

again, and I would lift the fragments; but, as he has not returned, I infer that he recovered the use of his jaw.

Symptoms.—An irregular projection or depression of the fragments is the only sign which can be relied upon to indicate the existence of this accident; and this must often be concealed by the swelling which follows so rapidly wherever the integuments are severely bruised over a superficial bone. This displacement can scarcely occur in but two directions, either outwards or inwards; since the attachments of the temporal aponeurosis above, and of the masseter muscle below, must effectually prevent its descent or ascent.

Neither motion nor crepitus will often be present. In some cases the difficulty in opening or shutting the mouth, occasioned by the projection of the fragments toward or into the tendon of the temporal muscle, or by the inflammatory effusions, may assist in the diagnosis.

Prognosis.—If the fracture has been produced indirectly by a depression of the malar bone, the prognosis must depend upon the amount of injury done to the other bones of the face; in itself, the fracture of the zygoma cannot be a matter of any moment. The same remark might apply also to any fracture of the zygoma in which the angles were salient outwards. If, on the contrary, the angle is salient inwards, the fracture having been produced by a blow inflicted directly upon the zygomatic arch from without, or by a blow upon the outer portion of the malar bone, it may occasion some embarrassment to the action of the temporal muscles.

If the force which produces the fracture has acted more upon the temporal portion of the arch, near where the process arises from the temporal bone, it may be accompanied with a fracture of the skull, and with serious cerebral lesions, as in one of the cases already alluded to as having been noticed by Dupuytren.

The abscess which followed in the case of the compound, comminuted fracture, quoted from the same author, indicates the danger of this complication; but it must be noticed that its evacuation resulted in a rapid cure, and that no deformity or difficulty in moving the jaw remained.

Treatment.—A fracture, accompanied with an outward displacement, and occasioned by a depression of the malar bone, will be adjusted by a restoration of the malar bone in the manner already described, when speaking of fractures of the superior maxilla, etc. If the fragments are displaced outwards, in consequence of a direct blow from within, then they may be replaced by pressing upon the projecting angle. In this way Duverney easily reduced the bones in the case which I have cited.

When the fragments, in consequence of a direct blow from without, have been driven inwards, and, as a consequence, serious embarrassment to the motions of the temporal muscle ensues, an attempt ought to be made at once to replace them; if, however, no impediment to the action of the muscle exists, it is scarcely necessary to say that no surgical interference will be required. It is quite probable, indeed, that a slight amount of embarrassment may be the result of the direct injury to the muscle inflicted by the blow, without reference to the displacement of the bone, and that a few days will suffice to remedy this evil entirely; and, moreover, experience teaches that in the case of a fracture in other

bones, where the fragments actually penetrate the muscles and remain thus displaced, the points are gradually absorbed, and rounded, so that after a time they constitute no impediment to the action of the muscles. It is proper to infer that the same thing will occur here. The surgeon may be reminded, also, that it is not the muscle, but its tendon, which is liable to be penetrated; and that this is usually protected somewhat by a plate of soft adipose tissue lying between the tendon and the arch.

If to these considerations we add the difficulties which we shall be likely to encounter in the reduction, we shall expect to find but few cases in which a resort to surgical interference will be necessary.

Duverney says that he restored a fracture of this arch, accompanied with depression, by pressing against the zygoma from within the mouth; but an examination of the interior of the buccal cavity will convince us that this is impossible when the fracture is at any point near the middle of the zygoma; and that it can be only when the fracture is at or near the junction of the zygoma with the body of the malar bone, that any effective pressure can be made from this direction. In such a case we may, perhaps, lift the portion of the zygoma remaining attached to the malar bone, by the same means which have already been suggested for lifting the bone itself.

If the bone is driven toward the tendon of the temporal muscle at or near its centre, and if its restoration becomes necessary, it can be accomplished only by approaching the bone from without.

Dupuytren found an external wound through which, by the aid of a levator, he easily restored the fragments to place.

M. Ferrier, however, of the Hospital of Arles, in a case brought before him, made an incision through the integuments down to the bone, and then attempted to slide underneath the small extremity of a spatula; but the aponeurosis would not yield, and he was obliged to cut it also. He was now able to lift the fragments easily. The wound healed rapidly, and the patient was dismissed without any deformity.¹

CHAPTER XIII.

FRACTURES OF THE LOWER JAW.

Division.—Of 55 examples of fracture of this bone which have been recorded by me, not including gunshot fractures, 52 were broken through some portion of the body.

Having made an analysis of 45 of the above examples, I find that 16 were broken completely asunder at two or more points, constituting double and triple fractures; and of the remainder, 5 were accompanied with detachment of portions of the alveoli, and one with detachment of a considerable fragment from the body.

¹ Ferrier, Bulletin des Sciences Méd., tom. x. p. 160.

13 were compound; not including in this enumeration several examples in which the partial or complete dislodgement of a tooth might entitle them to be called compound.

Four fractures through or near the symphysis were nearly or quite vertical, and most of the others were known to be oblique. Malgaigne has

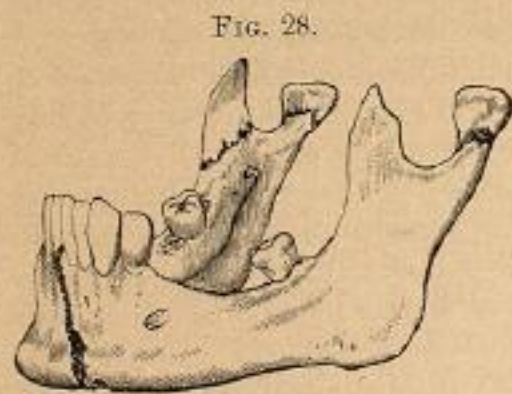


FIG. 28.

remarked, also, that in fractures of the body of the bone the direction of the obliquity is generally such that the anterior fragment is made at the expense of the internal face of the bone, and the posterior fragment at the expense of the external face, this latter overriding the former. Buck, of New York, has seen the fragments in an opposite condition, requiring the use of the knife and saw for their extrication.¹ I have myself recorded one

similar example, but in which the fragments were easily replaced.

In 30 examples of fractures through the body, not including fractures of the symphysis, the line of fracture has been observed to be 20 times at or very near the mental foramen, 3 times between the first and second incisors, 4 times behind the last molar, and 3 times between the last two molars.

Syme, Liston, and Miller have remarked, also, the greater frequency of fracture near the anterior mental foramen; but Mr. Erichsen thinks he has seen it most frequently broken near the symphysis, between the lateral incisors, or between these teeth and the canine. Boyer observes that it is generally somewhat in front of the foramen; for which reason, as he thinks, the dental nerve is rarely torn.

Says Boyer, in his *Traité des Maladies Chirurgicales*, "A fracture never takes place in the central point of the length of the jaw, called the symphysis of the chin; but when the solution of continuity occurs toward the middle of the bone, it is upon one or the other side of the symphysis, which remains always upon one of the fragments;" an opinion which, however, he does not seem always to have entertained, since Richerand, in a report of his lectures, has made him say that a fracture sometimes takes place "near the chin, but seldom so as to produce the division of the symphysis of that part, though it be not impossible." But many surgeons since his time have noticed this fracture, and Malgaigne assures us that J. Cloquet has demonstrated its existence upon an anatomical specimen.

Stephen Smith, of New York, has seen two examples;² Lonsdale mentions three;³ and Gibson has seen one;⁴ and I have met with two, both of which are recorded in the early editions of this book.

Velpeau, Fergusson, Gibson, Henry Smith, and others, have remarked

¹ Buck, *New York Journ. Med.*, March, 1847. *Proceedings of N. Y. Med. and Surg. Soc.*, Sept. 19, 1846.

² Smith, *New York Journ. Med.*, Jan. 1857, *Hospital Reports*.

³ *Practical Treatise on Fractures*. By Edward F. Lonsdale, London, 1838, p. 226.

⁴ *Institutes and Practice of Surgery*. By William Gibson. Philadelphia, 1841, p. 261.

that a separation at the symphysis takes place usually in infancy or childhood. But in the eight examples in which I find the ages reported, only one, a case mentioned by Lonsdale, occurred in a person as young as ten years; in one of the cases seen by myself, the patient was seventeen years old, and the remainder have ranged from twenty-five years to sixty; and the average age of all is thirty-two years.

I have seen one example of a fracture of the ramus, in a man twenty-three years old, who had been struck by a wooden block on the side of his face. The ramus was broken just above the angle, and the body was broken, also, obliquely near the symphysis. The intercepted fragment was carried inwards;¹ and in May, 1869, I met with another similar case at Bellevue Hospital, in a woman; a pharyngeal abscess resulted, threatening suffocation; for which my house surgeon, Dr. Francke Bosworth, performed tracheotomy successfully. Ledran mentions the case of a child, ten or twelve years old, in whom the fracture was double also; one fracture having taken place through the body, and one extending obliquely from the root of the coronoid process to the neck of the condyle. The intercepted fragment was, however, so little displaced that the fracture of the ramus was not discovered until after death.² Malgaigne refers to this as the only example recorded; but Stephen Smith, of the Bellevue Hospital, has met with it four times: in one case the ramus was broken on both sides; in two cases one ramus only was broken; and in one the body was broken on the right side and the ramus on the left.³ In two of these examples the fragments were not displaced.

The coronoid process is so well protected by muscles and by the surrounding bony projections, that it is very rarely broken.

Houzelot mentions a case in which a fall from a height produced at the same time a fracture of both condyles, of both coronoid processes, and of the symphysis.⁴

With this single exception, I am not able to find a recorded example of a fracture of this process.

At least nine cases have been reported of fracture of the condyles, in all of which the separation occurred through the neck, viz., three by Ribes, two by Desault, one by Bérard, one by Houzelot, one by Bichat, one by Packard, of Philadelphia, and two by Watson, of New York; the fracture always occurring through the neck and just below the insertion of the external pterygoid muscle.

