Application of Biological Principles to Treatment of Jaw Fractures*

SILAS J. KLOEHN, D.D.S.
Appleton, Wisconsin

FRACTURES of the maxillae and mandible are usually the result of some form of accidental violence, and in recent years this number has increased in direct proportion to the more rapid modes of travel. This increased demand for treatment has incited a search for a more efficient method than has heretofore prevailed. It is but logical that the knowledge of the physiology of occlusion as it relates to the supporting structures of the teeth should be a stimulating influence toward improving our methods and striving for better results. A good bony union in jaw fractures is no longer sufficient. We must restore this denture to its original functional efficiency and thereby maintain the original existing facial harmony.

A survey of the past and present literature, of the methods and appliances recommended, as well as clinical observation, clearly demonstrates that the foremost principle is bone apposition. A study of the mechanics of the appliances presents the evidence that an immediate reduction accomplished by a sudden force and followed by a fixation is the usual procedure. To quote from Dr. Wright's article in the April 1937 issue of THE ANGLE ORTHODONTIST:

"As we study past and present methods, both from the literature and clinical observation we discover that the basic principle is that of bone apposition, usually accomplished through immediate reduction by force. This is followed by fixation, using various mechanical devices which remain unchangeable throughout the duration of recovery. We further note that the means employed is entirely a matter of individual judgment and there is no suggestion of a standardized procedure. While in most instances teeth have been utilized as a guide and a means to control broken bone fragments, it is apparent that their use has been mainly for the purpose of obtaining and maintaining bone apposition. One need only study the methods and appliances used for verification of this fact. For example, the cast and vulcanite splints which cover the occlusal surfaces of the teeth preclude the re-establishment of occlusal relations. The various arch bars to which teeth are ligated, or the direct wiring methods which are dependent on individual teeth, usually result in a disturbance of those occlusal relations which existed before the fracture, thereby destroying occlusion as the guide. These, together with external contrivances which operated through soft tissues and which, because of this fact, possess nothing like accurate control, indicate that bone apposition has been the sole objective. That this has been the goal is further evidenced by the great number of failures of restored function one sees in jaw fracture cases.

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"That bone apposition should be considered the goal is but logical when we recall that the responsibility for the treatment of these conditions was originally assumed by the general surgeon whose objective in the treatment of other broken bones was bone apposition. Nor is it strange that the objective remained the same when the responsibility was shifted to the oral surgeon, when it is recalled that his training is based on general surgical principles. So long as the facts of occlusion remained unknown, such a philosophy was forced to endure. However, with the discovery that occlusion was the great end of the denture, a new philosophy and new methods of treatment became possible."

The literature also reveals that there has been failure in recognizing and analysing the forces operating on fractured jaws. The displacement occurring in all fractures is not entirely the result of the blow. Let us digress

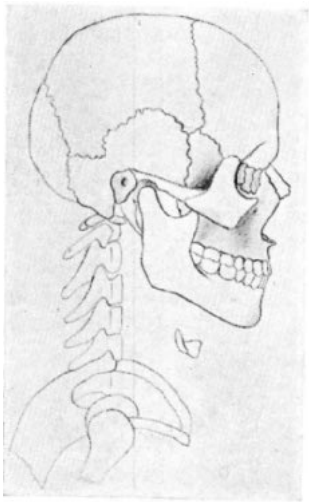

Fig. 1

for a moment to analyse the normal relationship of the maxillae and mandible from an anatomical and functional standpoint in order that we may better understand the forces operating when this relationship has been disturbed.

The upper jaw includes the right and left maxilla, portions of the ethmoid and sphenoid bones, and all the bones of the face: Two zygomatic, two nasal, two palatine, two lacrymal, two inferior turbinate, and the vomer. (Fig. 1)

The maxilla is an irregularly shaped bone and with its fellow on the opposite side forms the front and upper part of the face, the floor of the orbit, much of the outer wall and floor of the nasal flossa, most of the hard palate, supports all of the maxillary teeth, and contains the maxillary sinus. Because of its many functions it was necessary for nature to supply its anchorage to permit accommodation for the various surfaces. It is situated beneath and slightly anterior to the anterior fossa of the brain case and rather securely attached by what are termed buttresses. This type of support

is employed daily in mechanical engineering because it gives the required amount of support with the minimum amount of material, thereby reducing weight and bulk. The frontal process rests firmly against a buttress in the median line, the maxillary process of the frontal. Posteriorally there is a buttress attachment with the pterygoid process of the sphenoid. Laterally the upper jaw is supported by a flying buttress attachment, the zygomatic process through the zygomatic bone to the temporal. The buttresses not only afford support for normal stresses but also dissipate and diffuse shocks which would otherwise be transmitted to the cranium.

