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OCCLUSION AS APPLIED TO CROWN AND BRIDGE-WORK.

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THE subject is presented for the purpose of drawing special attention to the various phases of occlusion of the teeth.

First: The developing jaws.

Second: The bones adjacent to the maxillary bones forming the masticating organs of man.

Third: The segments or teeth mounted in this mechanism, forming the masticating members.

Fourth: The normal construction of the human jaw.

Fifth: Anatomical malformations of the mandibular mechanism.

Sixth: The construction of crowns and bridge-work in such a manner as to allow freedom of the range of occlusion, producing harmonious action and permanent health of the units.

Explanation of Terms.

In referring to "occlusion" and "Range of occlusion" I have reference to teeth in full occlusion and to teeth in contact in any position they may take in the act of mastication.

"Articulation" and "range of articulation" has reference to the temporo-maxillary articulation; while the word "Range" has reference to any position the mandible may take within the limits of the ligaments of this joint.

Dimensions of the Human Jaw.

The question arises what are the normal dimensions of the human jaw: We may accept as a general proposition that the normal jaw is one which has a geometrical balance in proportions.

In Dr. Bonwill's work on occlusion he has given to us the first scientific dimensions of which we make practical use in the development of this theory,—that of the equilateral triangle of four inches from condyle to condyle and from condyle to mesio incisal angle of the lower central incisors.

Triangle Not Always Equilateral.

This triangle *is not* always equal in its dimensions. It is sometimes an isosceles with two sides from condyle to incisal medium line equal. The short side is from condyle to condyle and in some specimens the angles are those of an acute triangle.

Geometric Basis of Calculation.

I wish at this time to add another geometric basis of calculation which I have found may be depended upon in determining the occlusal surfaces of the teeth in relation to the condyle movements.

The basis of this figure is a sphere whose radius is approximately four inches. The center is equi-distant from the occlusial surface of the teeth and the center of the condyle has the same radial dimensions.

The occluding surface of every tooth in the normal jaw will be found to be tangent to the radial line of the long axis of each tooth.

In the mandible where the teeth and condyles conform to the equilateral triangle or approaches these measurements, the "best" lines of force can be applied to the teeth in occlusion. That is, the long axis of the lower teeth more nearly approach the long axis of the upper teeth thus making a direct strain on the line of the teeth of upper and lower jaw.

In the case where the isosceles triangle dimensions are found, we also find an insufficient bony development of the mandible to accommodate the tooth or segments of the dental arch. This is evidenced by the short base line from condyle to condyle.

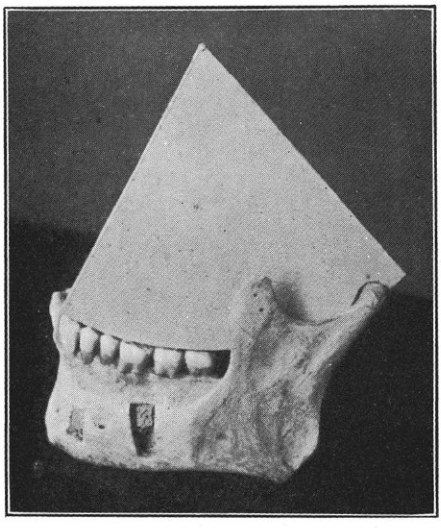
In these cases the individual has not developed the type of the parent dimensions. This is true as the enamel cap was developed at a time when function did not play a great part in developing its size. Hence the bony structure has not developed to accommodate the teeth or segments. In such cases we find the anterior teeth in the lower jaw not conforming to a radial line of the sphere, but taking a position as best they can in the bony structure developed.

In the individual where the acute triangle is developed we would find, if we could arrive at the complete history of the case, that during the development of the mandible, there was some interference with the normal masticating movements, due either to the loss of teeth or some discomfort on one side or the other.

If the function of mastication is normal during the period of development, there is a greater possibility of the triangle being equal in its dimensions, but in the majority of cases such perfect dimensions are not found.

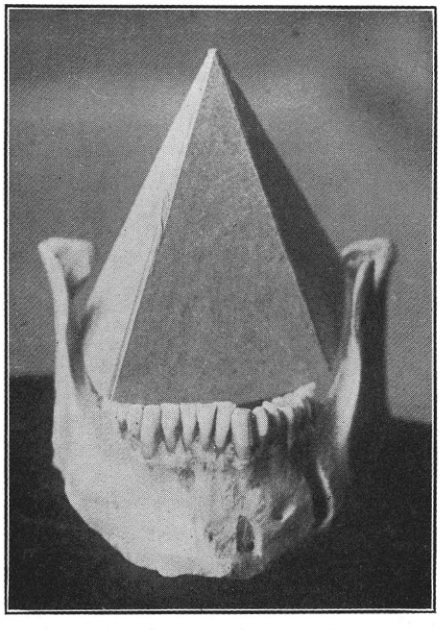
For the purpose of study it will be necessary to obtain as perfect a skull as possible; one having a complete set of natural teeth. I advise a subject that has lived to the age of thirty or thirty-five years, as one of this age would be more likely to have facets worn on all the teeth denoting full function of mastication. An individual having lost teeth on one side of the mandible would naturally have an excessive function on the opposite side and in this manner, both muscular and osseous structure excessively developed throwing the mandible to one side.