According to Malgaigne, the analysis of these cases, excepting those mentioned by Packard and Watson, shows two classes of examples; the one occasioned by falls or blows upon the chin, and producing a simple fracture of the neck of the condyle; the other occasioned by injuries inflicted upon the side of the face, and producing a fracture of the neck on the side corresponding to that upon which the injuries are received, and at the same time a fracture of the body upon the opposite side. These two varieties seem to be about equally common.

¹ *Trans. Amer. Med. Assoc. Report on "Deformities after Fractures,"* vol. viii. p. 385, Case 17.

² Malgaigne, *op. cit.*, p. 337, from Ledran, *Observ. Chirurg.*, tom. i. obs. vii.

³ Smith, *New York Journ. of Med.*, Jan. 1857. *Bellevue Hosp. Reports*.

⁴ Malgaigne, *op. cit.*, p. 400.

In the case mentioned by Houzelot, and already cited, there existed at the same time a fracture of both condyles, of both coronoid processes, and at the symphysis. The man also whom Watson saw in the New York Hospital had fallen from the yard-arm of a vessel, breaking his thigh and arm bones and both condyles of the lower jaw. "His face was somewhat deformed by the retraction of the chin; the mouth could not be opened so as to protrude the tongue to any great extent beyond the teeth, and the teeth of the upper and lower jaws could not be brought into contact. In attempting to move the jaw, the patient experienced pain and crepitation just in front of the ears; the crepitation could easily be felt by placing the fingers over the fractured condyles. Nothing was done for the fractures of the jaw. In a few weeks the rubbing of the broken surfaces and attendant soreness ceased to trouble him; but the shape of the jaw, and difficulty of opening the mouth to any great extent, still remained unaltered."¹

Etiology.—The causes, in such cases as I have myself investigated, seem generally to have been direct blows, in most instances inflicted by a club, or by the kick of a horse; in two examples the blow was inflicted by the fist. I have also seen a fracture immediately in front of the right cuspid, in a lad eight years of age, produced by being pressed between two wagons, the pressure being made upon the two angles of the jaw. A case came under my notice at Bellevue, in 1879, in which a double fracture was produced in a young woman by the grasp of her husband's hand. In ten of eleven cases mentioned by Stephen Smith, the causes were direct blows. Examples of fracture of the inferior maxilla from indirect blows have, however, been mentioned by other surgeons, the angles of the bone being pressed together by the passage of a wheel, and the fracture taking place usually toward the symphysis.

We have already alluded to the observation of Malgaigne, that fractures of the condyles belong to two classes: the one being occasioned by falls upon the chin, and the other by blows upon the side of the face; the former acting as a counter-force, and the latter as a direct.

The coronoid process can only be broken by a direct blow.

Symptoms.—Fractures of the body of the bone are characterized by the usual signs of fracture elsewhere, namely, displacement, mobility, crepitus, and pain.

The displacement is generally present; but its direction and amount vary according to the situation and course of the fracture, and also according to the violence and direction of the force producing the fracture. I have seen several cases unaccompanied with displacement, and one of these I think ought to be regarded as an example of a partial fracture.

A lad, æt. 9, was kicked by a horse on the 22d of June, 1858, the blow being received on the right side of the jaw. I saw him very soon after the accident, but could not detect any fracture, only the body of the jaw seemed to be bent in. On the third day, however, while endeavoring to straighten the jaw by violent pressure from within outwards, I detected a feeble crepitus, which on more careful examination

¹ New York Journ. of Med., Oct. 1840. Hospital Reports.

proved to be opposite the second incisor of the right side. I was also able to detect a slight motion at the same point. It was found impossible to rectify the bending, and no farther efforts were made. After the lapse of nearly a year, the natural curve was found to be partially, but not completely, restored.

Ledran and other surgeons have also seen examples where neither the periosteum nor mucous membrane was torn.

Generally, in fractures of the body, the anterior fragment is depressed; and Malgaigne affirms that where an overlapping occurs, the anterior fragment lies, generally, within the posterior; a fact which he explains by the direction which the line of fracture usually takes, namely, from without, inwards and backwards, as we have already mentioned. In one instance reported by me to the American Medical Association, where the jaw was broken at the symphysis and also on both sides through the body, the central fragments were found, after about four weeks, lifted two lines above the lateral fragments, and also slightly carried backwards.¹ I have twice also met with examples in which the posterior fragments were inclined to fall inwards toward the mouth, a circumstance which seemed to indicate that the course of the obliquity was in a direction opposite to that which Malgaigne has observed to be most frequent. In each of these examples the jaw was broken upon both sides, by blows inflicted with a club, and the fractures were situated well back.² It is possible, however, that the position of the fragments was due rather to the direction and force of the impression than to the direction of the line of fracture.

As to the action of the muscles in the production of displacement, Boyer, S. Cooper, Erichsen, and Malgaigne have observed that their action upon the anterior fragment is greater in proportion as the fracture is nearer the symphysis, and less in proportion as it approaches the angle. So that in the former case the attempt to close the mouth is sometimes attended with a depression of the anterior fragment, causing a separation of the fragments at their alveolar margins; while in the latter case the attempt to close the mouth forcibly is occasionally attended with separation of the fragments along the line of the base.

While I am not prepared to deny the accuracy of these observations, it is proper to notice that Liston found the greatest displacement when the fracture was opposite the first molar; and I must confess that the fact, as stated by Boyer and others, does not seem to admit of a satisfactory explanation, since the number, and consequently the power, of the muscles which act upon the anterior fragment from below is greater in proportion as the line of fracture is further back. These muscles, namely, the digastricus, the genio-hyoglossus, and the mylo-hyoideus, with several other muscles which act less directly, all tend to depress the anterior fragment, and in some slight degree to carry it backwards; a direction which, indeed, it usually takes, and which it would probably always take if left alone to the action of the muscles. If the fracture has occurred through the angle, or at any point within the attachments of the masseter

¹ Trans. Amer. Med. Assoc., vol. viii. p. 380, 1855, Case 6.

² Ibid., Cases 1 and 10.

muscle, the action of those fibres of this muscle which remain connected with the anterior fragment will sufficiently explain the fact that it is not now so easily depressed below the level of the posterior fragment; whilst the separation of the fragments along the line of the base, when an attempt is made to close the jaw forcibly, is probably due to the loosening and partial dislodgement of some of the molars, which, being pressed upwards, act as a pivot upon which the fragments are made to bend.

Boyer affirms, also, that "the fractured portions are never deranged so that one overrides the other in the direction of their length; for the action of none of the muscles of the lower jaw is parallel to the axis of that bone; besides, its extremities are retained in the glenoidal cavities of the temporal bones." But this theory is too exclusive, since the fragments may have become displaced in any direction independently of the muscular action. Moreover, the action of the muscles attached to the anterior fragment, although not parallel to the axis of the bone, does somewhat favor a displacement in this direction; and the action of the pterygoid muscles upon the posterior fragment still further favors this form of displacement.

An overlapping of the fragments in the direction of the axis is, in simple fractures, no doubt, exceptional, and in such examples as I have seen it was very trivial. It occurred in case "three" of my "Report," the fracture being near the mental foramen; in case "two," the fracture being just anterior to the last molar; and also in case "six," where the bone had been broken through the centre of the body on both sides and through the symphysis; but in neither case did the overlapping exceed two or three lines, and it was always easily overcome.

The mobility of the fragments is not so striking in these accidents as in fractures of the long bones, yet it is generally sufficiently marked, and especially where the bone is broken upon both sides at the same time. If only one side is broken, both motion and crepitus will be most easily detected by lateral pressure upon the posterior fragment, which, being the smallest and the least supported by antagonizing muscles, will be found to be the most movable. If the fracture is upon both sides, mobility and crepitus will be most readily developed by seizing upon the anterior fragment and moving it gently up and down, while the finger rests upon the alveolus within the mouth.

Sometimes a slight swelling or tenderness at some point of the dental arcade, or the loosening or complete dislodgement of a tooth, will indicate the point of fracture.

Pain, especially when the fragments are moved, is here more constant than in most other fractures, owing perhaps, in part, to the superficial position of the bone, which renders the soft parts lying over it more liable to injury from the causes of fracture; but also, in part, to the lesions which the inferior dental nerve may have suffered. It is, indeed, a matter of surprise that injury to this nerve does not oftener seriously complicate these accidents, coursing, as it does, through so large a portion of the angle and body of the bone. One might naturally suppose that its complete disruption would often occasion paralysis of those portions of the face to which it is finally distributed, and that its partial lesions and contusions would create, in many cases, the most acute and

constant suffering. It is rare, however, that we have present an amount of pain which might not be attributed to a severe shock, or a slight strain upon its fibres. I have myself never seen any extraordinary suffering distinctly attributable to an injury of the dental nerve after fracture; nor any degree of facial paralysis, except in the case to be hereafter described. Rossi relates a case in which convulsions followed this accident, and in which, as a final remedy, he proposed to expose and bisect the nerve; and Flajani saw a patient, whose jaw had been broken, die in convulsions on the tenth day, the muscular contractions having commenced as early as the fourth day after the accident. The autopsy disclosed a rupture of the dental nerve, but no injury to the brain.

Boyer explained the infrequency of severe injury to the dental nerve by the supposition that the "greater part of these fractures take place between the symphysis and the foramen by which this nerve comes out." An opinion which may be correct, but needs confirmation. I have seen the body or angle broken at points posterior to the mental foramen, and where the nerve lies within its bony canal, at least thirteen times, and in front of the mental foramen nine times; at other times the point of fracture has not been noted with such accuracy as to enable me to say whether it was in front or behind the foramen.

I suspect that a better explanation may be found in the fact that the fragments seldom overlap to any appreciable extent, and that even the displacement in the direction of the diameters of the bone is generally inconsiderable; or, if it does exist, the fragments are easily and promptly replaced.

