I applied a hard, vulcanized rubber splint, which inclosed the remaining teeth and gum of the lower jaw, its upper surface fitting well over the teeth above, except in front, where it was trimmed down to allow food to pass between the remnants of the superior incisors. The splint was fastened to the lower jaw by screws passing into a broken tooth on each side. The jaw was held up by starched muslin, moulded to a cast of the parts, in

repeated folds, until a line in thickness.¹ This reached to the zygomas, and was kept up by a band passing over the head. The splint was applied Feb. 12, 1861. Fragments of the bone came away for some time after, but the splint was not removed during the treatment. The jaw united well by the middle of May, and the man was sent home to Cuba.

Splints of similar construction, but without screws, and with a different bandage, were subsequently used with great success in over forty cases in one of the hospitals of the Confederate army in 1864.²

CASE 2.—I received a compound fracture in my own jaw between the right canine and lateral incisor teeth on November 4th, 1862, through my horse falling under me. The bone was much displaced and two incisor teeth loosened. I set the bone, and it was held by strong, well stretched silk, inclosing three incisors, the right canine and first bicuspid. This stopped the bleeding forthwith and held the bone firmly. A vulcanite splint was applied thirteen hours after injury. It inclosed all the lower teeth, and was fastened by gold screws to the first molars. It held the fragments so well that I was able to attend to patients in the afternoon, and continued to do so subsequently. The gum united by first intention, and the pain and swelling, which were very great in the external parts, diminished rapidly.

November 28th the splint was removed, and good but flexible union found. It was again fastened on, but after seven days was worn without the screws, and removed daily. The jaw grew strong, the teeth firm, and the splint was left off January 1st, 1863, but worn at night until February 1st. Jaw was used in eating, talking, etc., throughout the treatment. The incisor teeth have regained their communication with the inferior dental nerve. This was severed by the displacement of the fragments, which was so great as to admit the little finger between the teeth.

¹ A bandage of thick gutta-percha was tried first, but it yielded to the shape of the jaw so much that it increased the tendency to contraction. The pliancy of gutta-percha is a radical objection to its use in or out of the mouth, except when it can be supported.

² See Richmond Medical Journal, Feb., 1866.

Judging from the sensation of slight tightness between the front teeth in certain movements of the muscles, the bone was twelve months in growing as stiff as before the accident. The case was presented to the New York Academy of Medicine, January 7, 1863, by Dr. A. L. Sands. Prof. Alexander Stevens said the splint was a great improvement, and that the treatment would last forever.¹ The splint was brought before the Medical Society of the State of New York in February.²

CASE 3.—G. B., forty-five years old. Jaw fractured through socket of right second bicuspid, June 5, 1863, by a blow. Displacement of back fragment inward and forward. Patient could not lie down, but slept in a chair, *holding* the jaw, as the surgeons could not keep the fragments in place. The fracture commenced inside the first bicuspid tooth, and passed backward and outward through the socket of the second, and downward also, at the expense of the back fragment. As the loosened bicuspid had been extracted instead of being kept in place, there was nothing to prevent the back fragment from sliding inwards and over the front one. It was set and held in place by a jackscrew, of which one end rested on the left side, between the first and second molar teeth. The other end went into the short fragment, about the centre of the fracture, and as low down as the muscles under the tongue allowed. This held the parts firm while the impression and bite were taken, the mouth cup being notched out to go down over the ends of the jackscrew. On June 17th I applied a splint like Fig. 1, without screws, but held down by a strip of silk passing under the chin, and, supported by wings which projected from the splint, came out over the lower lip, and continued along the sides of the jaw like the wings of Fig. 4. Splint held the bone in place, although there were but two loose teeth in the back fragment—first molar having been out for years, and the second bicuspid lost through the fracture. Patient could now lie down comfortably. The band was worn snug until June 24th, when it was slackened because of painful swelling under

¹ See Bulletin of the Academy.

² See the Society's Transactions for 1863; New York Medical Times, August 8, 1863; Dental Cosmos, September, 1863.

the chin. No displacement following, the band was worn loose afterward. July 20th, splint removed to examine the jaw and flexible union found; 29th, callus firmer. August 8th, improving; 18th, wings cut off, but splint worn until September 3d. Jaw allowed its natural motions throughout treatment.

This splint was presented to the New York Academy of Medicine, in October, 1863.¹ I received the thanks of the Academy, accompanied by a request to report further when I should have completed the splint which I considered best adapted for general use. In answer to this request, the splint represented by Fig. 4 was fully described in the paper mentioned at the head of this article.

CASE 4.—J. Q., twenty-five years of age, had his jaw broken by being thrown from a cart, December 29th, 1863. On the same day he called in a physician, who tied the teeth together and sewed up a deep gash over the left masseter muscle. The ligature did not permanently control the fracture; the teeth became very loose and the front of the jaw was drawn back inside of the left fragment. Patient went into the Bellevue Hospital January 9th, 1864. The left lateral incisor, loosened by the accident, having been extracted, attempts were made to hold the jaw in place by passing wire around the teeth, but without success. January 14th patient was brought to my office. I find the jaw fractured through the socket of the left lateral incisor, slanting toward the symphysis as it descends, thence back at the expense of the inside of the left fragment. The gum is red and painful; great tenderness under the jaw and upon the ramus, which was also *supposed to be fractured*. I find it is not. The gash across the left masseter muscle is about two inches long, and through it the bone can be distinctly felt with the finger; much swelling, which is extending; pus discharging freely into the mouth and externally from the wound near the angle. Tied the fragments, taking in the remaining incisors, both canines and left bicuspid in the ligature, as the central incisors were quite loose, the one next the injury and also the left canine so much so that the fingers

¹ See Bulletin of the Academy.

would have taken them out easily. A piece of wood was placed endwise across the socket of the extracted lateral incisor, bearing against the central incisor and the canine, to prevent displacement while taking the impression. This held the fragments in place, but it was impossible to get the jaw into its natural position relatively to the upper. The left masseter muscle, weakened by the cut, having been inactive for so long a period, the parts had settled over to the left, and I was obliged to take the bite in that position.

