vals and with great rarity for a long time. Shakespeare has frequent references to it. In Richard III the Duchess of York says: "Marry, my uncle grew so fast that he could gnaw a crust at two hours old. 'Twas full two years ere I could get a tooth."

Queen Margaret: "That dog had his teeth before his eyes."

King Henry VI: "Teeth hadst thou in thy head when thou wast born to signify that thou camest to bite the world."

Richard: "For I have often heard my mother say: I came into the world with my legs forward. The midwife wondered and the women cried: O, Jesus save us, he is born with teeth; and so I was, which plainly signified that I should snarl and bite and play the dog."

In English and French history we have mention of Richard III, Louis XIV, Richelieu, Mirabau and Mazarin. Inheritance is shown in some cases. In the instance of Mattei, the infant's mother had been born with a tooth, and in Limerick's the mother had two congenital teeth, as did also her second child and a child of her sister.

The etiology of the premature eruption of the teeth is considered due to some abnormal development of the bone; probably most cases have some connection with rickets. In some children who cut their teeth young, the fontanelles close early, but not so in those cases where the teeth are congenital. The enamel is usually very thin or absent. The etiology of congenital teeth is in some instances described as the premature occurrence of the processes which normally lead to the cutting of the milk teeth, in a few cases it is probably due to a true ectopia of the dental follicles and its tooth. Such premature eruptions are usually found in children suffering from improper nutrition or other abnormal systemic conditions.

Treatment: A tooth dangling uselessly and aimlessly in the mouth should unquestionably be removed; otherwise inaction is preferable. The teeth are sometimes so situated as to prevent closure of the mouth, or to make nursing painful and futile, and endanger the nourishment or life of the child. The danger of hemorrhage is probably magnified by Magitot, having lost one child in which the hemorrhage recurred on four separate occasions and proved fatal despite all treatment. He lays down the rule to never extract the teeth. If the child is puny and delicate perhaps syphilitic, hemorrhages are possible.

MOVEMENTS OF THE MANDIBULAR CONDYLES AND DENTAL ARTICULATION.

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This paper is a continuation of the line of thought and investigation indicated in my paper entitled "The Glenoid Fossa; the Movements of the Mandible; the Cusps of the Teeth," read before the Southern Dental Association in November, 1895.¹

Up to that time I had not been able to find mention of the facts that, in the movements of mastication, the mandibular condyle moves "not only forward but also downward, causing the ramus to drop, in the anterior and lateral movements of the mandible"

and that the condyle on the side toward which the jaw is advancing, in the lateral movements, does not merely "rotate on its axis," otherwise "remaining stationary" as we are taught, but that it also moves both upward and backward, very slightly in many subjects, and not at all in some, but considerably in others.

I enlisted the services of men who have access to libraries not within my reach, but even with their assistance, I had been unable to learn of any description of the temporo-mandibular articulation and the movements of the mandible corresponding with my observations. I had therefore concluded that the observations were original.

My paper having been placed in the hands of Dr. E. C. Kirk, as editor of the *Dental Cosmos*, with the request that he would refer me to anything bearing upon these points, he later directed my attention to the report published in the *Boston Medical and Surgical Journal*, July 4, 1889, by Dr. Chas. E. Luce, of the Harvard Dental School, of certain original investigations in the movements of the lower jaw, conducted in the physiologic laboratory of the Harvard Medical School.

It was very gratifying to me to learn that these distinguished investigators, working by widely different methods from my own, had reached the similar conclusion that "certain errors exist in all descriptions of this articulation given by eminent anatomists and physiologists;" a partial explanation of some of the inaccuracies being assigned by Dr. Luce to "the fact that they have made too much use of the cadaver to demonstrate the actions of the articulations, whereas it may be that the contraction of the various muscles coöperating with and antagonizing each other, is the important factor in determining the exact movements of the jaw."

Another cause is in the failure, in studying the temporo-mandibular articulation, to make due allowance for the fact that "in the dried skull the glenoid fossa is emptied of its intra-articular fibro-cartilage, double synovial sacs and membranes, forming altogether a thickness of two or three millimeters, which space will be found, in the dried skull, between the upper surface of the condyle and the roof of the glenoid fossa" making it impossible to reproduce the normal play of the condyle in its socket, and consequently the true movement of the mandible. The published report of the Harvard investigations antedates my own studies by several years, but does not appear to have attracted the attention of the dental world.