If the displacement is sufficient to occasion a complete disruption of the nerve, some degree of temporary paralysis in the portions of the face supplied by it must be inevitable; and, perhaps this occurs oftener than it has been noticed, since, during the confinement of the jaw by dressings, it is not likely to be observed, and after the lapse of a few weeks it will probably cease altogether.

Boyer remarks that when it is torn, "the square and triangular muscles of the chin are paralyzed. The skin of that part and the internal membrane of the under lip preserve their sensibility, which it appears they owe to some threads of the portio dura of the seventh pair; but the paralysis of these muscles does not prove of itself that the jaw is fractured." Boyer has, however, noticed this result but once, and then in a case where the bone was broken upon both sides and the soft parts greatly contused. The triangular and square muscles were paralyzed, in consequence of which there was a slight contortion of the mouth. A. Bérard has also mentioned a case of vertical fracture occurring between the second and third molars, without displacement, which was accompanied with complete insensibility of the lip on the same side throughout the space comprised between the commissure and the median line, and between the free border of the lip and the chin. The paralysis disappeared after a few days.¹

At my request, Dr. Frederick S. Dennis, junior assistant at Bellevue Hospital (1874), furnished me with the following account of a case lately

¹ Malgaigne, from Gazette des Hôpitaux, 10 Août, 1841.

presented in one of my wards. I shall take the liberty of condensing somewhat the very full and interesting history which he has furnished me; remarking, however, that the observations are all the result of his own careful investigation.

Kate Campbell, æt. 30, was admitted December 11, 1874, suffering from an attack of acute tonsillitis. I subsequently opened an abscess in the tonsil, and she was soon discharged cured. While taking notes of her case, Dr. Dennis learned the following facts. More than a year before she had received a fracture of the lower jaw, right side, and a distinct callus remained near the angle of the jaw to indicate the point at which the fracture had occurred. Since that time there has existed complete insensibility of that portion of the face which is supplied by the inferior dental nerve and its branches. Careful experiments were made with different substances, and with sharp instruments, all of which indicated "that the nerve was destroyed in the immediate vicinity of the dental foramen. The gustatory nerve, as well as the chorda tympani from the facial, maintained their full physiological functions, both in reference to general sensation, and the special sense of taste. The mylohyoid branch of the inferior dental, which is given off just before the nerve enters the dental foramen, and which is motor in action, was not in the least impaired." Over the entire region supplied by the inferior dental nerve there was complete anaesthesia. Pins, thrust through the integument into the buccal cavity, caused no sensation. "The gums as well as the teeth, on the side corresponding to the fracture, were in a state of analgesia."

The case above described furnishes an example of *permanent* paralysis of the inferior dental nerve, from fracture; and upon this point the following comments made by Dr. Dennis, are of special interest:

"Hæmorrhage into the dental canal, or a slight laceration of the inferior dental nerve, with little displacement of the fragments, may cause a paralysis, which, in the former case after absorption, and in the latter case after repair of nerve-tissues, eventually terminates in complete recovery; but in the case under consideration there is no hope of the restoration of the function of the nerve, as too long a time has intervened, according to the views of the most sanguine neurologists.

"Malgaigne has never seen a case of total destruction of the inferior dental nerve, in which permanent paralysis followed, from a fracture of the lower jaw. He believes the severe pain, which frequently occurs, to be due to cerebritis rather than to injury of this particular nerve. He further states, in his work on "Fractures," that the cases in which the nerve is injured, even in a slight degree, are very rare.

"Petit, Rossi, Flajani, Foucher, Robert, and many other writers on this subject, give examples where the paralysis was of short duration; and they say that they have never seen a case where the paralysis remained permanent. The only cases that can be found, in the researches that have been made, where the paralysis was permanent, is one reported by Desirabode in the *Journ. des Connaissances*, 1857, No. 20, p. 538; and in this case the symptoms of injury of the inferior dental nerve are identical with those found in the case of Kate Campbell. The paralysis, in the case which Desirabode reports, was caused by a crude dental

instrument, which tore the alveolar processes of seven teeth, and exposed the dental canal."

To these signs now enumerated, we may add as occasional complications, rather than as diagnostic symptoms, salivation, swelling of the submaxillary and sublingual glands, abscesses, necrosis, etc. If the blow has been vertical upon the chin, and the direction of its force has been toward the articulations, the bony structure of the ear, and even the brain, may have suffered serious lesions, which may be indicated by a deafness or a roaring in the ears, by bleeding from the external meatus, and by fatal coma. Tessier saw a man who had received the kick of a horse exactly upon the centre of the chin, breaking the bone on both sides, and who, in consequence, bled freely from his ears;¹ and Alix relates the case of a young man who, falling from a height and striking upon his chin, had broken his jaw. Insensibility immediately followed; convulsions also ensued upon the fourth day, and he died upon the sixth.²

If the fracture is at the symphysis, it is generally vertical, and either fragment may be found slightly displaced upwards or downwards. In one of the examples seen by myself, the left fragment fell three lines below the right, and in another the right side had fallen about one line. In a case mentioned by Syme there was scarcely any displacement.³ Liston remarks that it is usually slight. Erichsen and B. Cooper have observed the same.

The signs which indicate a fracture through the angle have already been sufficiently considered when speaking of fractures of the body: from which it only differs in the less degree of displacement, and in the fact that the posterior fragments are a little more prone to fall inwards toward the mouth. I have noticed, also, that, owing probably to the loosening and partial dislodgement of the last molar, it is sometimes difficult to close the mouth, the same as in the fractures a little farther forwards.

In each of the two examples of fracture of the ascending ramus which I have seen, the bone being broken also through its body, the fracture of the ramus was recognized by both crepitus and mobility.

As to the signs which indicate a fracture of the coronoid process, I am only able to infer them from its anatomical relations. There must be some embarrassment in the motions of the jaw, occasioned by the detachment of a portion of the fibres of the temporal muscle; and it is probable that an examination by the finger within the mouth would readily detect mobility and displacement.

A fracture through the neck of the condyle is characterized by pain at the seat of fracture, especially recognized when an attempt is made to open or shut the mouth, by embarrassment in the motions of the jaw, by crepitus, which may usually be felt or heard by the patient himself, by mobility and displacement.

The upper fragment, if disengaged from the lower, is drawn forwards, upwards, and inwards, by the action of the pterygoideus externus; and it is felt not to accompany the movements of the lower fragment.

¹ Malgaigne, pp. 383 and 386, from *Journ. de Méd.*, 1789, tom lxxix p. 246]

² *Ibid.*, p. 386, from Alix, *Observata Chir.*, fascic. 1, obs. 10.

³ *Amer. Journ. Med. Sci.*, vol. xviii. p. 243.

The lower fragment is at the same time drawn upwards, in consequence of which the lower part of the face is distorted; a circumstance first noticed by Ribes, and which supplies an important diagnostic mark between a fracture of one condyle and a dislocation. In dislocation the chin is commonly thrown to one side, but it is to the side opposite that on which the dislocation has occurred, while in fracture the chin is drawn to the same side.

Prognosis.—Physick, of Philadelphia, saw a case of non-union of the body of this bone which had existed nine months.¹ Dupuytren mentions a case which had existed three years.² Stephen Smith, of New York, reports a case of fracture of both the body and the ramus, in a man forty-five years old. The severity of the injury, with the supervention of delirium tremens, prevented the application of dressings until the thirteenth day. On the twentieth day about a pint of blood was lost by hæmorrhage from the seat of fracture. He remained in the hospital one hundred and thirty-seven days, and was finally discharged, the fragments not having yet united.³ I have seen four examples of fibrous union. In Dr. Muhlenberg's tables sixteen examples are enumerated out of a total of six hundred and fifty-six cases of non-union and delayed union.⁴ In no instance of a simple fracture which has come under my personal care from the first, has the bone refused finally to unite, although I have seen the union delayed six, seven, ten, and even eleven weeks or more.⁵ In three of these cases the fractures were either compound or comminuted; but in one case the fracture was simple, the delay in the union being due to a feeble condition of the system, and in part, perhaps, to neglect of proper treatment. Since the commencement of the late war I have met with several examples of non-union, and of fibrous union, after gunshot fractures; but, so far as I can remember, in all of these cases necrosis existed, or some portions of the bone had been carried away.

The infrequency of non-union after this fracture is a fact worthy of especial attention, because of the extreme difficulty, if not actual impossibility, in many cases, of wholly preventing motion between the fragments, by any mode of dressing yet devised. Any one who has observed attentively, must have seen, not only that his dressings are more often found disturbed and loosened than in the case of almost any other fracture, unless it be the clavicle, and thus the fragments have been through all the treatment subjected to frequent changes of position; but, also, that even while the dressings remain snugly in place, the patient seldom is able to perform the necessary acts of deglutition, or to speak, even, without inflicting some slight motion upon the fragments.

Indeed, the rapidity as well as certainty with which this bone unites, has, I think, been observed by other surgeons, and I have myself noticed one instance, in an adult person, in which the bone was immovable at the seat of fracture on the seventeenth day, and perhaps earlier. In other instances, the union has been speedily effected after the removal of all dressings.

¹ Phila. Med. and Surg. Journ., vol. v.

² Leçons Orales.

³ Smith, New York Journ. of Med. and Surg., Jan. 1857.

⁴ Agnew's Surg., op. cit., vol. i. p. 804.

⁵ My Report on Deformities after Fractures, Cases 2, 14, 15, 18.

The amount of deformity resulting, also, from these fractures is usually very trifling, whatever treatment has been adopted. Only nine of the united fractures, seen and recorded by me, are imperfect, and in none of these is the imperfection such as to be noticed in a casual examination of the face. The deformity which is usually found, is a slight irregularity of the teeth, produced, in most cases, by a falling of the anterior fragment, but in one case by a slight elevation of the anterior fragment. But even this does not always interfere with mastication, and would often pass unnoticed by the patient himself. It is probable, too, that time, and the constant use of the lower jaw in mastication, will gradually effect a marked improvement in the ability to bring the opposing teeth into contact. I think I have observed this in several instances.