Figure 1.



Illustrating the application of the circle to the line of occlusion and the intersection of the same radius by the condyle.

Figure 2.

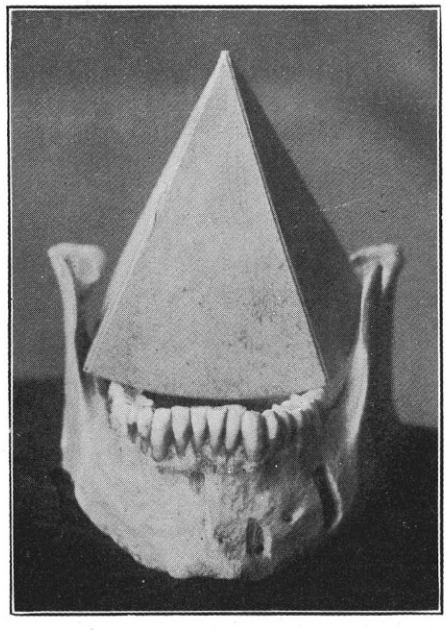


The application of the circle obliquely across the mandible.

In the study of the movements of the mandible let us confine ourselves to the occlusion and variation as the occluding surfaces offer us the best structures from which to take direction and measurements.

Examining as nearly a perfect set of teeth in the mandible as obtainable, Figures 1, 2 and 3, we will note they

Figure 3.



The same circle applied to the molars, showing the occlusion of the molars conforming to the circle.

conform to a circle with a radius of four inches, from cuspid to condyle, the line passing thru the center of the condyle. We further note that a similar circle will pass from the same cuspid thru the center of the opposite condyle. The circumference of the same circle when placed obliquely across the molars and bi-cuspids will conform to the occlusion of the teeth.

This may be demonstrated by an eight inch sphere used on the mandible to conclusively prove this basic principle, as

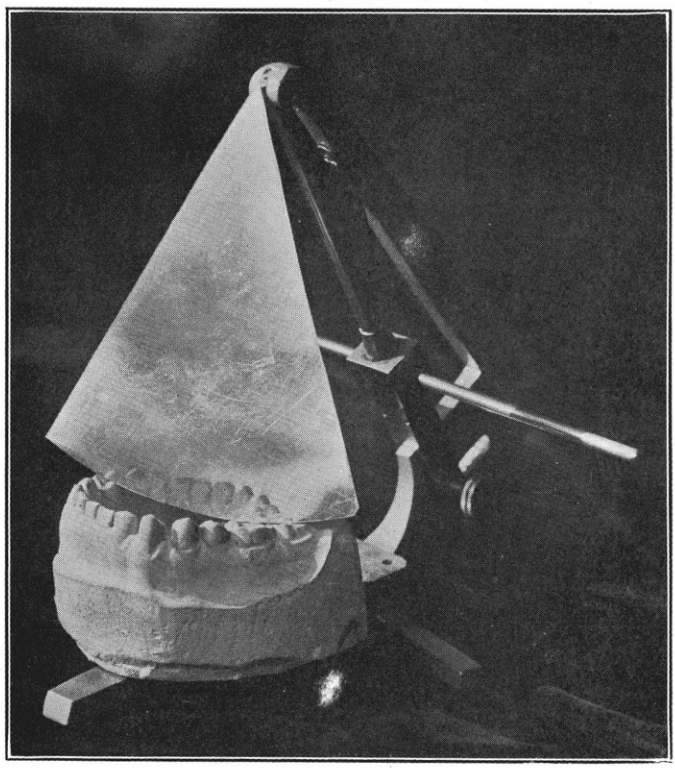
illustrated in the first three illustrations. Its practical application is shown in Figures 4 and 5.

FIRST—THE DEVELOPING JAWS.

Having stated this mechanical basis, let us take up the first phase of our discussion, "The Developing Jaws."

beauty has a mathematical basis. From childhood, the function of mastication is an essential factor in developing the normal jaws and the base of the cranium as well. If for any reason this function is impaired we find a lateral development, both in cranium and mandible.

Figure 4.



Practical application of the principle to models.

During early life we find the triangle narrower at the base, between the condyles, the superior maxillary bone having the same corresponding relation. The base of the cranium has corresponding dimensions and in full function the triangle develops toward an equilateral triangle.

BEAUTY HAS A MATHEMATICAL BASIS.