Dr. Kirk at the same time directed my attention to the Transactions of the International Medical Congress (Berlin), in which appears an illustrated paper by Dr. Schwarze (of Leipzig), giving an account of his attempts to improve upon Dr. Bonwill's anatomical articulator based upon the study of these Harvard investigations.

Dr. Schwarze failed, however, to grasp the idea of the relations existing between the line traced by the condyle movement and the planes of occlusion and articulation, and the plane of the alveolar process, and therefore missed the essential point, viz., that to secure normal articulation in each individual case, it is necessary to reproduce in the articulator the exact angle formed by the intersection of these lines in the subject.

While, in his experimental modifications of the Bonwill articulator, Dr. Schwarze used a movable

joint, it was all haphazard work. Not having recognized the existence of a definite angle, varying widely in different individuals,¹ he naturally made no effort to secure any definite angle in the articulator, and finally abandoned his attempted improvements with the remark that the nearer he approached nature the further he found himself from practical results.

In the words of Dr. Luce "the first requisite in the study of jaw movements is to move the jaw," and the second "to get a permanent record of the movement."

light, a profile view was photographed, the bright spot reflected from the bead during the motion of the jaw in opening and closing the mouth being continuously photographed, and recorded on the negative as a line, giving the actual movement of the place upon the jaw to which the bead was opposed.

As recorded by this device, the mouth being opened to its greatest extent, the movement of the condyle is traced "as a curved line with the concavity upward," the beginning of which, or that portion traced in the,

CASES.	EXTREMELY OPEN.	HALF OPEN.	SLIGHTLY OPEN.	RIGHT LATERAL MOVEMENT.	LEFT LATERAL MOVEMENT.	ANTERIOR PROTRUSION.
Case 10; male, aged 60. Right condyle						
Left condyle						
Case 11; female, aged 50. Right condyle						
Left condyle						

CASES.	EXTREMELY OPEN.	HALF OPEN.	SLIGHTLY OPEN.	RIGHT LATERAL MOVEMENT.	LEFT LATERAL MOVEMENT.	ANTERIOR PROTRUSION.
Case 12; male, aged 98 Right condyle						
Left condyle						
Case 13; female, aged 60 Right condyle						
Left condyle						

TABLE OF CONDYLE MOVEMENTS.

In the Harvard school investigation the photographic method of recording the movement of the jaw, was employed. A light frame-work was constructed, reaching around the face from the lower incisor teeth (to which it was securely fastened) nearly to the ear. By adjustable devices bright beads were placed directly opposite the condyle, gonion and symphysis. The subject being placed in strong sun-

"short openings" of the movements of mastication being in the "forward and downward" direction, and—as shown by a study of its illustrations—at about the same incline to the facial line that I had noted as the average in normal articulation.

After the reception of the report of Dr. Luce, in order to more thoroughly study the subject, and to confirm the results of these different methods of observation, I constructed an apparatus somewhat

¹ See Dental Cosmos, Jan. 1, 1896, p. 88.

similar to the one used in the Harvard laboratory, and obtained the photographs which I present for your inspection. The white spots show the location of the "beads" and the lines made by this change of position in the movements of the mandible.

No. 1 shows the right side, with extreme mouth opening, showing the distance traversed by the head at the symphysis, one at the region of the first molar and one over the condyle.

No. 2 is the left side, showing the same points.

No. 3 is the right side, showing the distance traversed by the three beads in moving the mandible from right cusp contact to occlusion and over to left cusp contact. The ink mark which was placed on the side of the face before photographing, shows where the bead rested in occlusion, the trace forward being the left lateral movement and back of it the tracing of the right.

No. 4 is the left side, showing the tracing of the beads in moving from occlusion to incisive contact.

No. 5 is a front view, showing the movement of the bead from right cusp contact to occlusion.

No. 1 shows the right side with extreme mouth-opening, showing the distance traversed by the bead at symphysis, one at the region of the first molar and one over the condyle.

To further verify these observations, in another series of experiments I replaced the "bright beads" by a small point of pencil, which traced the movement of the condyle on a sheet of stiff paper, held against the side of the face with the edge parallel with the facial line.