In a letter dated Sept. 30, 1876, Dr. John H. Packard, of Philadelphia, informs me that in a case of fracture of the lower jaw, occurring near the left anterior mental foramen, the right fragment was so forcibly displaced downwards, by the action of the muscles, that he was obliged to sever their attachments at the symphysis, in order to retain the fragments in place.

Chelius remarks that in "double or oblique fractures it is very difficult to keep the broken ends in their proper place; deformity and displacement of the natural position of the teeth commonly remain."

In the second example of fracture through the symphysis mentioned by me, the left fragment remained slightly elevated, and the patient could not close his teeth perfectly, yet he could close them sufficiently for the purposes of mastication. It is probable, however, that ordinarily no difficulty will be experienced in accomplishing a perfect cure when the separation has taken place only at the symphysis.

In fractures of the condyles, more care is requisite to retain the fragments in apposition, and sometimes it may be found to be impossible. Richerand mentions the case of a man, who, having been three months in the Hôpital de la Charité, for a double fracture of the lower jaw, one fracture being near the middle, and the other near the right condyle, left before the cure was complete. Seven or eight months after, he called upon Boyer, who extracted, from a fistula in the meatus auditorius externus, a bony mass which had evidently the form of the condyle.¹ Bichat mentions a similar case as having come under the observation of Desault;² possibly it was the same which Boyer saw. Ribes says that a Parisian surgeon treated a double fracture of the jaw in a gentleman, one fracture being through the body and the other through the neck of the condyle; and, in spite of the most assiduous and skilful attention, the patient recovered with a lateral distortion of the jaw, occasioned by the displacement of the fragments.³ Ribes himself had to treat an accident of a similar character, and, notwithstanding all his care, the result was the same as in the other example just cited.⁴ Fountain, of Iowa, was much more fortunate, having made a complete and perfect cure.⁵

The proximity of this fracture to the articulating surface may occasion

¹ Boyer, Lectures on Dis. of Bones, p. 53, Phila. ed., 1805.

² Desault, Treatise on Fractures and Luxations, Phila. ed., 1805, p. 3.

³ Malgaigne, op. cit., p. 402.

⁴ Ibid., p. 402.

⁵ Fountain, New York Journ. Med., Jan. 1860.

contraction of the ligaments about the joint; and a degree of embarrassment to the motions of the jaw has followed in the experience of Desault and others, even when the cure has been most complete; but this has usually remained only for a short period.

Sanson asserts that when the coronoid process is broken, the fracture never unites; but that mastication is performed very well, the masseter and pterygoid muscles then fulfilling the office of the temporal.¹

Treatment.—The few attempts which I have made to restore a completely dislocated tooth to its socket, or to retain it in place when very much loosened, have generally resulted in its removal at some later day, and especially where the fracture has been near the angle and a molar has been disturbed. I believe it would be better practice always to remove the molars under these circumstances, unless they remain attached to the alveoli, and cannot be removed without bringing them away also; and this, whether the loosened teeth are situated in the line of fracture or not. It is seldom that they can be made again to occupy their sockets perfectly, and where the teeth are in the line of the fracture, the attempt to restore them to place will sometimes prevent the proper adjustment of the fragments. In cases, also, in which the teeth farther forwards are completely dislodged at the seat of fracture, it is scarcely worth while to replace them.

As to those teeth whose loosened condition is due only to a splitting of the alveoli in a longitudinal direction, the same rule will not always apply. Sometimes, after a careful readjustment, the fragments will reunite, and the teeth remain firm.

If the bone is chipped off upon the outside, through or near the line of the sockets, the teeth may be not always much disturbed, and the loss of the fragments may be of less consequence, nor have I generally succeeded in saving them; yet, if they remain adherent to the soft parts, it is proper to make the attempt.

The expedients to which surgeons have resorted for the purpose of retaining in place the fragments, when the bone is broken through its body, may be arranged under the names of ligatures, splints, bandages, and slings.

The ligature has been applied both to the teeth and to the bone itself. Thus, in an oblique fracture near the angle, where the fragments could not otherwise be prevented from falling inwards, Baudens passed a strong ligature, formed of thread, around the fragments and in immediate contact with them, tying the ligature over the teeth within the mouth. No accident followed, and on the twenty-third day, when he removed the ligature, the bone had united firmly and smoothly.²

Picharel and Béranger-Féraud have successfully practised the same method in certain very oblique fractures of this bone, where it seemed impracticable to employ other means.³

In most cases, however, the ligature, when applied directly to the bone, has been employed as a suture, in the form of metallic wire. Thus, in the

¹ S. Cooper's First Lines, Amer. ed., 1844, vol. ii. p. 311.

² Malgaigne, op. cit., p. 398.

³ Béranger-Féraud, Traité de immobilization direct. Paris, 1870. (Poincot.)

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. Buck 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 become 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."¹ Dr. R. A. Kinloch, of Charleston, S. C., has reported a similar case, in which he employed successfully the wire.²

In May, 1858, while trephining at the angle of the jaw for the purpose of cutting out a portion of the dental nerve in a patient suffering from neuralgia, I accidentally broke the jaw in two at the point at which the trephine was applied. I immediately bored a hole in the opposite extremities of the two fragments, and fastened them together with a silver wire, by which I was able to maintain complete apposition, and in three weeks the union was accomplished, the wire separating and falling out of itself. No splints were ever used.³

James O'Neill, æt. 38, received a fracture of the inferior maxilla on the right side, between the second bicuspid and second molar. He came under my notice May 5th, nearly three months after the accident occurred. The fragments were united with a fibrous band, and with a good deal of displacement. I sent him to a dental infirmary, but the efforts to replace and retain the fragments, made by the gentleman in charge, were unsuccessful, and on the 20th of June following I operated, by making an external incision to the point of fracture, exposing the bone thoroughly, and, having freshened the broken surfaces, the fragments were perforated and secured in apposition with a silver wire. August 12th the ligature was removed, a bony union being effected with but little displacement. Other surgeons have reported similar successful examples.⁴

My experience has been that the perforations must be made perpendicularly, not obliquely, through the fragments, and some distance from their margins; and that to withdraw the wire or to return it from within

¹ New York Journ. of Med., etc., March, 1847, p. 211.

² Kinloch, Am. Journ. Med. Sci., July, 1859, p. 67.

³ Buffalo Med. Journ., vol. xiv. p. 148.

⁴ Béranger-Féraud. (Poincot.)

outwards, an instrument with a straight shaft, rather smaller than the perforation, and furnished with an abruptly curved, blunt extremity, is required. The wire should be large, strong, and flexible, and the perforation should be twice as large as the wire. The instrument and method devised by Mr. Thomas, Liverpool, in 1863, and reprinted in Kingsley's work on "Oral Deformities," is not satisfactory.

Ordinarily the ligature has been employed only as a means of retention, by fastening it upon the teeth, either upon those which are situated on the opposite sides of the fracture, or upon others a little more remote, or upon the corresponding teeth of the upper jaw, or upon the teeth on the opposite sides of the same jaw.

In most cases the ligature, composed of either fine gold, platinum, or silver wire, or firm silk or linen threads—(Celsus advised the use of horsehair)—has been applied to the two teeth on the opposite sides of the fracture, or, if these have not been sufficiently firm, to the next teeth. This practice, recommended first by Hippocrates, has received the occasional sanction of Ryff, Walner, Chelius, Lizars, Erichsen, Miller, B. Cooper, Skey, and others, but by Boyer, Gibson, and Malgaigne it has been disapproved.

Dr. S. G. Ellis, of New York, as we have already seen, has treated a fracture, occurring through the symphysis, in an adult, by placing the mainspring of a watch within the dental arcade, and securing it in place with silver wire. The mouth was kept closed by bandages carried under the chin. The fragments united with only a slight vertical displacement.¹

Dr. George Hayward, of Boston, surgeon to the Massachusetts General Hospital, says: "When the bone is not comminuted and there are teeth on each side of the fracture, the ends of the bone can be kept in exact apposition by passing a silver wire or strong thread around these teeth and tying it tightly. In several cases of fracture of the jaw, in which the bone was broken in one place only, I have, in the course of the last few years, adopted this practice with entire success, and without the aid of any other means. It will be found very useful, also, as an auxiliary, in more severe cases, in which it may be required to use splints and bandages, or to insert a piece of cork between the jaws, as recommended by Delpech. It requires some mechanical dexterity to apply the thread neatly; but in large cities we can avail ourselves of the skill of dentists for this purpose."² I have myself in two or three instances used a linen thread with excellent results.

Guilio Saliceto advises to secure with a silk thread, at the same moment, the teeth belonging to the two fragments, and the corresponding teeth of the upper jaw;³ whilst the dentist Lemaire, being applied to by Dupuytren to secure in place the ununited fragments of a broken jaw, fastened the two left canine teeth to each other by a wire of platinum, as had been already suggested by Guilio Saliceto; to those he added two other modes of ligature which were altogether original. One wire, fastened to the last molar upon one side, traversed the mouth and was

¹ Trans. Amer. Med. Assoc. My Report on "Deformities," etc., vol. viii. p. 388, Case 14.

² Boston Med. and Surg. Journ., vol. xix. p. 133, 1838.