January 15th. Applied a vulcanite splint, like Fig. 1, without screws or any other fastening. It held the fragments in place, and the patient experienced great relief. February 13th, took off the splint temporarily, no displacement followed, but union was very soft. After this, removed the splint and examined the parts weekly. March 19th, the wound is healed. Removed the necrosed socket of the extracted incisor. Union firmer, teeth improved. April 9th, union strong, but it is advisable to wear the splint longer, on account of the canine tooth, which is growing firm. The jaw now articulates with the upper, and the upper and lower teeth fit against each other well. May 1st, splint dispensed with.

I have used this kind of splint on many patients, and always successfully. Amongst them were cases which had been treated, without avail, in civil and military hospitals of this and other places. I have never seen it fail to hold the bone in place, although used without any fastening in the mouth, or support externally from bandage. In one case the jaw was broken by a Minie ball into seven or eight pieces, and part of them, with one tooth, lost.¹ In another much of the mental process was shot away, together with three front teeth.

¹ I extracted this tooth, the left central incisor, it being forced out in front, as the lateral had closed up so as to touch the right central incisor through the contraction of the parts, the fracture being two months and ten days old when I took charge of the case. One fracture went down through the socket of the ejected tooth, and another between the second left bicuspid and first molar. The alveolar inside the four teeth between these fractures was all necrosed, and that outside completely loosened from the bone below, the separation being horizontal and on a line with the end of the roots. This alveolar, with the four teeth attached to it, would have turned down externally at a right angle had the gum been cut vertically at the ends. I took away the

CASE 5.—Mary Ann D., twenty-nine years old, was found in a state of insensibility, Feb. 12, 1864, and sent to the Bellevue Hospital the next morning. She remained unconscious until the 16th.

February 17th. Dr. R. B. Brownell spoke to me of her broken jaw, but said nothing could be done to it at present, as her head and face were so terribly swollen.

February 21st. Saw the patient at the hospital, and found her lower jaw broken on the right side, commencing half an inch back of the canine tooth, and passing downward at the expense of the back fragment. There have been no teeth back of the canine for some time, and, the gum being torn, the back fragment rides over the front, with its point sticking out sharp and bare, for three-eighths ($\frac{3}{8}$) of an inch, in the direction of the symphysis. Although there is much swelling around the fracture, in and out of the mouth, also over the left zygoma and down the ramus, there is *great mobility* of the front of the jaw.

February 22d. Patient was brought to my office. Swelling on the face lessened somewhat, but still undiminished in the gum around the fracture. On the left side there are no teeth back of the bicuspid, and the gum is sound and healthy, but indented by the upper wisdom tooth which has been pressing into it since the accident, previous to which it had not done so, except when the gum was swollen eighteen months before. This condition of the parts induced me to examine the left ramus carefully, and I found great play of its upper back portion, especially inward, but the only displacement when at rest, is upward and forward, and this to no great extent, as it is checked by the upper wisdom tooth. Finally concluded that a fracture exists in the neck of the condyle, passing downward and backward, thus allowing the muscles to draw the bone upward and forward.

necrosed portion, made the outer part fit at the symphysis, and set all in place. The splint was applied July 22d, 1864. When it was taken off, December 11th, the jaw was united in every part, and the teeth were all fast, with the gum firm around them, but on the inside not quite as high as on the corresponding teeth of the other side of the mouth. To avoid being sent to the army again, the man wore the splint three months longer, without my knowledge, but the teeth and gum were not injured any by it.

The lower jaw contains only the four front teeth, the two canine and first left bicuspid. The gum back of these is free from roots, except that of the right wisdom tooth, which still remains, but decayed close down. The upper jaw has been without the eight teeth forward of the second bicuspids for some time; of the other eight, seven still remain, the right second molar only having been extracted.

To set the jaw, the right fragment was put in the best position that could be obtained with the fingers, assisted by a stout piece of silk passing round the left canine. A jackscrew, with a collar fitting against the root of the wisdom tooth in right fragment, and the other end bearing on the gum between the left lateral incisor and canine teeth, was then screwed out until the extension was sufficient to allow the fractured bone to come into proper position. The end of the long or forward fragment was then held up, and an impression in soft wax taken of all the teeth and gum, as far back as the ramus on each side. Care was taken to put the bone in place at the neck of the condyle while the bite was obtained.

February 28th. Applied the splint.¹ The surgeon who brought the patient to my office wished to try and hold the chin up with a leather bandage of Hamilton's pattern. It held the chin up very well for a short time, when tightly buckled, but in an hour the jaw fell away somewhat.

February 29th. Swellings on the head, temples, etc., with pain caused by the bandage.