By this method the movements in a large number of cases can be traced in the time required to photograph and develop the negative of a single case.

In edentulous cases I fastened the appliance to the handle of an "impression tray," in which I used Teague's impression compound, additionally securing it by clamping to the mandible when necessary.

By this method I obtained tracings from a large number of individuals, but failed in a single instance to obtain so great a curve, or proportionately to the size of the illustration, so long a line as shown in the Luce report. However, his curve was apparently derived from the movement of the condyle when the mouth was opened to a very extreme degree.

The Luce illustrations are given as a correct reproduction of the photographs, with the relative propor-

tion observed between the width of the face and the extent of mouth-opening.

Assuming this to be the case, the subjects opened the mouth much wider than I have been able to obtain. I have measured the mouth-opening compared with the width of the head sighted from the front and find that the mouth-opening is less than one-third of the width of the head, while in the illustration showing a front view it is more than one-half as great.

These tracings are spoken of by Dr. Luce as being "interesting to dentists, as they show what has to be contended against in taking the bite preparatory to the insertion of an artificial substitute."

But a far greater interest attaches to the correlation of the line traced by the condyle in the movements of the mandible and the facial line.

There is a certain definite correlation between the morphology of the morsal surfaces of the teeth and the angles made by the intersection of the functional portion of the condyle path² with the facial line, which I call the condylo-facial angle; also the angle

No. 2 shows the left side with extreme mouth-opening, showing the distance traversed by the bead at the symphysis, one at the region of the first molar and one over the condyle.

made by the intersection of the condyle-path with the plane of occlusion (or the alveolar plane in edentulous subjects), the condylo-occlusal, or the condylo-alveolar angle, as the case may be.

I show the tracings in two cases, taken:

1. With the mouth opened to its fullest extent.
2. With the mouth half-opened as in admitting food to the mouth.
3. Short openings as in biting and grinding the food.
4. Right lateral, and
5. Left lateral movements of the mandible.
6. Anterior protrusion.

Only the first of these were recorded by Luce, and that seemingly exaggerated.

The cusps and incisive edges of the teeth come in contact only in the short openings represented by the straight portion of the upper end of the line traced in the lateral and protruding movements, and it is that portion of the tracing only that bears any relation

² I mean that short straight portion of the condyle tracing forward and downward made in the movements of mastication, extended till it intersects the facial line.

to the cusps of natural or artificial teeth, the angles formed by the intersection of the extension of this portion of the line with the facial line and the oral planes mentioned being the angles in which we are interested in our studies of the movements of the mandible in connection with dental articulation.

In the paper before referred to³ I gave the conclusions which I had deduced from my experiments in the articulation of the models of natural teeth, and the great variations found in the condylo-occlusal angle of different subjects—ranging as I there stated from 22.5 degrees in one case to 45 degrees in another, those being the greatest extremes noted up to that time. More extended observation, however, has shown an even greater range.

Having proven to my own satisfaction the fact of this variation in the condylo-occlusal or condylo-alveolar angle, I constructed an articulator with an adjustable angle to reproduce these variations—with degree gauges to record the measurement of the angle, which varies not only in different subjects but also very considerably in the movements of the two condyles of many individuals.

No. 3 is the right side, showing the distance traversed by the three beads in moving the mandible from right cusp contact to occlusion and over to left cusp contact. The ink mark, which was placed on the side of the face before photographing, shows where the bead rested in occlusion, the trace forward being the left lateral movement and back of it the tracing of the right lateral movement.

I have also constructed an apparatus which I have called a facial clinometer.

This device registers the direction of the condyle path, and of the plane of occlusion (or the alveolar plane of edentulous subjects) as compared with the facial line, and measures in degrees the angles formed by the intersection of these lines, also the "classic facial angle," the mandibulo-facial angle, etc.

It also measures in millimeters the distance that one condyle moves forward with the synchronous backward movement of the other condyle, in the function of mastication.

I quote from Holden's Human Osteology: "In masticating we can readily feel that one condyle advances toward the anterior margin of the glenoid cavity, while the other recedes to the posterior."

The authorities are not in accord on this point, but

³ See Dental Cosmos, January, 1896.

the clinometer shows it very plainly; it is true that in some subjects the condyle does not move back at all, while in others it recedes considerably, and often one condyle recedes more than the other.