³ Malgaigne, op. cit., p. 392.

secured to one of the bicuspid upon the opposite side; the other was stretched from the first inferior bicuspid on the right to the first superior bicuspid on the left. A cure was accomplished at the end of two months, but one of the wires had nearly bisected the tongue; and as it had gradually become imbedded, the flesh had closed over it until it rested like a seton through the middle of the tongue.¹

None of these various methods, however, will in general be found to possess much value; for besides that they are all of them, in a large majority of cases, wholly unnecessary, and in other cases, owing to the absence of the teeth, or to their loosened or decayed condition, or to the closeness with which they are set against each other, absolutely impracticable, it must be seen, also, that they will generally prove feeble and inefficient. The wires act only upon the upper extremity of the line of fracture, leaving its lower portion liable to be disturbed by trivial causes; they tend gradually to loosen even the firm teeth which they embrace, and not unfrequently, after having been made fast with much labor, they soon become disarranged or break. They require, therefore, almost always the additional protection afforded by bandages, interdental splints, etc. Alone they are usually insufficient, and if properly constructed bandages, slings, interdental splints, etc., are employed, they are not needed. Sometimes, moreover, they are actually mischievous, as when they loosen a sound tooth or press upon and inflame the gums. A. Bérard passed a silver wire twice around the necks of two adjoining teeth on the opposite sides of a fracture. It retained the fragments perfectly in apposition during several days; but soon the gums swelled and became painful; the teeth loosened, and it was found necessary to remove the wire. Chassaignac sought to avoid these evils by placing the wire upon the middle of the crown, free from the gums, and by including four teeth instead of two. A waxed linen thread was made fast in this manner, in a case of simple fracture, on the seventh day. On the following morning the thread was found broken. He applied then a silk ligature in the same manner. On about the third day this also was disarranged; the ligatures were now discontinued until the eighteenth day, when he renewed the experiment with a piece of gold wire. Fourteen days after this the ligature remained firm, but the gums were red and bleeding. The patient not having again returned to Chassaignac, the result is not known.²

As to the method suggested by Guilio Saliceto, it presents no advantages to compensate for its inconveniences; while that actually practised by the dentist Lemaire, successful indeed, threatened to substitute a loss of the tongue for an ununited fracture of the jaw.

Splints have been employed in various ways. First, simply interdental splints, laid along the crowns of the teeth, and only sufficiently grooved to be easily retained in place; second, clasps, which are applied over the crowns and sides of the teeth, operating chiefly by their lateral pressure, or made fast by screws; third, splints applied to the outer and inferior margin of the jaw; fourth, interdental splints combined with outside splints.

¹ Journ. Univer. des Sci. Méd., tom. xix. p. 77.

² Lond. Med. and Phys. Journ., Nov. 1822, p. 401.

Interdental splints have been recommended by many surgeons from an early day, and they continue to be employed occasionally up to this moment.

Boyer advises the use of cork splints, placed one on each side between the upper and lower jaws, in a few exceptional cases. Miller recommends the same in all cases, the "two edges of cork sloping gently backwards, with their upper and under surfaces grooved for the reception of the upper and lower teeth." Fergusson also has usually adopted the same practice. Muys and Bertrandi employed ivory wedges.¹

On the other hand, interdental splints are rejected entirely by Syme, Chelius, Skey, Erichsen, and Gibson.

The objections which have been stated to their use are: that they are unsteady and become easily loosened and disarranged; that they occasionally press painfully upon the inside of the cheeks; that they accumulate about themselves an offensive sordes; and finally that they are unnecessary, since experience has proven, says Gibson, that "there is always sufficient space between the teeth to enable the patient to imbibe broth or any other thin fluid placed between the teeth."

It is not strictly true, however, that in all cases there will be found sufficient space between the teeth, when the mouth is closed, for the imbibition of nutrient fluids. I have myself seen exceptions; and in such a case the patient, if the mouth were closed in the usual way, would have to be fed through a tube conveyed along the nostrils into the stomach, as suggested by both Samuel and Bransby Cooper in certain bad compound fractures, or through an opening made by the extraction of one of the front teeth; neither of which methods ought to be preferred to the interdental splints; but then the separation of the front teeth for the purpose of receiving food, is by no means the only object to be gained by their use, nor indeed the principal object. Their great purpose is to act as splints whenever the absence of teeth, either in the upper or lower jaw, renders the two corresponding arcades unequal and irregular, and prevents our making use of the upper as a kind of internal splint for the lower jaw.

It is with a view to the accomplishment of this important end that they are often valuable, and ought sometimes to be considered as indispensable. I believe also, that many of the inconveniences which have been found to attend the use of cork or wood, are obviated by the substitution of gutta percha in the manner which I recommended to the profession in 1849,² and also again in my report to the American Medical Association, made in the year 1855.

The mode of preparing gutta percha, and of adapting it between the teeth, is as follows: Dip a couple of pieces of the gum, of a proper size, into hot water; and when they are softened, mould them into wedge-shaped blocks, and carry them to their appropriate places between the back teeth on each side of the mouth; taking care, of course, that on the fractured side the splint extends sufficiently far forwards to traverse thoroughly the line of fracture. Now press up each horizontal ramus of the jaw until the mouth is sufficiently closed, and the line of the inferior margin is

¹ Lond. Med.-Chir. Rev., vol. xx. p. 470.

² Buffalo Med. and Surg. Journ., vol. v. p. 144, Aug. 1849.

straight; in this position retain the fragments a few minutes, until the gum has well hardened. Meantime it will be practicable, generally, to introduce the fingers into the mouth, and to press the gutta percha laterally on each side toward the teeth, and thus to make its position more secure. When it is hardened, remove the splints, for the purpose of determining more precisely that they are properly shaped and fitted.

It is scarcely necessary to say that in carrying the long wedge-shaped block into the mouth, the apex of the wedge is to be introduced first.

The superiority of this splint is now at once perceived. If properly made, it is smooth upon its surface, and not, therefore, so liable to irritate the mouth as wood or cork, and it is so moulded to the teeth that it will never become displaced. It possesses this advantage, also, that in case more or less of the teeth are gone in either the upper or lower jaw, it fills up the vacancies, and renders the support uniform and steady.

The "clasp," applied over the crowns and sides of teeth, is not intended to act as an interdental splint; but by its lateral pressure it is expected to hold the fragments in apposition upon nearly the same principle with the ligature.

Mütter, of Philadelphia, and N. R. Smith, of Baltimore, employ for this purpose a plate of silver, folded snugly over the tops and sides of two or more teeth adjacent to the fracture.

Nicole, of Neubourg, employed for the same purpose a couple of steel plates fitted accurately along the anterior and posterior dental curvatures, secured in place by a steel clasp, the clasp being furnished with a thumb-screw, in order the more effectually to accomplish the lateral pressure.

Malgaigne has extended the idea of Nicole, by substituting for the two steel plates a single plate composed of flexible and ductile iron, which is fitted accurately to all the irregularities of the posterior dental arch. From the two extremities of this plate, and from two other intermediate points, four small steel shafts arise perpendicularly, cross the crowns of the teeth at right angles, and then fall down again perpendicularly upon the anterior dental arcade. Each steel shaft being furnished with a thumb-screw, the iron plate can now be made to bear against the teeth so as to form a posterior dental splint. The teeth are also protected in front against the direct action of the thumb-screw by the interposition of a leaden plate.

J. B. Gunning, dentist, of New York, substituted for all these materials vulcanized India-rubber, which he employs both as a clasp and as an interdental splint; and, according to Dr. Covey,¹ the same material has been used with excellent results by J. B. Bean, dentist, of Atlanta, Ga. The following is Dr. Bean's plan of procedure:

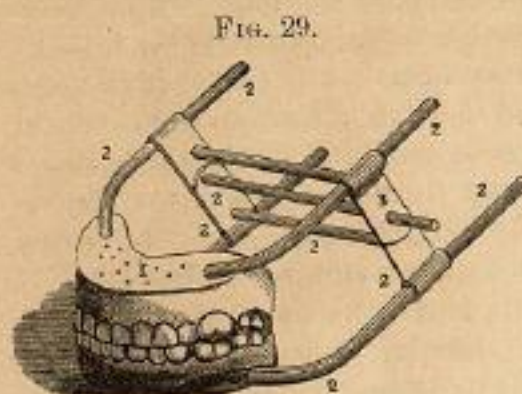
An impression is taken in wax of the crowns of the teeth of the uninjured jaw, and of each fragment separately of the broken jaw. When, in doing this, the ordinary "impression cup" used by dentists cannot be introduced, one composed of a thin metallic plate, which is covered with wax and stiffened by a rim of wire, may be substituted.

"From these impressions are made casts of plaster of Paris, very

¹ Bean, Richmond Med. Journ., Feb. 1866.

carefully prepared, so as to produce a smooth, hard surface, and giving as perfect a representation of the teeth as possible. These plaster models are then adjusted, properly antagonized in their normal position, and placed in the maxillary articulator.

"The fragments of the model representing the broken jaw are held in their proper position by wax, being secured thus one to the other, and to



Maxillary Articulator.
1, 1. Upper and lower plates.
2, 2. Adjustable rods.
3, 3. Adjustable hinge.

the remaining plate of the articulator." . . . The model jaws are now opened from three to five lines, and a wax model of a splint is built up between the molars, covering also the inner and outer surfaces of the teeth. A connecting band of wax is laid from one side to the other behind the upper front teeth, leaving thus an opening in front for the reception of food. This wax and plaster model, now composing one piece, is then removed from the articulator, and placed in a dentist's "flask," and a complete

mould of the model is again formed from plaster laid on in sections, in a manner which those accustomed to make plaster moulds will readily understand. The plaster having fairly set, the flask and mould are opened, the wax carefully removed, and the spaces thus left in the mould at once filled with the rubber rendered soft by heat. The mould is again closed, replaced in the flask, and by heat the rubber is thoroughly vulcanized. The flask is again opened, the plaster removed, and an interdental splint of rubber remains, which is fitted accurately to all the surfaces of the teeth both above and below.

The splint is now placed in the mouth, adjusted to the teeth, and the lower jaw secured in position by the apparatus represented in the accompanying woodcut.

Dr. Covey says that, during the late war, Dr. Bean was placed in charge of a hospital at Macon, Georgia, devoted exclusively to the reception of this class of injuries, and that over forty cases were treated, and with eminent success.