The mandible is the only bone of the skull which is movable. It is developed in two halves which fuse at a point termed the symphysis. It consists of a body which supports the teeth and two rami, one on either side projecting upward and backward for articulation with the mandibular fossa of the temporal. This articulation is well supported by ligaments, but the principle support of the mandible is supplied by the musculature with attachments on the cranium, hyoid bone and thorax. When analysing the bone structure of the mandible, the statement is often made, "Its function is pure," meaning mastication, but the significant part the mandible plays in swallowing, speech, and the balancing of the head is often overlooked. An analysis of these latter functions demonstrates the various stresses and forces operating on and through the mandible.

The complications arose when man acquired an upright posture and placed the head above the shoulders, resting on top of the vertebral column. The only articulation and bony support the head receives from the rest of the body is through the atlanto occipital articulation by a very small convex surface on the occipital bone and a very small concave surface on the atlas. Nature has provided an active equilibrium through use of the principles of polarity and a balancing of the musculature to permit man to acquire an upright posture and keep the head erect. In acquiring this upright posture, we have moved the weight center upward until it lies perpendicular above the small supporting surface formed by the contact area of the lower extremities with the floor.

Man possesses bilateral symmetry of form which balances him in the lateral plane. Anterior posteriorally however his center of gravity lies well within his body and passes through the head at the anterior portion of the atlanto occipital articulation. He is held in an upright position by a balance of all the muscle tension which comes in equilibrium in the vertebral column. It is easy to comprehend this balance in the bilateral arrangement where everything is arranged in pairs. Anterior posteriorally the entire load seems to lie in front of the column, so one would expect him to fall forward which is always the case when muscle tension is lost. The powerful muscles of the back serve as check reins against the heavy load and the anterior muscle tension. The various movements of the human body demand a change in muscle tension to maintain this equilibrium.

The same principles of polarity and muscular balance are active in maintaining correct posture of the head and permit its various movements. (Fig. 2) An examination of the musculature of the two lateral surfaces and the posterior demonstrates the principles of mechanics as we find it in various other parts of the body. The right and left sides of the head have

a group of muscles similar in size, attachment, and function which maintain the correct posture and control lateral tipping and rotation. This group is similar because of the bilateral balance of the structures, attachments, and

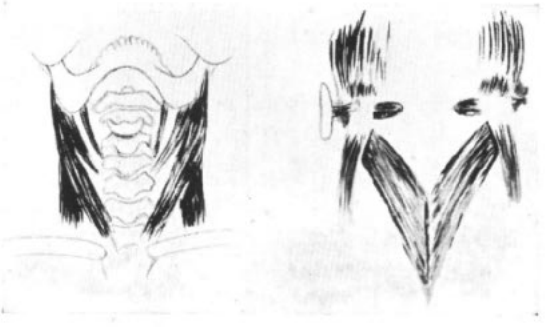

Fig. 2

function. (Fig. 3) The posterior portion of the head has a powerful group of muscles arising from the occipital bone and running downward to the middle of the back. They serve as check reins and tip the head backward. The antagonist to this group must naturally be in front of the vertebral column and here we find a series of groups that differ in size, shape, and attachments. This difference is the result of the additional special functions of mastication, swallowing, and speech.

Fig. 3

This is the group we must analyse to fully understand the forces operating on the mandible when fractured. Anatomically they are divided into three groups.

1. The masticatory group which has one attachment on the face or cranium and the other on the posterior surfaces of the mandible. This group con-

trols mastication and has the additional functions of assisting in swallowing and speech, and serving as antagonist to the post cervical muscles.

2. The supra-hyoid group which arises on the anterior and lower border of the mandible and runs downward, backward, and inward to the hyoid bone. Their function is reduced to assisting in swallowing, speech, and antagonist to the post cervical muscles.

3. The infra-hyoid group which arises from the hyoid bone and the tracheal cartilage attached to the hyoid bone by the ligaments and are attached to the thorax. They function solely as antagonists to the post cervical muscles.

In normal functions these groups maintain an active balance which permits movement of the mandible, hyoid bone with its attachments and still supplies sufficient tension to maintain normal posture of the head against the post cervical group. The mandible and hyoid bone are held in suspension by these groups of muscles and at the same time serve as balancer by maintaining an active equilibrium.

Mechanically it is rather simple to analyse the disturbance to muscle balance when a fracture of the mandible occurs. The greatest complication in reduction, however, arises in the abnormal muscular reaction occurring from abnormal stimuli produced by injury.

Muscle tissue has the property of extensibility and contraction. If a muscle is severed by an incision across its fibers, the ends retract. Muscle that is normally maintained in a state of elastic tension contracts more effectively for a given stimulus than one which is entirely relaxed. The various muscles which maintain the posture of the head must maintain a certain amount of tonus. Tonus of muscle is a condition of tension which exists independently of voluntary innervation. It is neurogenic rather than myogenic, that is to say the cause of it lies in the nervous system and not in the muscle itself.