The ratio between the forward movement of one condyle and the synchronous backward movement of the other varies greatly in different individuals, and even in the same individual the ratio often varies in the left lateral movement as compared with the right.

This distance-measurement is registered in millimeters by the clinometer and also on the articulator, where it serves to correspondingly regulate the distance at which to place the bite-correcting fulcrum-screws from the condyles of the articulator.

The importance of being able to recognize the extent to which, in any given case, one condyle recedes as the other advances, and of being able to utilize the observation is shown by the following diagram:

The mandible, as we know, is based on the equilateral triangle, the sides measuring four inches.

In the diagram, A and B represent the condyles, C the point between the central incisors.

If we imagine that the mandible is thrown to the left, and that the left condyle A does not recede, B,

No. 4 is the left side, showing the tracing of the beads in moving from occlusion to incisive contact.

the condyle of the right side takes the position of B', while C, the median line of the incisors, travels to C'. In the molar region F travels to F' on the left and H to H' on the right.

But in a case in which the right condyle, B, advances the same distance as before, while the left condyle, A, recedes one-third of that distance, moving to A'', we will find that the entire triangle acts as though turning on the fulcrum D.

C instead of moving to C', will reach C'', while F will have moved to F'', and H to H''.

In constructing a set of teeth for a subject in whom, by reason of the condyle receding on the grinding side, the fulcrum is at D, as shown, instead of at A, if, by reason of the construction of the articulator the fulcrum is immovably fixed at A, instead of being movable to suit the case, we would find the articulation at fault to the extent of the difference between the points F' and F'', H' and H'', C' and C'' respectively, causing inevitable interference of the cusps, necessitating

either the sacrifice of the cusps or the reconstruction of the set.

There are two reasons why teeth mounted upon plates should have cusps.

Dr. Bonwill points out that it is necessary in order that there may be a reciprocating or balancing articulation; that is, that when the incisors are brought in contact the molars will also touch to balance, and that when the buccal cusps of one side are brought in contact for the purpose of grinding food, we may have a balancing contact on the opposite side, the upper lingual cusps resting upon the lower buccal.

This "balancing articulation" I have illustrated on pages 39 and 40 of the January, 1896, *Cosmos*.

Dr. G. V. Black, in his recent experiments with the dynamometer, has shown that the subject wearing plates can not exert nearly so much force as those having the natural teeth.

He also found, in studying the physical characteristics of foods, that it requires very much less force to comminute food with a cusped crusher than when placed between plane surfaces.

This is the second reason why cusps are necessary to artificial teeth, and in fact, even more essential to teeth inserted upon plates than to the natural teeth.

It is much to be regretted therefore, that so many of the unfortunate people who have to wear plates which deprive them of a portion of the crushing power, should also, from lack of an adjustable articulator, be deprived of cusps upon the artificial teeth, thus still further diminishing their masticating force.

In my work thus far I have used only a heavy, clumsy working-model of the clinometer, made of brass in order that it might be altered as found necessary in the test of actual use. I hoped to have it here in its perfected form, made of aluminum, but have been disappointed.

Photograph No. 6, however, represents the head-piece of the clinometer in position (the jaw-piece, which is secured to the lower jaw to indicate the movement of the condyle, being here omitted).

An adjustable frame surrounds the head, resting upon it at the points A and B. A slender, dependant piece C, not very clearly shown in the photograph except on the forehead and just at the base of the nose, indicates the facial line. The piece D set par-

allel with C by the set-screw E, and held rigidly in position by the brace G, carries the adjustable transverse piece H, the degree gauge I registering the angle formed at the intersection of D and H.

In this position it serves to register the condylo-facial angle when H is placed parallel with the condylo-path indicated by the jaw-piece when the latter is in position and the jaw moved as heretofore described, a point over the condyle traveling freely in the slot of the loosely adjusted transverse piece H, the latter being fixed by a set-screw when its direction has been determined by the movement of the condyle pointer. The position of the transverse piece H can also be changed so that it will register the "classic facial angle," the maxillo-facial angle, etc.

The same dependant piece D, when placed in front of the face supported by the projection J and the brace K, and placed parallel with the facial line indicator C, and using the same transverse H and degree gauge I, serves to register various other angles.