My own judgment of this apparatus is, that, so far as the substitution of vulcanized rubber for gutta percha is concerned, it is wholly unnecessary in the great majority of simple fractures of the jaw. Gutta percha is applied with great facility, and with equal accuracy to all the dental surfaces, and it speedily hardens sufficiently for all practical purposes.

In gunshot fractures, however, and in certain other badly comminuted fractures, I can well understand how the surgeon may advantageously avail himself of vulcanized rubber, which, being somewhat harder, may be made to grasp the teeth attached to the several fragments more firmly; and, indeed, may, in a few cases, allow of the teeth being made fast to the splint by screws.

It will be observed that these are the cases which Dr. Bean has had chiefly under treatment.

An examination of the cases recorded by Dr. Covey will also show that the apparatus was never applied earlier than the tenth day, even when the patients were under the charge of Dr. Bean from the first, and that in most cases the application of the apparatus was delayed to a much later period. Indeed, it is apparent that there may be the same reasons for occasional delay in the application of vulcanized rubber as in the application of gutta percha, or any other mode of support and dressing.

In reference to the head apparatus, or sling, as used by Dr. Bean, I have only a single remark to make. It is a modification of the apparatus employed for many years by myself—the modification consisting in the use of a horizontal piece of wood supporting a cup which is placed under the chin, the purpose of which is to prevent the lateral pressure usually made by the maxillary bands. The necessity of avoiding lateral pressure in certain cases has long been recognized by myself and others; and it has been found to be especially important in all comminuted and gunshot fractures. To the attainment of this purpose, I have employed usually a firm gutta-percha splint under the chin, to the projecting lateral extremities of which the maxillary bands have been attached; and I think it much better than Dr. Bean's piece of wood. In a great majority of cases, however, occurring in civil practice, that is to say, in most simple fractures, this submental splint is unnecessary, since the lateral pressure is harmless, especially when the interdental splints of gutta percha or of vulcanized rubber are employed.

In short, while I am prepared to admit that Dr. Bean has by his *appareil*, and by the application of great mechanical skill, talent, and industry, treated successfully many cases which, by other appliances and in other hands might have resulted most unfortunately, yet it is plain that his method will find its field of usefulness in civil practice limited to exceptional cases.

Dr. J. S. Prout, of Brooklyn, New York, has suggested to me a very ingenious mode of employing the interdental splint and wire ligature conjointly, and which method, at my request, he adopted recently in a case under my care at Bellevue Hospital. A plate of gutta percha was placed upon the top of the teeth across the line of fracture, and this was secured in position by silver wire, which had been made to grasp firmly the crowns of the adjacent teeth, and was then brought over the horizontal gutta-percha plate. In this case it accomplished all that was desired.

External splints, applied along the base or outside of the jaw, were first recommended by Paré, who used for this purpose leather; and they have been employed in some form, occasionally, by most surgeons. Gen-

FIG. 30.



Bean's apparatus for broken jaw, applied.

erally they have been composed of flexible materials, such as wetted pasteboard, first recommended by Heister, felt, linen saturated with the whites of eggs, paste, dextrine, or starch; plaster of Paris has also been used; and they have been retained in place by either bandages or the sling. As before stated, I have myself used as a sub-mental splint gutta percha, and I shall speak of it again as a part of one form of my sling dressing.

Undoubtedly useful, and even necessary in some cases, especially where there exists a great tendency to a vertical displacement, they will be found, also, in many cases, to render no essential service, and may properly enough be dispensed with.

Whatever objections hold to the use of metallic clasps, must apply in some degree to the use of those forms of apparatus in which it is attempted to secure the fragments by means of a combination of these clasps with outside splints, and in which it is proposed to dispense with all bandages or slings, the mouth being permitted to open and close freely during the whole treatment. Motion of the jaw cannot be permitted in any case where the fracture is far back, since it is then impossible to grasp the posterior fragment between the two parallel splints. Nothing but complete immobility of the jaw will now insure immobility to the fracture. Some of these forms of apparatus are liable to additional objections, which will be readily suggested by an explanation of their mode of construction.

Chopart and Desault originated this idea as early as 1780, for fractures occurring upon both sides; in which cases they advised "bandages composed of crotchets of iron or of steel, placed over the teeth, upon the alveolar margin, covered with cork or with plates of lead, and fastened by thumb-screws to a plate of sheet-iron, or to some other material under the jaw."

The apparatus invented by Rutenick, a German surgeon, in 1799, and improved by Kluge, is thus described by Dr. Chester: "It consists, 1st, of small silver grooves, varying in size according as they are to be placed on the incisors or molars, and long enough to extend over the crowns of four teeth; 2d, of a small piece of board, adapted to the lower surface of the jaw, and in shape resembling a horseshoe, having at its two horns two holes on each side; 3d, of steel hooks of various sizes, each having at one extremity an arch for the reception of the lower lip, and another smaller for securing it over the silver channels on the teeth, and at the other end a screw to pass through the horseshoe splint, and to be secured to it by a nut and a horizontal branch at its lower surface; 4th, of a cap or silk nightcap to remain on the head; and, 5th, of a compress corresponding in shape and size with the splint. The net or cap having been placed on the head, and the two straps fastened to it on each side, one immediately in front of the ear and the other about three inches farther back, which are to retain the splint in its position by passing through the two holes in each horn, a silver channel is placed on the four teeth nearest to the fracture; on this the small arch of the book is placed, and the screw end, having been passed through a hole in the splint, is screwed firmly to it by the nut, after a compress has been placed between the splint and the integuments below the jaw.

"If there is a double fracture, two channels and two hooks must, of course, be used."¹

Bush invented a similar apparatus in 1822,² and Houzelot in 1826; since which the apparatus has been variously modified by Jousset, Lonsdale, Malgaigne, and perhaps others.

Lonsdale says he has employed his instrument in numerous cases, and with complete success.³ Rutenick succeeded with his apparatus in a case where the displacement persisted in spite of all other means.⁴ Jousset was also successful in two cases.⁵ Wales, Asst. Surg. U. S. Navy, succeeded with an instrument of his own invention.⁶

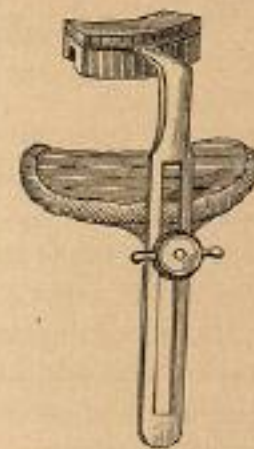
But others have not been equally fortunate; or, if they have succeeded in holding the fragments in apposition, and in securing a bony union, other serious accidents have followed.

In the first case mentioned by Houzelot, the instrument was kept on thirteen days, after which an attack of epilepsy deranged everything, and the patient was transferred to Bicêtre. The second patient complained immediately of an intense pain under the chin, and a profuse salivation followed. These symptoms were subdued by the sixth day, but, for some reason, the apparatus was finally removed on the tenth day. The fragments thereafter showed no tendency to derangement. Seven days after its removal, an abscess which had formed under the chin, was opened. In the third case the apparatus was left in place thirty days, and an abscess formed also under the chin. Neucourt applied it in a double fracture where the central fragment was much displaced. The apposition was well preserved, but he was obliged to remove it on the seventeenth day on account of a phlegmon which was forming under the chin. The patient to whom Bush applied his apparatus would wear it but a few days. Malgaigne had the same experience with Bush's apparatus.

In addition to the pain and inflammation, followed by submaxillary abscesses, which have been such frequent results of its use, Malgaigne has noticed that it is exceedingly inclined to slide forwards and become displaced.

In short, notwithstanding the unqualified testimony of Lonsdale in favor of this method of treatment, especially in fractures at the symphysis, and in fractures through any portion of the shaft anterior to the masseter muscle, it is, in my judgment, applicable to only a very limited number of cases; but if I were to recommend any form of apparatus constructed with a view of permitting mobility of the jaws during the process of union, it would be that invented by Norman Kingsley, dentist,

FIG. 31.



Houzelot's apparatus.

¹ London Med.-Chir. Rev., vol. xx. p. 471; from Monthly Archives of the Medical Sciences, 1834.

² Malgaigne, op. cit., p. 395.

³ Lonsdale, Practical Treatise on Fractures; London, 1838, p. 234.

⁴ Malgaigne, op. cit., p. 396.

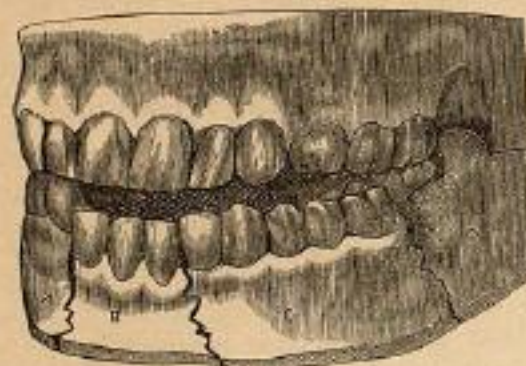
⁵ Ibid., p. 396.

⁶ Wales, Am. Journ. Med. Sci., Oct. 1860.

of this city, and which I have seen used with excellent results at Bellevue Hospital.

Impressions in plaster are first taken of both upper and lower jaws. Models made from these impressions will represent the lower jaw broken and the fragments displaced. The model of the lower jaw is then separated at the point representing the fracture, and the fragments adjusted to the model of the upper jaw. In most cases the position which these

FIG. 32.



Plaster model of jaws.

fragments assume when thus placed determines accurately the original form and position of the lower jaw. Upon the plaster model of the lower jaw, obtained and rectified in this way, a splint or clasp of vulcanite rubber is then made, embracing the arms, which are made of steel wire, one-sixteenth of an inch in diameter. The arms must curve upwards a little as they emerge from the mouth, to avoid pressure upon the

lips, and then curve backwards, terminating near the angles of the jaw.