Experiments have shown that this condition of involuntary contraction of muscle can be maintained through long periods, and unlike ordinary contraction there is very little indication of any underlying chemical changes. This lack of consumption of material and energy in these involuntary contractions of muscles accounts for the lack of fatigue in trismus found in the masticatory and super-hyoid groups of musculature in mandibular fractures. To remove the trismus of this musculature, anesthesia or fatigue is necessary. Fatigue can be produced by placing a voluntary stress on this musculature which will result in a consumption of material and energy.

The normal tension maintained in the masticatory group antagonizes the tension of the supra-hyoid group. A break in the mandible causes a change of balance and these muscles contract until a balance is reached which will serve sufficient stress to antagonize the post cervical group. (Fig. 4)

In fractures of the mandible the tension of these various groups of muscles usually disturbs their continuity. The blow may only result in a break but the antagonizing force of these groups of muscles usually results in displacement. This in turn produces abnormal stimulus to the muscle and very often causes the muscles to contract to the state of trismus.

A blow resulting in a fracture between the 1st molar and 2nd bicuspid on the right and left side of the mandible almost always results in a downward and backward displacement of the anterior segment of the mandible and an upward displacement of the posterior segments.

Fractures occurring in the anterior segment of the mandible produce various displacements depending upon the exact position of the fracture line. (Fig. 5) The most severe would be a fracture between the canine and lateral incisor on the right and left side. The displacement resulting in this case would be a downward and backward displacement of the segment containing the incisor teeth by the force of the supra-hyoid mus-

Fig. 4

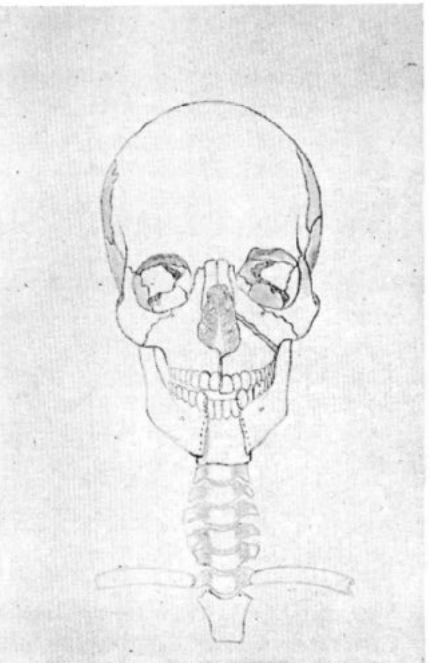

Fig. 5

culature attached at the symphysis. The two segments would collapse as a result of the pull of the mylohyoid muscle and the added pressure of the buccinator.

Fractures in the maxillae can be classed as partial and complete. The displacements resulting from fractures in these bones are usually the result of the blow plus gravity and possibly a slight force from the buccinator. A transverse fracture through the body of the maxillae usually results in a downward displacement due to gravity. In complete fractures through the upper half of the body with an opening of the zygomatic sutures, or fractures of this bone and other facial bones, we often find a jamming or interlocking of the fragments, resulting in a backward displacement. The many surfaces, cavities, and sutures in the maxillae make jamming and interlocking of fragments a common occurrence.

Partial fractures of the maxillae are usually simple fractures with very few complications. The displacement is always the result of the blow with no outside force or stress to hinder reduction, thus making this treatment rather simple. The unfractured portion serves as a good guide and sufficient anchorage for reduction and fixation.

The principles of treatments of all fractures of the human body are to restore bone apposition so that normal function is restored. The evidence of all scientific work points to the fact that the face has arisen primarily for the demand of the organ of mastication. The teeth came first, then came bone to support them, and then came the union of these bones to the brain case. Therefore our first consideration in management of jaw fractures must be the teeth and occlusion, and thus restore this organ to its normal functional efficiency. The scientific work reported in the field of periodontia seems to conclude that traumatic occlusion is the underlying cause of most of the diseased condition of the periodontal tissue and alveolar bone. Traumatic occlusion may be caused by an abnormal line of occlusion permitting intermaxillary contact of only part of the denture or it may be caused by teeth receiving their stress in an abnormal direction. It has been demonstrated that a definite ratio exists between the normal functioning surface area and anchorage in every tooth, and the ratio is constant in all animal dentures. If occlusion is disturbed, this ration is altered with a resulting traumatic injury to the supporting structures of the teeth. Nature always uses the minimum amount of material to carry the maximum load. If the ratio of the functioning surface area to anchorage is one to fifty, as was found, we are assured that this ratio must be maintained to provide the normal stimulation necessary to keep the periodontal tissue and alveolar bone healthy.

If we accept these facts and recognize the teeth as origin of the development of our face as it is today, we must recognize occlusion as the goal to be achieved in jaw fracture management. Therefore, the basic principle of any method must be the restoration of the occlusion that existed before the fracture occurred. When occlusion has been restored, the original existing facial symmetry will be obtained, as well as good bone apposition.

515 Irving Zuelke Building

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