Compresses were placed over the head and temples, and great pains taken to prevent the bandage from hurting. It was worn so loose that the teeth went up and down in the splint to such an extent that it was feared the jaw would get out entirely.

March 2d. Patient brought a request from the surgeon in charge of her case at the hospital that I would screw the splint fast to the teeth, that the bandage may be dispensed with, for the swellings on the head, temples, etc., are much increased. The lower lip is also very painful on the right side, in front of the canine. Gum has grown over the point of the bone; it is

¹ See Fig. 2, taken from the original.

therefore only a simple fracture now. Screwed the splint fast.

March 10th. Swellings caused by the bandage nearly gone. Patient complains of pain in swallowing. Removed splint, and shortened the left end, which had cut into the palatoglossus muscle. Bone is united so well as to keep its form, and the fracture at the neck of the condyle is doing well. No complaint as to the teeth.

March 14th. Patient in good spirits and quite comfortable. Wants to leave the hospital and go to work. No complaint as to the teeth.

March 26th. At my request patient was discharged from the hospital, but still wearing her splint.

April 8th. Splint removed and good union found. Splint was worn just forty days, but the patient has a fine constitution and the bone united rapidly.

June 7th, 1865. Patient sent me word that the jaw was all right.

In this case the fractured jaw was held by the splint in proper relative position to the upper jaw, but in the next case the jaw was held *out* of its proper position.

CASE 6.—Patient thirty-six years old, the son of a physician in Brooklyn; jaw fractured through the symphysis, and the right condyle dislocated outward and backward, February 10th, 1866, in falling down stairs, and striking the chin on a small desk. The dislocation was reduced, but the displacement of the jaw being found uncontrollable, I was called in consultation.

February 14th.—Patient has been confined to his bed since the accident, motion being insufferably painful. The right side of the jaw is so much out of place that the lower back teeth strike nearly outside the upper. At the point of fracture, the left fragment is inside the right with a lateral displacement of five or six lines, and nearly that much vertical displacement. Much swelling and pain under and inside the front of the jaw, with terrible suffering in the right glenoid fossa and ligaments when the condyle is moved. There is a firm, smooth swelling upon the outer part of the neck of the condyle, but nothing that indicates fracture of the bone,

although the back teeth touch too soon, and it is impossible to get the lower bicuspid up to those above them. This is probably caused by some displacement or injury of the interarticular cartilage, which allows the condyle to go up too far into the glenoid fossa. The left side of the jaw will move in any direction, being uninjured, and the muscles in good condition (except at the symphysis). This accounts for the fragments being carried over to the right side, where the ligaments and muscles are so *crippled* as to be *unable* to *balance*, or antagonize those in good condition on the left. Packthread was passed around the left bicuspid, with a piece of wood through the other end, to assist the fingers while the bone was drawn over to the left side. At the same time this fragment was pressed down with the fingers, aided by levers and wedges of wood. The muscular resistance to motion was so great that all efforts to bring the fragments into position were ineffectual for a long time, although the left half was drawn steadily over to its own side. But after two hours' effort the parts yielded sufficiently, and a piece of wood was fitted across the roof of the mouth, between the upper teeth, and extending under their crowns. Its lower surface was cut out to receive the teeth of both sides of the lower jaw, and the fractured ends, at the symphysis, were secured by thread passed around the teeth. The patient felt much relieved by this, although exhausted by the pain experienced in accomplishing it, as it was not thought advisable to give anæsthetics. Probably the parts would have come into place readily under their influence, but whether they could have been held there so well afterward is more doubtful.

February 15th. Patient walking round, feeling much better. The halves of the jaw are in comfortable position. The parts near the fracture have improved greatly since relieved from the pressure of the displaced ends of the bone, and the jaw opens wider. Took wax impression of upper and lower teeth, etc. The lower jaw being only imperfectly set, the plaster cast was sawed apart between the central incisors and adjusted by the upper cast. The packthread was still allowed to remain on the lower bicuspid, that the patient might draw the jaw into place, should it settle to the right again.

February 16th. The general condition of the soft parts

much improved, but no difference in the right articulation. It is yet impossible to set the halves of the jaw together properly, without bringing the left half down to meet the other. The right condyle, although apparently in its place in the glenoid fossa, is not so, as the back teeth on this side meet too soon, so that the teeth cannot close, at the canines, by about two lines. The *left half* was therefore brought forward at the condyle, *until a full quarter of an inch down at the wisdom tooth and the same at the canine*. In this position, it was set up in the wax resting upon the upper teeth and the bite taken. When the casts were placed in the wax bite, to form the mould for the splint, the upper and lower right wisdom teeth were separated about a line. This was done in the hope that when the splint was applied the parts might yield, so as to allow the condyle to fall away some.

February 19th. On applying the splint the right fragment would not go up into place, even under much pressure, until the part between the crowns of the wisdom teeth was all cut away—showing that no improvement has taken place in the joint to this time. The right wisdom tooth is hard against the one above, while the canine teeth and the other wisdom tooth are considerably below the upper ones. Splint left unfastened.

February 20th. Patient very comfortable, except that the edge of the splint cuts the gum a little. The splint was removed and made easy, then screwed to the first right upper molar and left canine, and to both lower canines. The jaws are held as close together as the back teeth permit, for as all the four upper incisor teeth have been absent for some time, the opening in the splint is large enough without depressing the lower jaw. A channel is cut in each side of the splint, that the saliva from the parotid glands may get into the mouth.