When the apparatus is applied, the teeth must be pushed into the sockets of the splint with some force. The dressing is now completed by a sling made of strong muslin, extending beneath the chin from one arm to the other.

Dr. Kingsley says, in his late excellent work on "Oral Deformities," that he was not aware of the fact until recently that Mr. Hayward, of London, had so early as 1858 constructed a similar, but, as I think, less perfect apparatus.¹

George L. Fitch, dentist, California, believes that "dental gutta percha" may be made to answer the same purpose as vulcanite rubber, in the construction of this and other similar splints.² In this opinion, however, Dr. Kingsley does not concur.

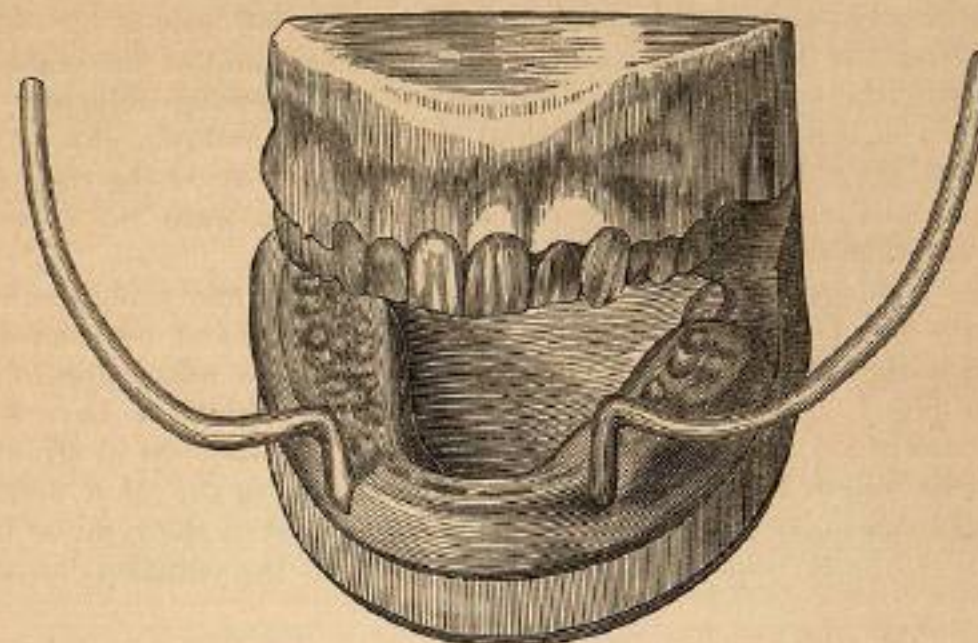
The treatment of fractures of the inferior maxilla by a single-headed bandage or roller, numbers among its distinguished advocates the names of William Gibson and J. Rhea Barton, of Philadelphia. Gibson gives the following directions for applying his roller: "A cotton or linen compress, of moderate thickness, reaching from the angle of the jaw nearly to the chin, is placed beneath, and held by an assistant, while the surgeon takes a roller, four or five yards long, an inch and a half wide, and passes it by several successive turns under the jaw, up along the sides of the face, and over the head; now changing the course of the bandage, he causes it to pass off at a right angle from the perpendicular cast, and to encircle the temple, occiput, and forehead, horizontally, by several turns; finally, to render the whole more secure, several additional horizontal turns are made around the back of the neck, under the ear, along

¹ "Oral Deformities," by Norman W. Kingsley, M.D.S., D.D.S., New York, pp. 397-399. Appleton, 1880.

² Fitch, New York Med. Gazette, 1869.

the base of the jaw, under the point of the chin. To prevent the roller from slipping or changing its position, a short piece may be secured by

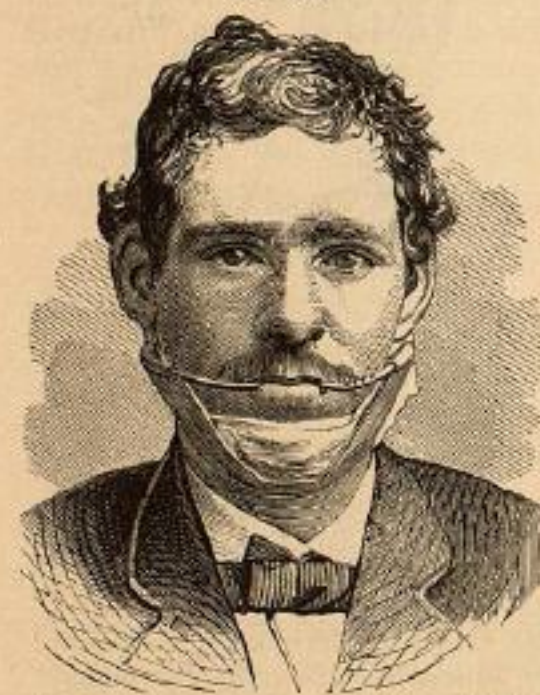
FIG. 33.



Kingsley's apparatus applied to model. (From Kingsley.)

a pin to the horizontal turn that encircles the forehead, and passed backwards along the centre of the head as far as the neck, where it must be

FIG. 34.



Kingsley's apparatus applied to patient. (From Kingsley.)

FIG. 35.



Gibson's bandage for a fractured jaw.

tacked to the lower horizontal turn—taking care to fix one or more pins at every point at which the roller has crossed."

Barton employed, also, a compress, and a roller five yards long, the

application of which is thus described by Sargent: Place the initial extremity of the roller upon the occiput, just below its protuberance, and conduct the cylinder obliquely over the centre of the left parietal bone to the top of the head; thence descend across the right temple and the zygomatic arch, and pass beneath the chin to the left side of the face; mount over the left zygoma and temple to the summit of the cranium, and regain the starting-point at the occiput by traversing obliquely the right parietal bone; next wind around the base of the lower jaw on the left side to the chin, and thence return to the occiput along the right side of the maxilla; repeat the same course, step by step, until the roller is spent, and then confine its terminal end.

These bandages possess the advantages of being easily obtained, of simplicity and facility of application, and, we may add, if considered in relation to the majority of simple fractures, of tolerable adaptation to the ends proposed. The only objections to their use which I have ever noticed are occasional disarrangements, and the tendency, as in all other continuous rollers, to draw the fragments to one side or the other, according as the successive turns of the bandage are carried to the right or left. There is one other objection, having reference to the occasional inade-

FIG. 36.



Barton's bandage for a fractured jaw.

FIG. 37.



Four-tailed bandage or sling for the lower jaw.

quacy of this dressing to prevent an overlapping of the fragments; to which objection also the sling, as usually constructed, is equally obnoxious, and of which I shall speak presently.

Finally, it is to the sling, in some of its various forms, with or without the interdental splint, that surgeons have generally given the preference. The sling is known, also, by the name of the four-headed or the four-tailed roller or bandage.

B. Bell, Boyer, Skey, S. Cooper, B. Cooper, Syme, Fergusson, Mayor, Lizars, and Chelius employ the sling, usually; and the favorite mode is to use for this purpose a piece of muslin cloth about one yard long and four inches wide, torn down from its extremities to within about three or

four inches of the centre. Others have used leather, gutta percha, adhesive straps, gum-elastic, etc.

Where the muslin is used, it is quite customary to lay against the skin a piece of pasteboard, wetted and moulded to the chin, or simply a soft compress; and some choose to open the centre of the bandage sufficiently to receive the chin. The middle of this bandage being laid upon the chin, the two ends corresponding to the upper margin of the roller are now carried across the front of the chin, behind the nape of the neck, and made fast; whilst the two lower heads are brought directly upwards from under the sides of the chin, along the sides of the face, in front of the ears, and made fast upon the top of the head. The dressing is completed by a short counter-band extending across the top of the head from one bandage to the other; or the several bands may be made fast to a nightcap, in which case the counter-band will be unnecessary.

It only remains for me to describe my own method of dressing these fractures with the sling.

Having frequently noticed the tendency of the sling, as ordinarily constructed, and of Gibson's roller, to carry the anterior fragment backwards, especially in double fracture where the body of the bone is broken upon both sides, I devised, some years since, an apparatus intended to obviate this objection, and which I have used now many times with entire satisfaction.

It is composed of a firm leather strap, called maxillary, which, passing perpendicularly upwards from under the chin, is made to buckle upon the top of the head, at a point near the situation of the anterior fontanelle. This strap is supported by two counter-straps, made of strong linen webbing, called, respectively, the occipito-frontal and the vertical. The occipito-frontal is looped upon the maxillary at a point a little above the ears, and may be elevated or depressed at pleasure. The occipital portion of the strap is then carried backwards, and buckled under the occiput, while the frontal portion is buckled across the forehead. The vertical strap unites the occipital to the maxillary across the top of the head, and prevents the upper part of the latter from becoming displaced forwards. At each point where a buckle is used, a pad must be placed between the strap and the head.

The maxillary strap is narrow under the chin, to avoid pressure upon the front of the neck, but immediately becomes wider, so as to cover the sides of the inferior maxilla and face, after which it gradually diminishes, to accommodate the buckle upon the top of the head. The anterior margin of this band, at the point corresponding to the symphysis menti, and for about two inches on each side, is supplied with thread-holes, for the purpose of attaching a piece of linen, which, when the apparatus is in place, shall cross in front of the chin, and prevent the maxillary strap from sliding backwards against the front of the neck.

