The Lower Incisors In Theory And Practice

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We orthodontists customarily regard the denture as a whole; we do not confine ourselves to the denture only, but also take into account the entire patient and his constitution. Nevertheless, there sometimes arises the need to concentrate one's attention upon a certain section of the denture. Such a section presents itself today in the lower incisor region. First, because of the fact that there has been a certain eclipse of the six year molar as the "key to occlusion", lower incisors have usurped a kind of "key position" in newer diagnostic procedures. Second, these teeth seem to have also become a problem in therapeutic procedures during the last few years. While in Bogue's and Angle's times widening was the cure-all, today we have quite a range of possibilities. One may be that of resignation, as expressed by Howes: "The patients and their parents are prepared for some irregularities of the mandibular incisors." Another is the outright extraction of two premolars. In between is the extraction of an incisor, stripping and, of course, widening.

Though all this has been treated and discussed repeatedly so that there hardly appears to be any need to go into it once more, it seems to the best of the author's knowledge that the interrelation between diagnostic and therapeutic precedures has not yet been investigated, i.e., the *double personality* of the mandibular incisors as diagnostic subjects on the one hand and as therapeutic objects on the other.

The significance of the lower incisors as therapeutic objects is threefold:

(1) As the first to erupt they may be the first sign of an incipient malocclusion.

(2) They are difficult to treat as they relapse easily.

(3) Crowding of the mandibular incisors is the most frequent anomaly.

In this connection it might be opportune to give a few statistical figures.

STATISTICS

In Table I the results of some investigations regarding crowding have been collected. They are rather uniform and may be roughly summarized as follows: (1) crowding of lower incisors occurs in about fifty per cent and (2) crowding in the lower jaw is between fifty and one hundred per cent higher than in the upper.

Table I

Frequencies of maxillary and mandibular crowding

	Barrow and White	Huber and Reynolds	Lundström*	Moore	Moorrees* and Reed	Seipel
	Anteriors	Anteriors		Anteriors		
Maxilla	24%	32.2%	35%	26.4%		25%
Mandible	51%	52.6%	50%	48.3%	69%	51%

* Estimate from histo or scattergram respectively

These figures call for some explanation. Generally, disrelations between the widths of the upper anterior teeth and of the lower ones are thought to be the cause. But if this were the only cause, it should work both ways, i.e., leading equally to crowding and spacing. Further, it does not explain the twice as much occurrence of crowding in the mandible. Thus we are led to the conclusion that there exist still other factors responsible for this peculiarity. It seems to the author that we might get a clue from studying phylogenetic development.

Phylogenetics — The Mandible

It goes without saying that though this paper is concerned with the lower incisors, we cannot treat them in a kind of "splendid isolation". There must be considered relations with the other mandibular teeth, with their antagonists and with their very base, the mandible itself, and especially with that part of it which has evoked so much interest among dentists, anatomists, anthropologists and even laymen: the chin.

A few years ago the chin problem was comprehensively treated by DuBrul and Sicher under the rather challenging title *The Adaptive Chin*. After reviewing and rejecting the current theories, especially that of reduction (Weidenreich), they proceed to develop their own theory: the chin is a sort of buttress which has come into existence to reinforce this part of the mandible against the masticatory stresses which converge here and which, after the mandible has undergone phylogenetic changes, make this point a particularly vulnerable one. Thus, the chin has arisen in response to changed conditions and they speak therefore of the "adaptive chin".

The author cannot but look at the problem differently. Siding with the representatives of the reduction

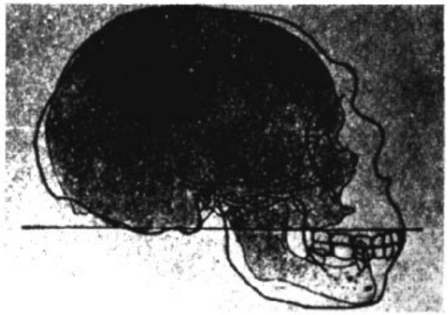


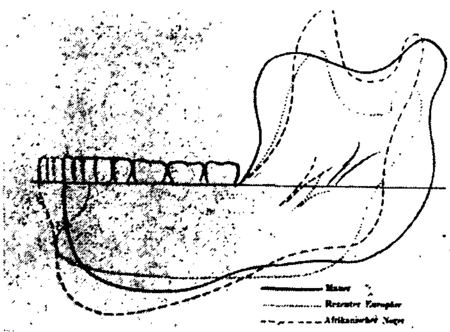
Fig. 1 Modern skull (E.D.Cope) in comparison with Neanderthal (La Chapelle-aux-Saints). After Boule.