February 24th. Patient very comfortable and much pleased with the splint. All going on well.

March 16th. Swelling set in over right condyle and ramus in the beginning of the month, but passed off. About the same time the part under the symphysis opened, but closed up after a teaspoonful of pus had discharged. The swelling on the neck

of the right condyle is still very painful; doing well in other respects.

March 30th. Swelling all gone, except the small lump near right condyle, which is still painful. Left central incisor (next to the fracture) quite tender, and pus discharging from its socket.

April 12th. Tooth better. Swelling near condyle less painful.

April 22d. Swelling near right condyle much less painful. Splint has been worn sixty-two days, and been on without a moment's intermission just sixty-one days. Removed it and good union found. Upper part of the splint cut off, and the *jaw allowed to move*—the lower part being put on again, as the union is not yet stiff enough. The jaw is therefore left in a splint, like Fig. 1, but still screwed to the canine teeth.

May 18th. Splint dispensed with. Jaw firmly united and the same shape as before the accident. *Also going into its place as regards the upper jaw*, the top of the splint, where the points of the upper teeth rest, having been cut down about once a week since the jaw has been allowed to move. It continued to improve and go up closer to the upper teeth until the beginning of July, when it was nearly in place. The jaw moved very well *up* and *down*, but the right condyle had very little ability to come forward in the lateral movement of the jaw.

September 8th. The patient is out of town; but I have heard from several sources that the jaw is all right.

September 15th. The patient's father says the lateral motion is nearly perfect again, and the jaw in place.

This case shows the necessity of some intervening support between the teeth in some cases during treatment, and therefore affords another argument in favor of interdental splints.

CASE 7.—P. N., thirty-six years old, was struck with a club on the left side of the jaw, August 19, 1866. Went to the Demilt Dispensary, from whence he was brought to me, August 22. Find the jaw-bone broken on both sides. The lower lip and parts covering the mental process have little sensation, owing to the separation of the inferior dental nerves. Fracture on the left side, between the bicuspids; it is square

across, vertical and smooth. The bicuspid teeth quite firm. The first downward and forward about four lines from the second. The other fracture is through the socket of the lower right wisdom tooth, leaving one root in front fragment, while the crown of the tooth is held by its back root, in the part attached to the ramus. Fracture passes down, inclining to the angle. The back fragment keeps forward and up, so that the wisdom tooth strikes against the upper teeth, while the forward fragment is full half an inch down when at rest. Much swelling, pain and discharge of pus. The jaw settles over to the right. The teeth above and below are all present, except the lower left wisdom tooth, and pretty firm, except the one in the fractured socket. Both upper and lower teeth show distinctly where their antagonists closed against them. The lower jaw shuts a trifle outside the upper at the *right* bicuspid, owing to a very peculiar curl outward of the *left* angle, which has caused the muscles to swing the jaw over somewhat. The patient says this irregularity was caused by the kick of a mule, when he was about nine years old. Tied the bicuspid together with silk, and took a wax impression of the fourteen teeth, leaving out the elevated wisdom tooth, of which an impression was taken separately. The parts were not precisely placed, therefore the plaster-cast was sawed apart between the bicuspid, and adjusted by the cast of the upper jaw. The wisdom tooth was added in the same way. The lower cast then included the fifteen teeth of the lower jaw, *all in place*. It was placed against the upper cast, and *both set in an articulator*. The jaws were then opened nearly three-eighths of an inch, and a gutta-percha splint made. This was tried in the mouth, and being right was trimmed to the form required for the splint; then, with the upper and lower casts, set in a vulcanizing flask, with the female screws all in place. After the plaster had set the flask was made quite warm, in order that the plaster teeth should not be broken when drawing out the gutta-percha to make room for the rubber. The opening in front of the splint reached from one canine to the other, and from the points of the upper teeth to those below, and holes were made through the sides for the saliva.

August 25th. When applying the splint considerable diffi-

culty was experienced in getting the jaw into place, owing to the pain and displacement of the fragments; but after placing packthread around the front teeth, and pulling the jaw over to the left, every part went up into the splint, although scarcely as high as they should, the splint being rather tight, because of the improper omission of the two or three coats of silicious varnish usually given to the plaster teeth before packing the soft rubber. The splint was screwed to both canines, on the left side, and to the upper first molar and lower first bicuspid on the right.

August 27th. Swelling and pain lessened very much.

August 28th. All going well; patient wants to know if he may go to work.

August 29th. Parts begin to look natural. Patient sleeps well, except when coughing, through a severe cold.

August 31st. Patient quite comfortable, except when coughing at night. Has begun to work at his trade (glass cutting).

September 5th. Patient has been out in the country to see a sick relative. Removed the splint and cut away some parts pressing too hard on the roof of the mouth. Fractures making fair progress. Took away the right wisdom tooth, it being very loose, as in addition to the loss of one root the tooth had been further loosened by attempts to extract it before the patient went to the dispensary. Replaced the splint.

September 8th. Sensation returning to lower lip, etc. Doing well in every particular. The right back fragment has no tooth to hold it, but the muscles keep it firm against the portion in front.

September 15th. All going on well.

The man was spared much pain by adjusting the casts by the articulator. In fact, it would have been hardly possible to have set the fragments of the bone in place and held them there while taking the impressions and bite, the case being so extremely severe in every particular. All attempts to hold it in place by bandage, even temporarily, were ineffectual.