Function develops well-balanced geometric proportions. Thus we see all

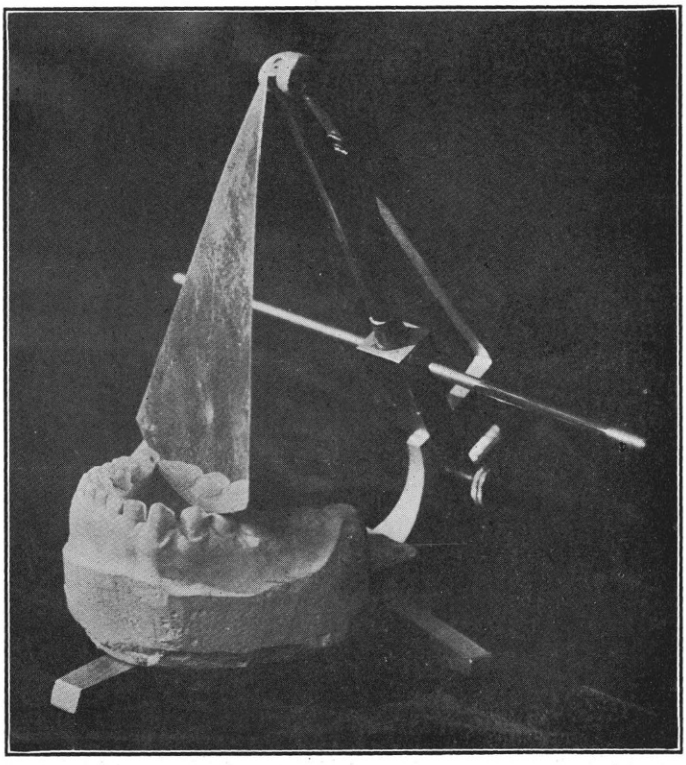
This leads to the necessity in early life of correction of improper function, due to loss of teeth, improper food and habits.

If these are not corrected and the child put to proper function of this organ of digestion, we find insufficient bony structure to accommodate the permanent teeth or segments. In such cases they take a position in the lines of least resistance, producing a permanent mal-

occlusion, also improper alignment to the center of applied force. This has the effect of producing more than one center and inharmonious action of the mandible, which would necessitate placing the jaw in a position to apply the force on the long axis of a tooth or teeth in the masticating movements.

The result of all these minor defects tends to produce a total mechanical defect of the mandibular mechanism and a resultant permanent deformity.

Figure 5.



The opposite oblique application of the principles.

STUDY OF THE MECHANISM OF MASTICATION AS A WHOLE.

It has been the misfortune of the profession that we have been compelled to study detail phases of many of these deformities instead of taking the study collectively as a mechanical whole. Our case is similar to the artist who dwells on the detail and overlooks the total scheme of his composition producing a mass of detail but no picture. A duty the dental profession owes humanity is to see that the child properly develops facial and cranial dimensions. This means more than merely proper mastication. It means the beauty of the individual when he reaches full development. The dental profession if it rises to its full possibilities will have more to do with the facial beauty of the coming generation than any other body of men. Were a new school to be founded whose

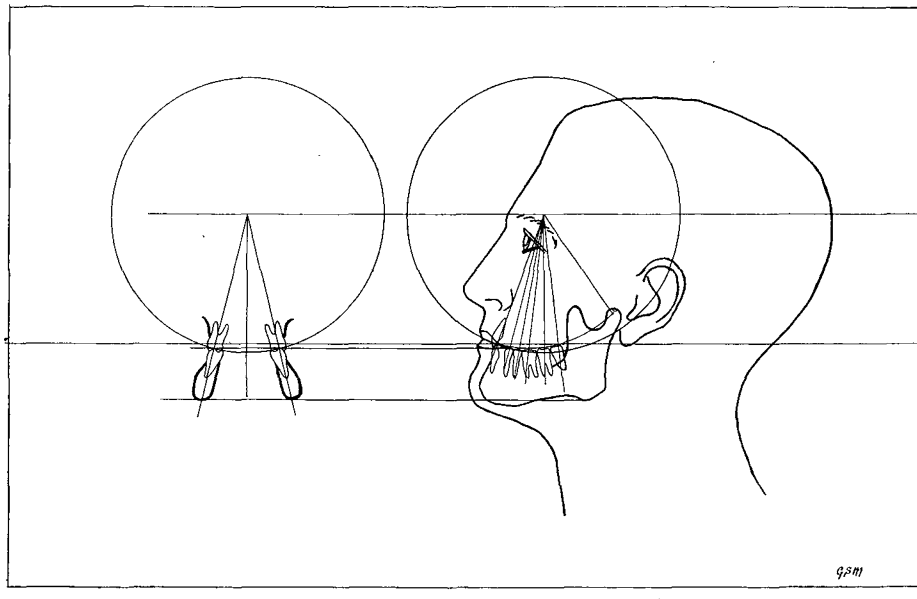
mission was the study of beautifying the human race during the period of development, this school would soon find that the basis of their operations must be the study of Dentistry in its advanced phases.

These advanced phases would be food and function in mastication, as food and function equal Force and Form. This means bodily strength and beauty. All beauty is founded upon well-balanced geometrical proportions, and well-balanced geometric proportions in the human face and cranium must come thru food and function.

As dentists, we must not confine our work to the individual tooth, but to the total masticating mechanism. This work comes well within the province of the dentist. The development of the entire human body depends upon your understanding of what its food and function should be.

Function is dependent upon food. It can possess its proper calories, but it also must possess resistance to properly develop the muscles of this mechanism. The bony structure or framework gives origin and attachment for the muscles and in turn will develop the proper dimensions to sustain them. Thus we develop an harmonious whole. So food and function will create force and form.

Figure 6.



A. Cross section showing the lines of force.

B. Anterior posterior section showing the conformity of the lines to a radial point.

On the development of the jaws of the child, depends largely the development of the entire human body. Digestion can never be complete where the first step, that of mastication, which is a voluntary act, is neglected. The whole development of the entire body is impaired from an incomplete beginning. The perfect development of the human jaws is a first requisite and first evidence of a perfectly developed human body.