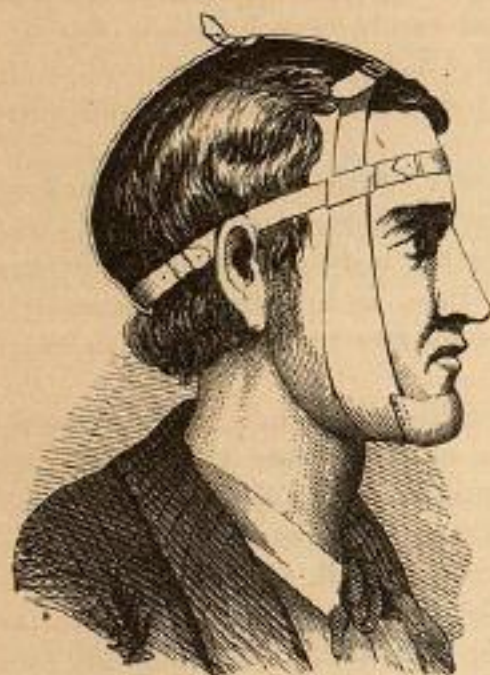
The advantage of this dressing over any which I have yet seen, consists in its capability to lift the anterior fragment almost vertically, whilst at the same time it is in no danger of falling forwards, and downwards upon the forehead. If, as in the case of most other dressings, the occipital stay had its attachment opposite to the chin, its effect would be to draw the central fragment backwards. By using a firm piece of leather,

as a maxillary band, and attaching the occipital stay above the ears, this difficulty is completely obviated.

Having removed such teeth as are much loosened at the point of fracture, and replaced those which are loosened at other points, unless it be far back in the mouth, and adjusted the fragments accurately, the lower jaw is to be closed completely upon the upper, and the apparatus snugly applied. It is not necessary in most cases to buckle the straps with great firmness, since experience has shown that a sufficient degree of immobility is usually obtained when the apparatus is only moderately tight.

If the integuments are bruised and tender, a compress made of two or more thicknesses of sheet lint should be placed underneath the chin, between it and the leather.

FIG. 38.



The author's apparatus.

If the inability to introduce nourishment between the teeth when the mouth is closed, or the irregularity of the dental arcade renders the use of interdental splints necessary, gutta percha, as I have already explained, ought, in general, to be preferred to any other material.

The patient must be forbidden to talk or laugh, and when he lies down, his head should rest upon its back, for whatever mode of dressing is employed, and however carefully it is applied, it will be found that a slight motion and displacement will occur whenever the weight of the head rests upon the side of the face.

Occasionally, indeed, as often as every two or three days, the apparatus may be loosened or removed, only taking care generally not to disturb the interdental splints, when they are used, and to support the jaw with the hand, during its removal; and, at the same time, the face may be sponged off with warm water and castile soap. It should not be left off entirely, however, in less than three or four weeks, even where the fracture is most simple, nor ought the patient be allowed to eat meat in less than four or five weeks.

To cleanse the mouth and prevent offensive accumulations, it should be washed several times a day with a solution of tincture of myrrh, prepared by adding one drachm to about four ounces of water.

The same apparatus, and without any essential modification, is applicable to fractures of the symphysis and of the angle of the inferior maxilla, as well as to fractures of the body of the bone.

Instead of the leather, I have in a few instances, especially of compound fractures where it became necessary to allow the pus to discharge externally, used a sling or a splint composed of gutta percha, suspended by bands carried over the top of the head. The piece from which this splint is made should be three or four lines in thickness, covered with cloth, and padded under the chin. It will be found convenient to cover

it with cloth before immersing it in the hot water. The water should be nearly at a boiling temperature, so that the splint may become perfectly pliable; and it should be laid upon the face and allowed to mould itself while the patient lies upon his back.

Having thus fitted it accurately to the face, it may be removed and openings made at points corresponding with the wounds upon the skin, before it is reapplied.

As has been already explained, the gutta percha, if sufficiently thick, and if the lateral wings are allowed to project a little on either side, will serve effectually to protect the sides of the face against pressure from the bandage; and being more easily moulded to the base and front of the chin than any other material which has yet been employed, must have the preference. The necessity for its use, however, is only occasional.

Dr. S. O. Vander Poel, Jr., late House Surgeon at Bellevue, has employed successfully a modification of my apparatus, made of plaster-of-Paris bandage.¹ The apparatus having been applied over a linen night-cap, and having been permitted to harden, the maxillary straps are cut on a line with the ears, or portions removed and pieces of webbing with buckles substituted. The pieces of webbing may be fastened with stitches or with plaster. Perhaps it would be quite as well to leave the bandage as at first applied until a change becomes necessary—possibly a week or two—and then cut and insert the webbing.

In fractures of either condyle, unaccompanied with displacement, the simple leather or muslin sling will sometimes accomplish a perfect and speedy cure, as the two cases reported by Desault will sufficiently demonstrate. But if the fragments have become separated, the replacement is difficult, and the retention uncertain.

Ribes was the first to suggest and to practise a very ingenious method of reduction in these cases. Having seen two examples which had resulted in deformity under the usual treatment, which consisted in simply pressing forwards the angle of the jaw, it occurred to him that when the upper or condyloidean fragment was not acted upon at the same moment by pressure from the opposite direction, a reduction must be impossible. The case of a cannoneer 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 the pharynx; but this is a slight inconvenience. The reduction obtained, bear

¹ Vander Poel, Archives of Clinical Surgery, Jan. 1, 1878.

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 a sling." The fragments were thus easily brought into apposition in the case reported by Ribes, and the patient was cured without any deformity.

In addition to these means, the angle of the jaw ought to be pressed permanently forwards by means of a compress placed between it and the mastoid process, and held in place by a suitable bandage; or we may adopt the method which proved so successful with Fountain, namely, wire the front teeth of the lower jaw to the front teeth of the upper in such a manner as to draw the chin forwards, and thus maintain apposition.

If the coronoid process be alone broken, it is sufficient to close the mouth with any form of sling or bandage which may be most convenient.

In cases of *delayed or non-union* of the fragments, we may resort to the wire ligature, as was practised by myself in certain cases already described, or to any other of those expedients described in the chapter on General Prognosis. In Dr. Muhlenberg's tables, 14 cases are recorded. Of 7 treated by mechanical appliances, 5 were cured, 1 was relieved, and 1 died; and of 7 treated by drilling, with its modification, all were reported cured.

CHAPTER XIV.

FRACTURES OF THE HYOID BONE.

M. ORFILA has reported the case of a man, aged sixty-two years, who had been hanged, and whose os hyoides was broken through its body on its right side.¹ M. Cazauvielh has also seen a fracture of this bone in two persons who had been hanged, in one of whom the fracture was probably in the body of the bone, and in the other through one of its cornua.²

Lalesque published in the *Journal Hebdomadaire* for March, 1833, a case which occurred in a marine, sixty-seven years old, "who, in a quarrel, had his throat violently clinched by the hand of a vigorous adversary. At the moment there was very acute pain, and the sensation of a solid body breaking. The pain was aggravated by every effort to speak, to swallow, or to move the tongue, and when this organ was pushed backwards, deglutition was impossible. The patient could not articulate distinctly; and he was unable to open his mouth without exciting a great deal of pain. He placed his hand upon the anterior and superior part of his neck to point out the seat of the injury. This part was slightly swollen, and presented on each side small ecchymoses; one above, more decided, immediately under the left angle of the lower jaw. The large cornu of the os hyoides was very distinctly to the right side," and it could be felt on the left deeply seated by pressing with the fingers; in

¹ *Traité de Méd. légale*, troisième éd., tom. ii. p. 423.
² Cazauvielh, du *Suicide*, etc., p. 221.

following it in front toward the body of the bone, a very sensible inequality near the point of junction of these two parts could be perceived. By putting the finger within the mouth, the same projections and cavities inverted could be felt, and even the points of the bone which had pierced the mucous membrane, etc., were evident. Having bled the patient, and placed a plug between his teeth to keep the mouth open, the broken branch was brought by the finger back to the surface of the body of the bone, and easily reduced. The position of the head inclined a little back; rest, absolute silence, diet, and some saturnine fomentations, composed the after-treatment. To avoid a new dislocation by the efforts of swallowing, the œsophagus-tube of Desault was introduced, to conduct the drinks and liquid aliments into the stomach; this sound was allowed to remain until the twenty-fifth day; at this time the patient could swallow without pain, and began to take a little more solid nourishment, and at the end of two months the cure was complete. By placing a finger within his mouth, a slight nodosity could be felt in the place where, in the recent fracture, the splintered points were perceptible.¹

Dieffenbach has also recorded a fracture of the great right horn, produced in the same manner, by grasping the throat between the thumb and fingers, which occurred in a girl only nineteen years old. Very slight pressure upon the side of the bone was sufficient to move the fragment inwards, and to produce a crepitus; but it immediately resumed its place when the pressure was removed. There being, therefore, no displacement, the cure was effected in a short time without resort to any remedies except tisans and antiphlogistics. She was not even forbidden to speak.²

Auberge saw a similar case in a person fifty-five years old, occasioned by grasping the throat. The fracture was in the great horn of the right side, and the displacement was so complete that crepitus could not be felt, and the mucous membrane of the pharynx was penetrated by the broken bone.³

The following example is reported by Dr. Wood, of Cincinnati, Ohio, as having come under his observation in the year 1855:

"Through the kindness of our friend Dr. P. G. Fore, of this city, we were invited to examine a case of fracture of the os hyoides, that had occurred about one week before we saw it, in one of his patients. The patient was a female, about thirty years of age, who had fallen down the cellar steps, striking the prominent parts of the larynx and hyoid bone against a projecting brick, severely injuring the larynx as well as fracturing the bone.

"The fracture was on the left side, and near the junction of the great horn with the body of the bone. Crepitus was distinctly felt on pressing the bone between the thumb and finger; or when the patient would swallow; though, at this time, the severe symptoms that followed the accident, and continued for several days, had somewhat subsided.

"Immediately after the accident there was profuse bleeding from the fauces, and she experienced great difficulty and pain in the act of swal-

¹ *Amer. Journ. Med. Sci.*, vol. xiii. p. 260.

² *Medic. Vereinszeitung für Preussen*, 1833, No. 3; *Gazette Méd.*, 1834, p. 187.

³ *Revue Méd.*, July, 1835.