CASE 8.—I applied the wings of Fig. 3 in the case of a distinguished statesman in Washington, whose jaw was fractured on both sides between the bicuspids.

The injury was caused by falling from a carriage, April 5th, 1865. Unsuccessful attempts had been made to hold the jaw in place by bandages, and also with ligatures on the teeth, by the surgeons first called to the case. On the 14th the patient, while asleep, was attacked by an assassin, and a cut inflicted which reached from under the right zygoma to the left of the trachea. Steno's duct was severed, and the right fracture laid open externally, the bone being also much exposed in the mouth from the original injury.

In accordance with letter of April 14th, from Dr. Wm. Whelan, chief of the Naval Bureau of Medicine and Surgery, in answer to one by Surgeon Bache, chief of the Naval Laboratory, suggesting the use of an interdental splint, and telegrams of the 15th, urging me to come on at once, I started for Washington, and reached the patient's house at twelve, noon, on April 16th. Attending Surgeon, Basil Norris, U. S. A., informed me that the jaw was fractured on the right side, between the bicuspid teeth, and also in the ramus of same side; that the jaw had been bandaged against the upper gum, but this proving insupportable to the patient the bandages were removed. Upon examination I found discoloration caused by the accident still remaining on the right side of the face. A cut (inflicted in the attempted assassination) commenced under the zygoma, passed forward about three inches, then downward and backward an equal distance, to the lower border of the jaw, from whence it crossed over the front of the throat to the left of the trachea. On the skin its first direction fell somewhat from a horizontal line, the second passed down at a little less than a right angle to the first, while the third went forward and downward. These three divisions, of nearly equal length, appeared to have been made by one sweep of the knife. Across the throat the wound was superficial, but above the border of the jaw it grew deeper, as it *split* the cheek—the point of the knife making no entrance into the mouth, except so far as it may be considered to have done so by laying open the right fracture externally, the gum being already lacerated internally from the great displacement of the bone following upon the original injury. The knife was evidently aimed at the throat, but the head being thrown over (the right arm

being useless) the cheek and jaw received the brunt of the blow. No arteries had been ligatured. The wound was neatly sewed up, and healing by first intention, except immediately under the fracture. The swelling and stiffness made the examination difficult, but the ramus proved to be uninjured. There was, however, a second fracture, but on the other side of the mouth, the jaw being fractured on both sides between the bicuspids. The jaw contained all the ten forward teeth. The right wisdom tooth and root of the left were all that remained back of the bicuspids. The part in front, containing eight teeth, was drawn down out of place, while the right back fragment, with the wisdom tooth and second bicuspid, was drawn up, showing its fractured end white and bare. The fracture was square across, vertical and smooth, and the parts were separated vertically over a quarter of an inch when at rest, sometimes much more. On the left side, the first bicuspid fell forward and downward from the second one-quarter of an inch. This fracture passed forward somewhat in descending. Here the bone could not be seen, as the gum had separated from both teeth and lay swollen over it. Pus discharged profusely from both fractures. The gum was pale and flaccid, in keeping with the general condition of the patient. The upper jaw was entirely without teeth. Deeming it important to set the exposed bone in place as early as possible, and also to give the patient time to recuperate—as he had already been subjected, during the morning, not only to a relation of the President's death, but to much that was said and written upon the subject—I obtained the patient's artificial teeth, intending to cut out the front teeth, and tie the lower natural canines to the upper artificial ones. In this way the back fragments would have been kept down in place, and in return would have held the artificial teeth up against the roof of the mouth. They could have been used therefore to support the front of the lower jaw temporarily, without assistance from bandages, which were not only inadmissible in consequence of the wounds, etc., but would have increased the tendency to necrosis by interfering with the circulation. But the patient's experience with the teeth had not been such as encouraged him that he could bear them in his mouth. It was therefore necessary to leave the parts as they were until the next morning.

In the afternoon, while explaining the treatment proper for the case to Dr. Whelan, I also stated my unwillingness to commence, except with the understanding that I should control it entirely.

April 17th. Was informed, by Surgeon Norris, that the friends of the patient were unwilling to have the splint fitted to the jaw at present, and that the surgeons agreed with them.

Upon giving my views to the contrary, Dr. Norris came over to my opinion. I consented to wait until the following morning, when it was finally decided not to proceed in the matter. I protested, in vain, but promised to return when sent for.

April 28th. Arrived in Washington; Surgeon-General Barnes informed me that the jaw was more displaced, but the patient otherwise much improved. I found the sensation of the right side of the forehead, face and lips deficient. The separation of the inferior dental nerve by the displacement of the bone, and of branches of the facial nerve, by the knife, did not seem sufficient to account for it. There was also irregular motion in the right eye. The front of the jaw was lower, and the right back fragment showed its alveolar to a greater extent. There were no indications of any tendency to union on either side. The fragments could be put precisely in place, no splinters or any thing else intervening. There was little swelling, but great discharge of pus. Took wax impression of upper jaw, and removed the tartar from lower teeth.

April 29th. I set the jaw, and held it in place by wire and silk ligatures, as described in pp. 4, 5. Took a wax impression of the teeth and gum, and obtained the bite directly from the teeth, etc.¹

April 30th. Patient felt much relieved, as the ligatures held the front of the jaw up well. Tried in a gutta-percha splint, arranged the wings in it, removed it carefully from the mouth, placed the upper and lower casts and female screws in it, and set them in a vulcanizing flask.