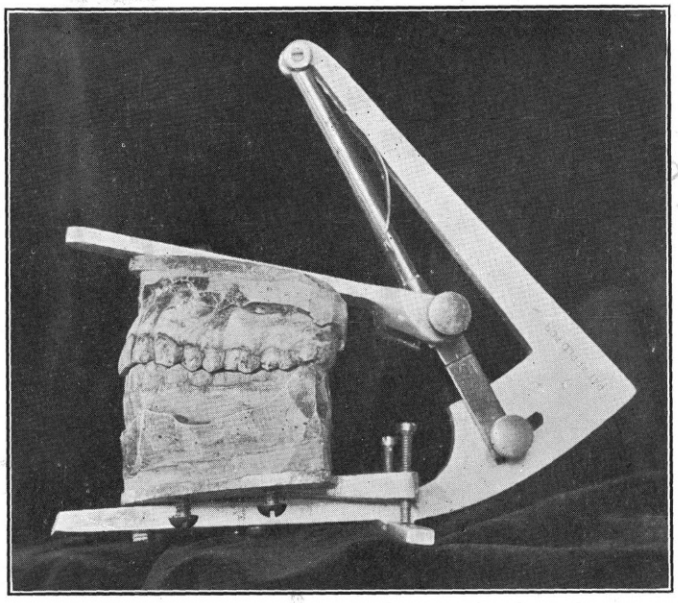
SECOND—THE BONES ADJACENT TO THE MAXILLARY BONES FORMING THE MASTICATING ORGANS OF MAN.

The crushing seat upon which the upper members or teeth are placed form a radial center in the superior maxillary bone, and are supported by a Pyramidal structure and conform to the general scheme of a segment of a sphere, approximating in its dimensions a four inch radius, are buttressed by the malar bones and the Zygomatic arch laterally, and by the palate bones distally and are supported on the median line by the vomer.

Let us consider this mechanism from an engineering standpoint, noting the features that are utilized in engineering practice. Within this Pyramidal structure we have the nasal passage. Laterally the antrum of Highmore forms coring or spacing for a structure that is light and yet gives the maximum amount of strength for the crushing base.

The seat of the condyles are placed on the base of the cranium and are supported from above by the temporal bone and laterally by the bones forming the base of the cranium and zygomatic arch, making a total of a powerful base upon which the superior maxillary bone and teeth articulate and occlude. The muscles have a general distribution above and verge upon the inferior maxillary bone.

Figure 7.

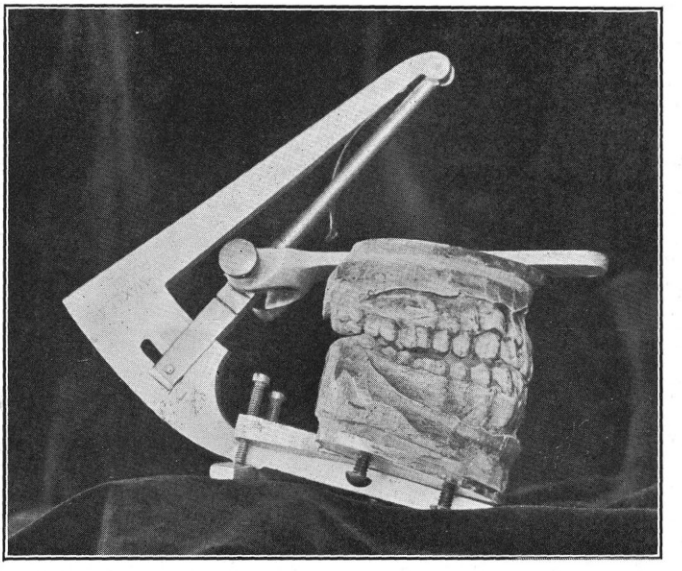


Full occlusion.

The total action of the muscles converge to a common center.

Thus we see the fixed point has a total general formation for the origin of the muscles to render the greatest power possible to their insertion. The muscles of mastication play an important part in the development of the base of the cranium as well as the masticating mechanism. This group of muscles demonstrate the physical law that to every action there is an equal and

Figure 8.



The excising position.

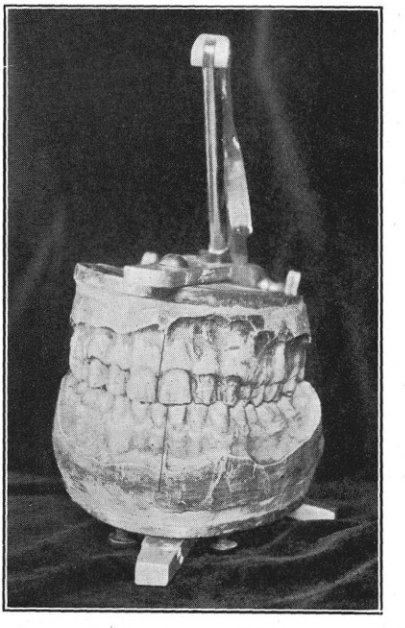
opposite reaction. As the origin of the muscles is in the facial and cranium bones and the insertion in the mandible, it plays an important part, according to this law, in the development of the cranial and facial bones. Function is the main factor in the developing of this entire mechanism to well-balanced geometric proportions.