Photo. No. 7 shows a modification of the transverse H, which enters the mouth and indicates the plane of

No. 5 is a front view, showing the movement of the head from right cusp-contact to occlusion.

occlusion—not from the incisive edges and cusps of the upper teeth with the mouth open, but the morsal edge of the lower incisors and the summit of the cusps of the lower first molar when in complete closure.

To obtain this plane, points are affixed to the device which enter the sulcus of the upper molars to exactly the depth of the overlap of the incisors when the incisors are in occlusion. This function of the transverse H is also seen in the photograph No. 8, where it serves by other slight modifications to measure the plane of occlusion as described, also the plane of articulation, the alveolar plane, etc.

The angles and measurements thus recorded by the facial clinometer not only fully confirm the deductions from my experiments with models of the natural teeth, but show an even greater range of variation in the angles in question, not only between different individuals, but in the movements of the two condyles of the same person.

It has been said: "In the domain of organic life

there is rarely perfect symmetric correspondence in the two halves."

This condition was therefore anticipated, but not to the remarkable extent demonstrated by actual measurement.

I will cite two remarkable illustrations of this great variation:

One, a gentleman of 60 years, for whom I made full upper and lower sets. He had never worn plates before. The clinometer recorded the condylo-alveolar angle as 1 degree on one side and 10 degrees on the other, with which angles in the articulator a reciprocating articulation was obtained. This case was the lowest angle I have ever encountered, but it is largely due to the fact that his molars were lost some years ago, while a pair of bicusps and the incisors have only been removed a few months. Thus the alveolar process is greatly absorbed at the rear but scarcely any at the anterior portion. When absorption takes place in front the angles will undoubtedly become greater.

No. 6. The facial clinometer in position.

The second case is that of a lady 70 years of age. She has natural teeth below but has worn an artificial set above for over twenty years, having had different sets made but not with satisfaction, not having been able to bite.

The condylo-alveolar angle in this case was 22 degrees on one side and 44 degrees on the other. The variation was so great that I doubted the correctness of the record. Not wishing to trouble the patient with a repetition of the measurements, in placing the case in the articulator I made a compromise, taking 5 degrees from one side and adding 5 degrees to the other.

But I found it impossible to get a reciprocating articulation until I had restored the angles to the clinometer record. This was a peculiarly difficult case, not only because of the extreme angles but because the lower molars were worn by contact with porcelain teeth above, and the lower incisors having been relieved of all work were long, and the patient was unwilling to have them shortened.

The articulators devised by Drs. W. G. Bonwill, E.

T. Starr, W. W. Westmoreland and more recently by R. H. Antes, have both a lateral and a protrusive movement, but inasmuch as they fail to reproduce the drop of the ramus due to this hitherto unrecognized combined forward and downward movement of the condyle, they do not reproduce the true movement of the mandible, and therefore do not permit the normal articulation of the cusps of models of the natural teeth. Consequently they can not be relied upon to produce a correct articulation of artificial substitutes.

The physiologic articulator, with its adjustable angle, its degree and millimeter gauges for recording the measurements taken by its adjunct, the facial clinometer, will probably appear too complex for some, especially as compared with the dental articulators heretofore in use, which, with few exceptions, have been mere occluders.

But to those who desire to give their patients the best results possible, and who are not satisfied with anything short of scientific accuracy, the study of the

No. 7. The plan of occlusion.

mandibular movements as measured and recorded by the clinometer, and reproduced by the adjustable articulator, will be found not only instructive and interesting, but also of great practical value in their application.

As I have said in the article before referred to: "The movement of the condyles constitutes an important factor in many departments of our work, as in its bearings upon the articulation of the teeth, in the study of the cusps of the natural teeth with a view to bettering the articulation, either in orthodontia or in the treatment of the disease commonly known as pyorrhea alveolaris, in the shaping of artificial cusps, whether in fillings, crown, bridge or plate work; in the treatment of diseases of the facial muscles, of the glenoid fossæ, or of plastic adhesions, etc."

The Vogt Prize.—The pupils of Professor Vogt of Moscow collected 2,000 roubles on the occasion of his recent twenty-fifth "jubilee," the income of which is to be awarded each year to the last work on general pathology by a former student of the university.—*St. Petersburg. Med. Woch.*