Although the front of the jaw containing the eight forward

¹In doing this, and in making the splint, I was assisted by Mr. J. Adams Bishop, who accompanied me from New York.

teeth was greatly displaced (before the setting), the silk and wire ligatures held well until May 2d, when they were removed and the splint applied. It was of hard, vulcanized rubber, covered the roof of the mouth and adjacent gum, inclosed all the lower teeth, and went down over the gum on the outside somewhat. The opening in front was seven-eighths of an inch wide, and half an inch high in the centre, the wings preventing any more room sideways, as they were set clear of the commissure of the lips. To have given more room in the height, by depressing the lower jaw, would have made it very difficult to prevent the saliva from overflowing at the lips. Upon putting in the splint the breathing was very spasmodic for several minutes, but this soon passed off, and I screwed it fast to the lower teeth. They held it against the upper gum for the first night, but after that a cap, with adjuncts, as in Fig. 3, was worn to support the splint. The upper wings only were used, as the lower jaw was held up in the splint by screws passing into the lower canines. The mental band was consequently not applied, although the lower wings were left on in case of need. The upper wings being kept clear of the zygomas, the parts around the jaw and face were left free from pressure—this being important, in order that the vascular and nervous circulation should be unimpeded. After giving the excellent army nurses who were in attendance upon the patient full direction for keeping the splint clean in the mouth, and properly balanced by the cap, which I had fitted to the head, I left Washington, May 3d.

Arrived in Washington again on the 8th, having received a telegram saying that the patient was suffering much pain. Found him quite comfortable, talking freely, and much encouraged. Saliva had accumulated several times in the cheek, but had been let out by lancing externally. The splint had been kept quite clean, and as every thing was going on well I left on the 9th.

June 11th. Saw the patient again. The left side appeared to be well united, but the right gave no indication of union, although the wound under it was nearly closed, the last of several pieces of bone having been removed some days before.

I promised to remove the splint in four weeks from that date to examine the parts.

This splint held the jaw firm for sixty-eight days, when I removed it.

There was good union on the left side, but the right fracture was still ununited. For this, however, I was prepared, as the bone had been exposed so much during the twenty-four days which elapsed before I set it, and the saliva from the right parotid gland had discharged through the fracture from a short time after the attack. These unfavorable conditions, with other depressing circumstances, associated with an enfeebled condition from loss of blood, had been followed by necrosis of the ends of the bone on that side, and several pieces had come away externally during the first six weeks from the time the splint was applied, and also a long piece from the inside of the jaw on the left side.

I now removed the necrosed alveolar of the second bicuspid, but left the tooth in, as it appeared to have healthy connection with the lower part of its socket. The other teeth had grown firm. The splint had not been off the jaw a moment since its first application, and therefore little examination had been made internally, but external appearances had indicated that the saliva followed the course taken by the point of the knife. At this time, July 9th, Steno's duct proved to be completely closed. I could not pass the smallest probe even into its mouth, and the saliva discharged wholly through the ununited fracture.

Upon removing the first splint I immediately put another upon the teeth. This splint was ready for application, having been made on a cast taken from the original impression. This second splint was like Fig. 1. It covered all the teeth and gum, and was worn from July 9th to August 4th, when I removed it and put on a splint which allowed all the teeth to be seen, except the wisdom tooth on the right and the root on the left side, upon which it rested. This splint was worn screwed to the canines, until the beginning of September, four months from the application of the first splint. I saw the patient several times during the month of October. The jaw seemed to be

getting firmer on the right side. On the left it was then quite strong, and all precisely in place.

The patient talked freely while wearing the splints, except for a few days at the commencement. From the time the second was applied the jaw has been used for eating.

In letter to me of March 29, 1866, the patient says: "The whole jaw moves quite well and firmly. Thus at last I begin to regard my cure in that respect complete."

I have not seen it myself since October, 1865, therefore cannot speak of it by personal observation.

Of the splints spoken of in this paper, with their wings and other appliances, I am enabled to give most decided assurances of their perfect adaptability to the purpose for which they were devised.

Having personally experienced their great advantage, and believing them to be superior to all other treatment, I have endeavored to make the application of them as easy as possible, desiring that others, whether practitioners or patients, may have the benefit of their use, when necessary.

CONCLUSION OF CASE 7.

Sept. 18th. Pus again discharging profusely from the right fracture. Patient says, the bone moves; he points to the coroid process. When the temporal and masseter muscles are brought into action, crepitus can be distinctly felt, especially if the finger is placed on the left angle where there is no swelling.

Sept. 20th. Displacement of the right ramus outward, forward and upward.