THIRD—THE SEGMENTS OR TEETH MOUNTED IN THIS MECHANISM FORMING THE MASTICATING MEMBERS.

The occlusion of the teeth presents to the food the greatest amount of crushing surface at all times and in all positions within the range of occlusion.

This is due to the fact that the occlusion of the teeth is in the main at right angles to the lines of stress and no matter what positions the mandible may take in a forward or lateral position, they present the long axis of the teeth to

Figure 9.



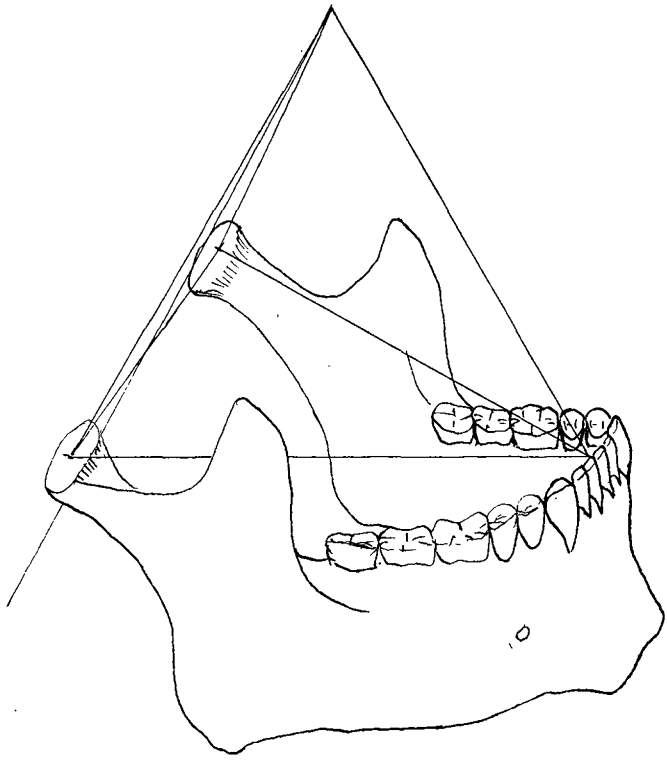
Extreme lateral position.

the center of applied force or radial point, as illustrated in Figure 6.

The general conformity of the tooth and structure of the bone is modified to take care of the hinged action of the jaw, producing a Pyramid with a slight curve

the long axis of the tooth which, would in time destroy the proper line of the force in the act of mastication, throwing the mandible out of balance in relation to the superior maxillary and producing malocclusion and a faulty relation of

Figure 10.



The pyramid constructed on the "Bonwill Triangle."

to conform to the hinging action of the jaw.

If we consider the buccal cusps of the upper teeth continuous with the overbite and the lingual cusps of the same teeth as the crushing seat upon which the greatest amount of work is placed, we can readily see why the lingual cusps of these teeth are worn off. The reverse is true of the teeth in the mandible, the buccal cusps being worn off, producing an oblique surface on the occlusion to the bones. The greatest cause of the disturbance of the geometric balance in the entire mechanism is the malocclusion of the teeth caused by such an abrasion, forcing the jaw back and the condyle encroaching on the auditory canal, lessening the diameter of this canal for the sound waves, thus impairing the hearing of the individual.

This mechanism for mastication can be best illustrated by diagrams showing their relations at different positions in the range of occlusion.

Figure 7 shows full occlusion.

Figure 8 shows location of the mandible in the excising position and the extreme forward range.

Figure 9 shows the extreme lateral position when the mandible is in the act of crushing.

Any degree of angle intermediate between the extreme forward and extreme lateral positions is within the range of occlusion. This limitation has a marked difference in different individuals. The evidence of this is the over-jet. Where there is a marked over-jet we have the isosceles triangle.

In the well-developed jaw where the triangle has equal angles the forward range and lateral range is about equal.

Fourth—The Normal Construction of the Jaw.

In the normally constructed jaw the equilateral triangle approximating four inches is in evidence.

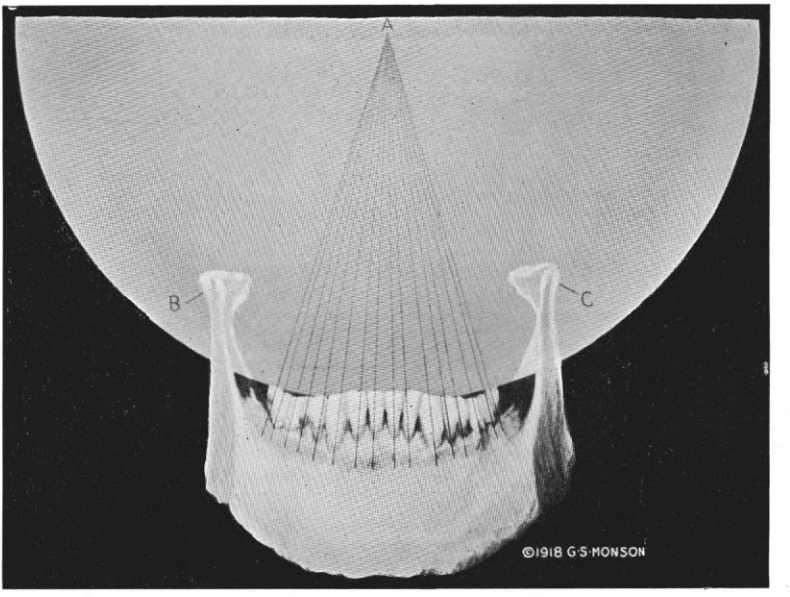
Let us once more define the anatomical dimensions upon which this triangle is placed as it forms the base of the spherical pyramid which is a segment of a sphere, which determines the radial center of the mechanism of mastication.