Sept. 21st. Swelling and pain increased since yesterday. On removing the splint, I find good but flexible union on the left side; the right fracture proves to be very oblique and diagonal to the thickness of the bone; it commences outside the second molar, passes through the socket of the third (the extracted tooth), and terminates somewhere on the inside, short of the angle. Since Sept. 5th, when the wisdom tooth was extracted, this fragment has had nothing to hold it back in place, except the roughness of the fractured surfaces, which may have given way under the action of the unusually strong muscles and the jarring of a severe cough. When describing the splints before the Academy of Medicine, I suggested that, when necessary, metallic points could be arranged in them to go into the bone. I now decided to apply one in this case, for as the line of fracture averages three inches around the bone, a salient edge, one inch and a half wide on each fragment, is pressing into the periosteum and other tissues. This can all be remedied by the aid of a piece of wire, which may go into the muscles, etc., perhaps a quarter of an inch, and press against the bone even less than that. A steel hook was, therefore, screwed into the end of the splint, just below the back corner of the upper wisdom tooth. The wire is a line in diameter and three-quarters of an inch long, clear of the splint. It is bent, so as to go down outside the bone

where the ramus starts from the body. The point of the hook goes through the buccinator muscle and rests firmly on the bone. Firm pressure on the splint forced the ramus back, and the splint went on to the upper teeth, but at the expense of carrying the front of the lower jaw too much to the right, as the overlapping of the fragments did not yield readily. Pack-thread was passed around the right bicuspid and canine, and after drawing the front of the jaw to the left for ten or twelve minutes, the fragments came into position and the teeth went up in the splint. The bone was then quite firm, the action of the muscles causing no motion in it whatever.

Pain was felt for several days near the condyle and in the front of the ear, with occasional stinging in the temple; but this, with the swelling and suffering of the previous displacement, rapidly passed away.

Oct. 4th. All the parts are looking better than at any time since the injury. The pus is much diminished, and the bone is held quite still.

Oct. 8th. Only a little pus to be seen, but a piece of the alveolar which lies in the gum on the outside of the right second molar is nearly detached. No motion has been felt in the ramus since the hook was applied.

Oct. 11th. Removed the loose piece of alveolar easily.

Oct. 19th. Patient failed to call on the 15th and 18th, but came to day, quite drunk. The splint is firm, however, and the bone doing well.

Oct. 26th. His wife called and said he had been in jail since the evening of the 19th, and that for a week previous he had been drunk nearly all the time. She was afraid his jaw was injured, as he had thrown himself about very much and vomited frequently.

Oct. 28th. I called at the prison. He looks thin and pale, but the jaw is doing well, and the splint secure.

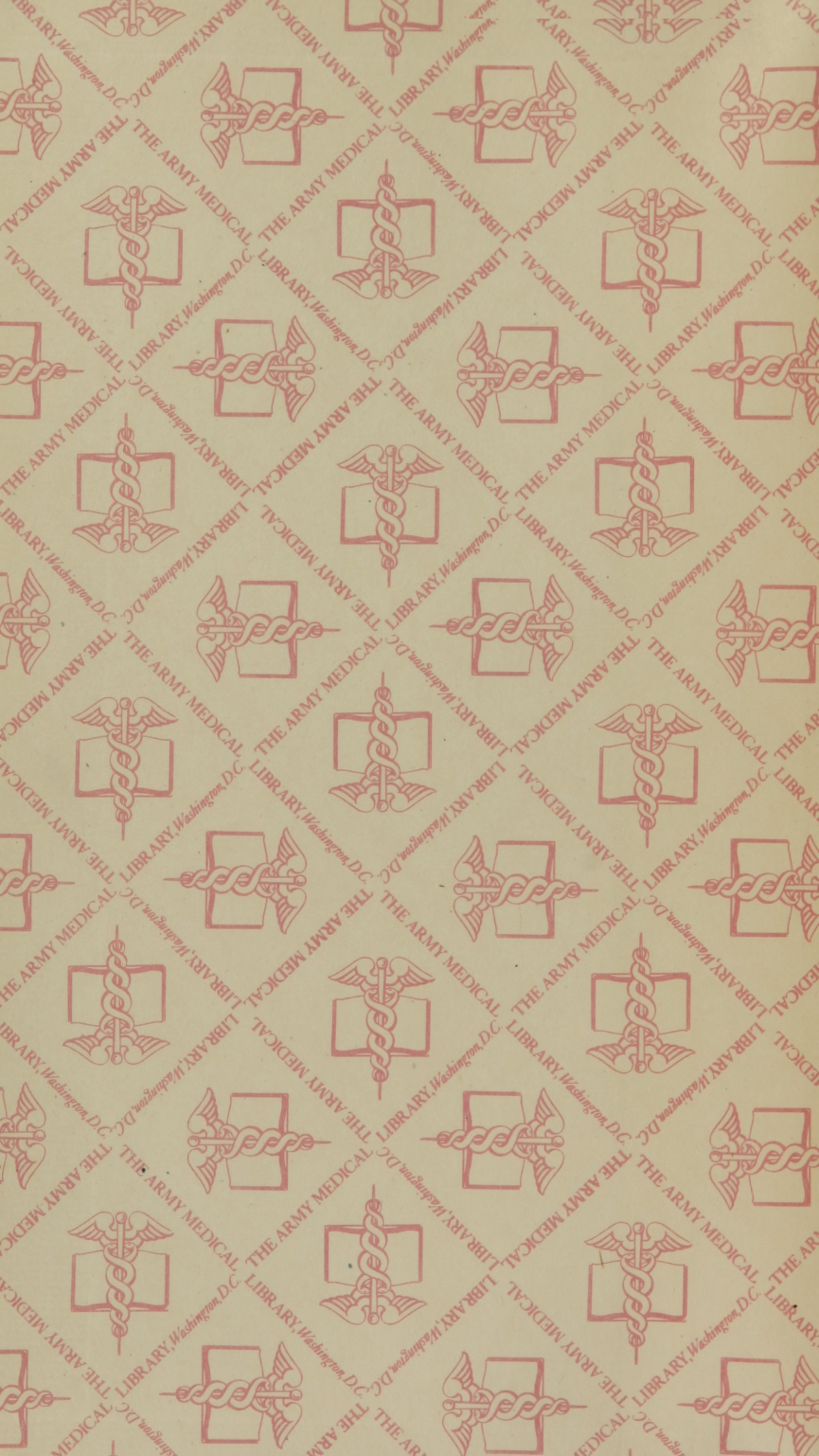
Nov. 24th. He has been out some time; I removed the splint to-day. The left side of the jaw is quite strong and there is good but flexible union on the right side. The hook has been worn sixty-four days without a moment's intermission; the hole left in the gum is just the size of the wire and the parts around are quite healthy. Splint dispensed with.