The line drawn from condyle to condyle I will designate as base. The lines drawn from condyles to medial incisal angle of lower incisors complete the triangle. The figure thus outlined is known as Bonwill's triangle.

A pyramid erected on this triangle as base with the angle lines of four inch length converge forming the center or radial point at the apex from which the radius of occlusion of each tooth is determined. This is illustrated by the outline drawing, Figure 10.

In the normal jaw, the occlusion of the teeth conforms to the surface of a sphere of eight inches in diameter whose center is the radial point. A line drawn

Figure 11.

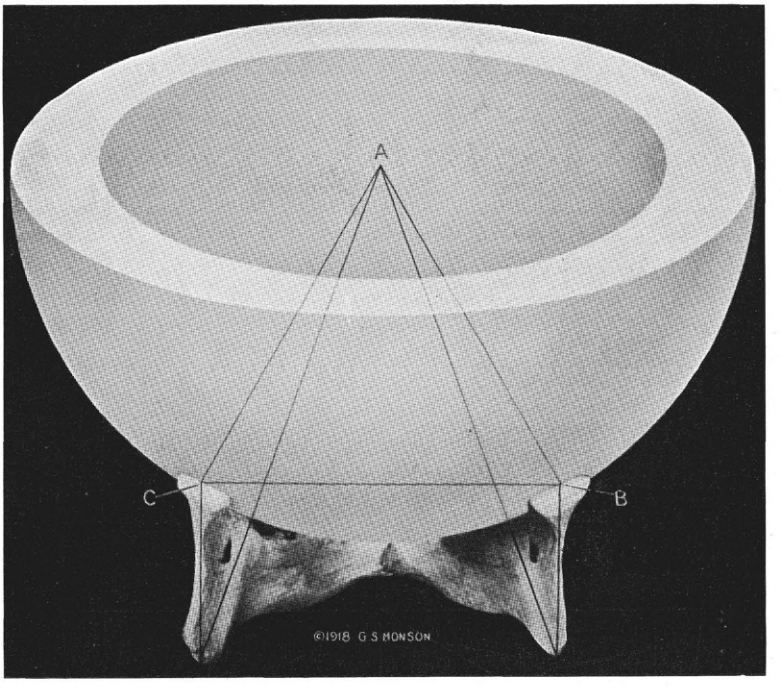


Illustrating the radial lines of force.

from the center obviously must pass thru the long axis of each tooth. This is illustrated by the front view of the mandible applied to the sphere, Figure 11.

The posterior view of the sphere applied to the mandible is illustrated by Figure 12. In this illustration, the center of the condyles are shown conforming to the surface of the sphere, giving the same radial dimensions from the centers of the condyles to the apex as from the points of occlusion of the teeth to the same radial center.

Figure 12.



The posterior view, illustrating the application of the radial lines to the condyles.

Thus we see that this radial center must be the center of applied force in our mechanism of mastication. It is also the center of the entire muscular action. This is evident as the development of the angles of the jaw conforms to the radial lines centering at A, the common center as shown in Figures 12 and 13.

A Simple Method of Testing a Normally Constructed Jaw.

That you may apply to any mandible the rules or proportions that demonstrate it to be normal or abnormal, let us consider a test which I have worked out by experience with many sets of teeth which come under my observation in connection with demonstrating my theory that the equilateral triangle is the normal basis of construction of the mandible.

The simple method of determining the radial center and the dimension of the triangle forming its base is to cut a circle of cardboard with a radius of four inches; divide it into semi-circles, using one of them as in illustration, Figure 14.

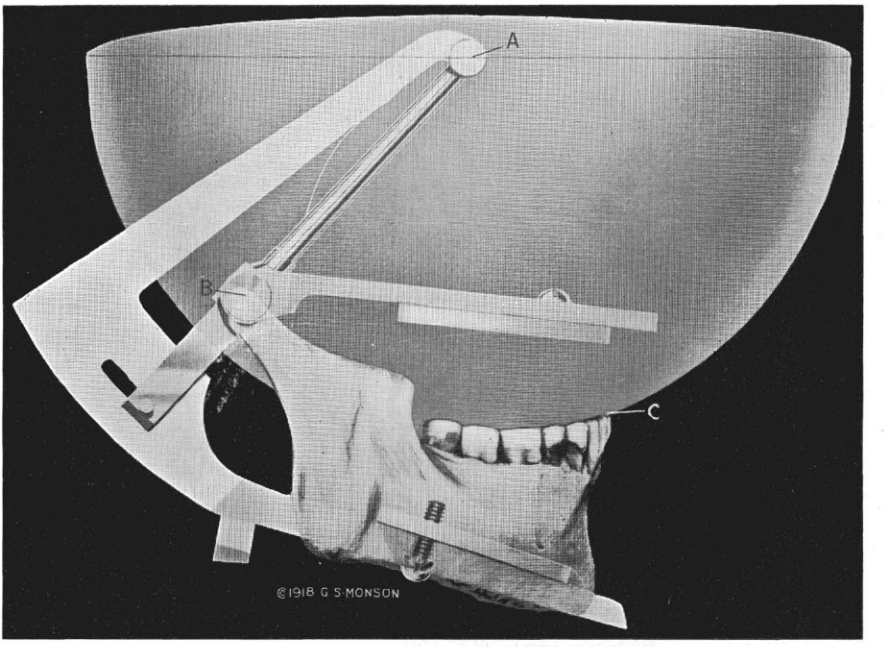
Divide it into segments as in Figure 14, so that the combined smaller segments form the third side of a spherical pyramid with three equal sides. The

lines at the base will represent the Bonwill triangle when the pyramid is formed by joining the two sides EA and AF, and fastening them in place with a paper clip.

The application of this spherical pyramid to the mandible to determine proportions is illustrated in Figures 15, 16 and 17.

You will note that the distal angles pass thru the radial center of the condyles and the anterior angle resting on the medial incisal angle of the lower teeth. In case of a perfect mandible, it

Figure 13.



Side view of the sphere applied to the mandible.

Figure 14.

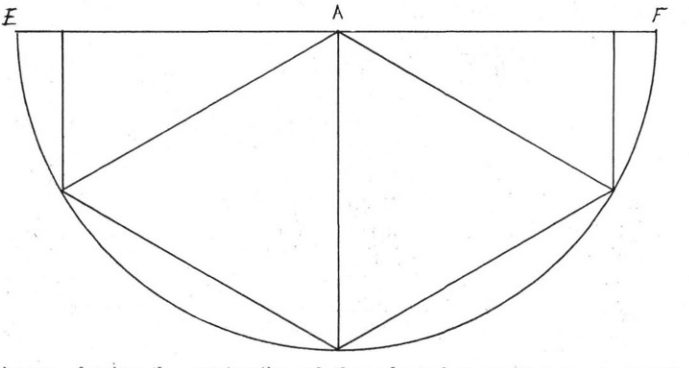
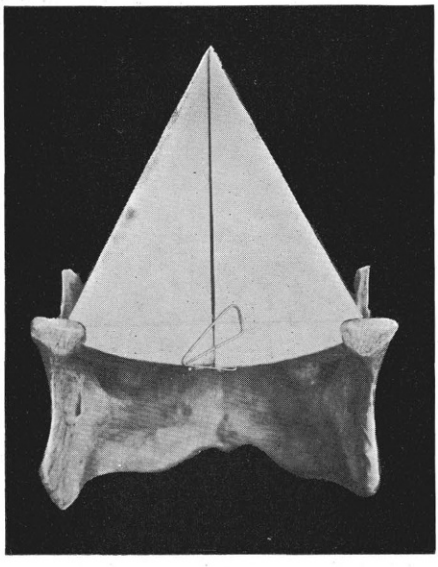


Diagram showing the construction of the spherical pyramid from cardboard.

will have balanced geometric proportions or an equilateral triangle.

The Bonwill triangle used on the mandible shown in the specific case, Figure B is an isosceles, the condyles being three and one-half inches from center to center. The one-half inch which it lacks of being normal is divided and added to the lineal measurements of the other two sides.

Figure 15.



Showing the application of the spherical pyramid to the condyles.

I have made observations on many mandibles and the evidence gathered in my research all points to this general rule.

In case of a shortening of the condyle to condyle dimension, nature endeavors to compensate by the elongation of the lateral sides.

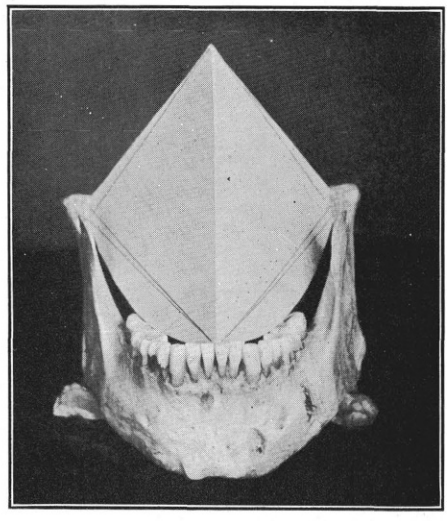
The fact that we find a variance in both directions from the equilateral triangle further strengthens the assumption that the normal mandible is the one outlined by an equilateral triangle.

The evidence of my total investigation to the present time points, conclusively to this fact that the mandible based on the equilateral triangle is the highest form of development in the basic construction of the human jaw.

FIFTH—ANATOMICAL MALFORMATIONS OF THE MANDIBULAR MECHANISM.

Malformations of the mandible are deviations from the equilateral triangle of approximately four inches.

Figure 16.



The front view of the application of the pyramid.

Mandibles with the isosceles triangle and mandibles based upon acute triangles are abnormal developments. In such cases one of the lateral sides is shorter from incomplete functional development than the other, forming an acute triangle with unequal sides and angles. This constitutes a typical form of malformation and is due to an impaired function.