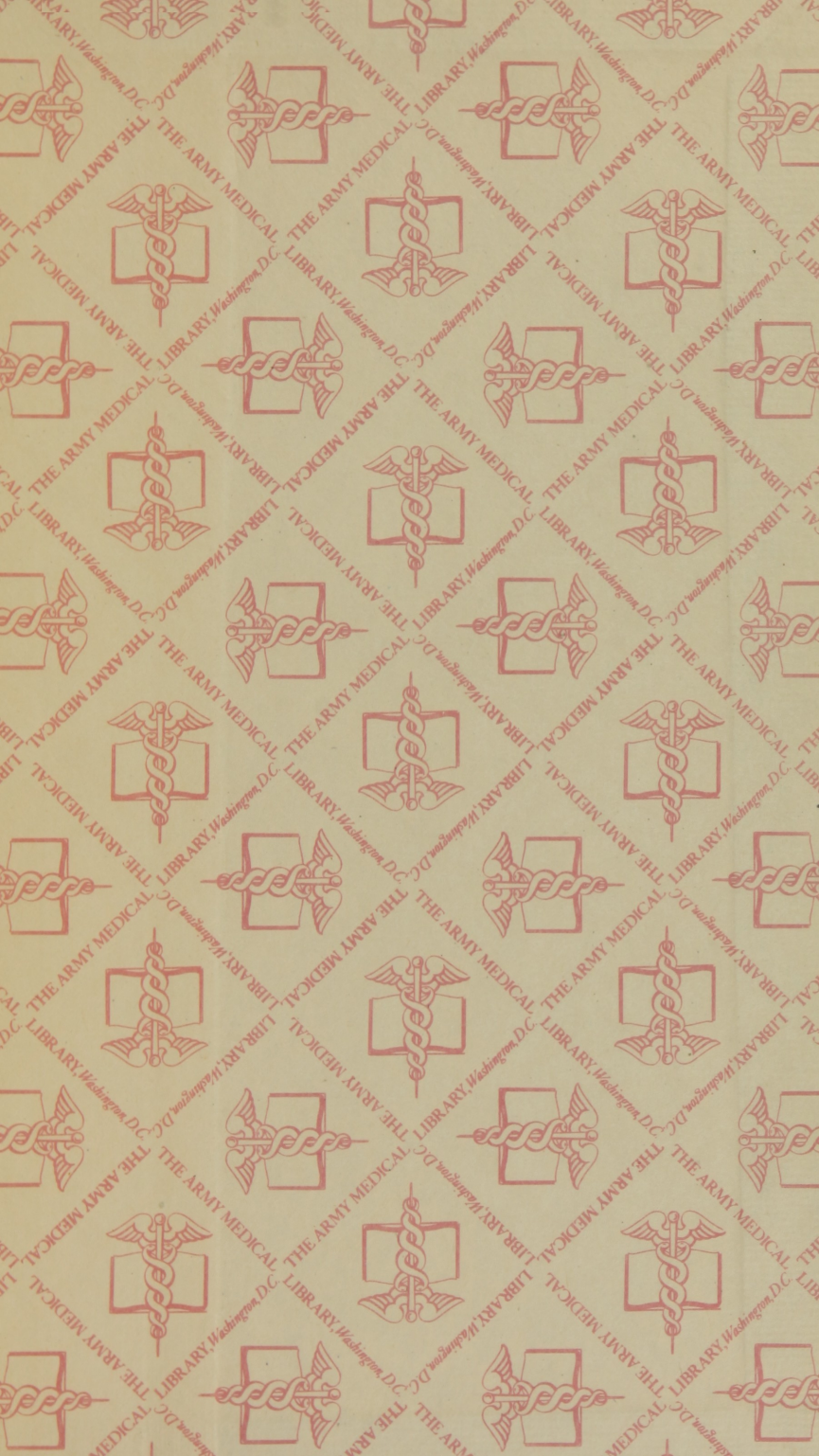
Dec. 10th. The callus has stiffened very much since the splint was left off, and both sides of the jaw are now used in eating.

In this case neither weight nor distension could have displaced the bone, for the ramus was drawn upward and the swelling had subsided. The temporal and associate muscles must therefore have been the only cause of the displacement, although opposed by the body of the jaw, which was held still by the splint. This case, therefore, with the others used to illustrate the treatment, shows that the muscles are active causes of displacement, as distinctly intimated by me throughout the subject, and formally stated in the paper read before the New York Academy of Medicine, June 1, 1864.

Other cases treated and seen by me also demonstrate that the opinion expressed so decidedly by Malgaigne and entertained by Hamilton, 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*.

In view of the importance of correct opinions upon this subject, my next paper will be upon the muscles which control and influence the lower jaw.





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