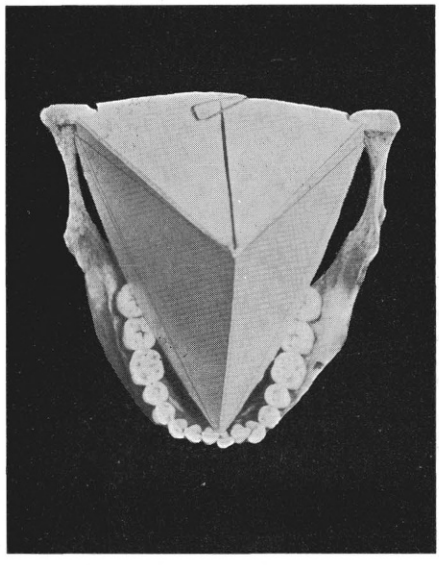
This covers in a general way the malformations arising in the course of development of the mandible.

Having reached complete development, another form of deviation from the

normal arises after the full development of the individual. This is in reality a retrogression and is common in middle age.

This deviation consists of a shortening of the lateral sides of the triangle and an increase in length of the line from condyle to condyle, approaching an obtuse triangle. This development of

Figure 17.



Looking down upon the mandible, showing the angles of the pyramid from the radial center.

the mandible in later life is no doubt the cause of many obscure disorders.

There is one of these to which I particularly wish to call your attention. This cause of broadening between the condyles is due to a wearing away of the teeth and a consequent unbalancing of the muscular mechanism bringing about a backward thrust of the mandible encroaching upon the auditory canals. This I am convinced is the cause of a great deal of deafness, not only in people of advanced years but of many individuals in their prime.

SIXTH — THE CONSTRUCTION OF CROWNS AND BRIDGEWORK IN SUCH A MANNER AS TO ALLOW FREEDOM OF RANGE OF OCCLUSION, PRODUCING THE HARMONIOUS ACTION AND PERMANENT HEALTH OF THE UNITS.

The work of constructing crowns and bridges to replace lost segments in the mouth can be carried under as exact rules and principles as those employed in architecture or engineering.

These rules are based upon estimates made from the radial center of the spherical pyramid of which the Bonwill triangle is the base. The deviations from the normal in the construction of the mandible must be taken into account in the application of these principles.

A patient presents himself requesting a restoration of lost members of his mechanism of mastication, either by fillings, crowns or bridge-work. X-rays are taken of the roots of the teeth in position and other diseased conditions. I would suggest in all cases where the teeth are worn, throwing them out of position, that full impression of upper and lower teeth be taken. Place these casts in an instrument which will reproduce the correct movements giving the occlusion and its full range as found in the mouth. It is further proven by a series of check bites in sheet wax taken from the mouth of the patient, in various contact positions. The occlusial surfaces of the teeth of the casts thus mounted should come in contact in the check bites absolutely as found in the mouth. This is the proof that they are in correct relation in any position taken by the mandible.

Another point in diagnosis is a test as to the displacement of the mandible due to the backward thrust caused by the abrasion of the teeth, and lessening of the distance between the chin and the nose, shortening the anterior angle of the pyramid, from the radial center to the mesial incisal angle of the lower incisors.

This test is made standing in front of

the patient and placing the little fingers in the auditory canals and pressing forward toward the condyles as the patient opens and closes the jaws to full occlusion. If you feel the backward thrust of the condyles on the fingers you may be positive that the patient's bite is too short. Further evidence of this may be secured by placing two sheets of base plate wax between the teeth and noting a diminution of the backward thrust of the condyles as the patient opens and closes his mouth to this new dimension. In the majority of these cases it will be necessary to open the patient's jaws from two to five millimeters when in the position of full occlusion. Bear in mind that in many cases of forward dislocation of the mandible in the act of yawning the function throws the muscular action so the mandible is carried forward slipping over the anterior process giving a positive forward thrust of the mandible. Again the backward thrust is produced by a wearing away of the natural teeth causing a too short dimension on the anterior angle of the pyramid.

With the casts on the instrument use a six inch divider set to four inches with one point curved to be placed on the radial center and the other point sweeping the occlusal surfaces of the lower model. You will note that all the teeth in function have equal radius with the condyles. This will be found to be approximately four inches and all teeth out of function or partially so will be found elongated or tipped in the line of least resistance, thus destroying their function because of their occlusion not being a tangent to a radial line of the sphere. In certain ones of the teeth the occlusion may be worn obliquely to a radial line, which must be restored if their permanent position is to be maintained.

Elongated teeth must be reduced in their length and teeth that have been in excessive function built up to their proper occlusion, bringing the occlusion of all the teeth to conform to the surface of the sphere having proper interlocking cusps to maintain them in their alignment. The teeth are then ground into the full range of occlusion.

If this mode of procedure is neglected it is similar to the man who buys an old house, painting and decorating it before using the square and level to put it in plumb.

The real engineer would see to it that it was plumb and of true angles before spending money on the decorating. Let us as dentists determine the position and relation of the mandible to the adjacent structures and build our improvements so that they will be permanent and real in value to the patient.