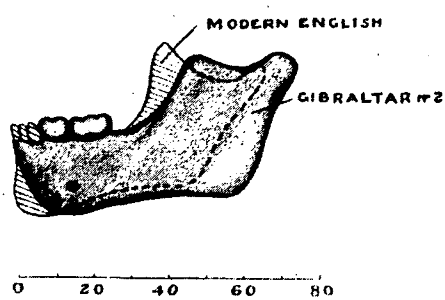
theory, he thinks that not the chin, but the teeth and especially the lower incisors are "adaptive", since it is they which had to adapt themselves to a reduced space. A few illustrations shall elucidate this point. Fig. 1 shows the changes which have taken place in the build of the skull since paleolithic times. Of special interest for us will be the reduction which befell the face and jaws. As we are now mainly concerned with the conditions in the mandible, the next two pictures will give us more details. Fig. 2 is a reproduction of Schoetensack's comparison of three mandibles of which only the Heidelberg jaw and the modern one will concern us here. Fig. 3 is Keith's comparison of the mandible of a Neanderthal child with that of a recent juvenile specimen. If we look at these pictures, we are immediately aware of the fact that a substantial reduction has taken place, but we will not get any hint as to where it has taken place; the superimpositions as they are made here might easily lead to the idea that out of these changes the chin has evolved as something new. If, however, we superimpose the same mandibles as in Figs. 4 and 5, i.e., on a point corresponding approximately to the gnathion, we shall get quite another impression.

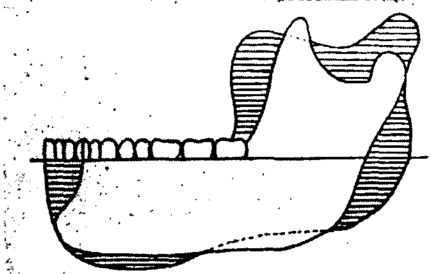
From comparing different growth stages we know the difficulties we have to contend with when we wish to fix growth centers in order to superimpose tracings. In the same way we have, of course, no certainty where to place—if one may say so—the *reduction center*. Superimpositions like those in Figs. 2 and 3 would imply reduction at the distal part of the corpus and ramus and apposition in the front. But, if we superimpose the tracings as in Figs. 4 and 5, we are led to the conclusion that reduction has taken place rather equally in the corpus and the ramus, yet the tooth bearing part has changed drastically in extension as well as in position. Such a process seems to us very probable, as the extremely massive corpus mandibulae should resist radical changes more effectively than the cancellous tooth bearing part.

In addition to this we also have to consider what has been called the *chin of the upper jaw*—the anterior spina nasalis. This process, too, does not exist in apes or early men, and comes into existence simultaneously with the chin. Both these developments we can explain by the same process, namely the reduction of the tooth bearing parts in the upper and lower jaw, a reduction which has not yet enveloped the basal parts in either jaw. For the emergence of the chin, the mandibular prominence, particularities of muscular behavior and masticatory stress have been adduced by DuBrul and Sicher. It should be difficult for them to claim the same causes for the development of the anterior nasal spina.

DuBrul and Sicher try to discredit the reduction theory further by stating that reduction should have acted on both corpus and alveolar process to-







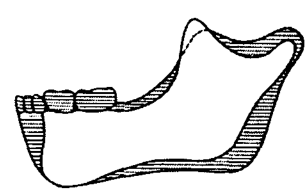


Fig. 2, upper left. Superimposition of mandibular profiles of Heidelberg man (———), recent European (. . . . .) and African negro according to Schoetensack.

Fig. 3, upper right. Superimposition of mandibular profiles of Neanderthal child and recent one according to Keith.

Fig. 4, lower left. Superimposition of mandibular profiles of Heidelberg man and recent European according to the author.

Fig. 5, lower right. Superimposition of mandibular profiles of Neanderthal child and recent one according to the author.

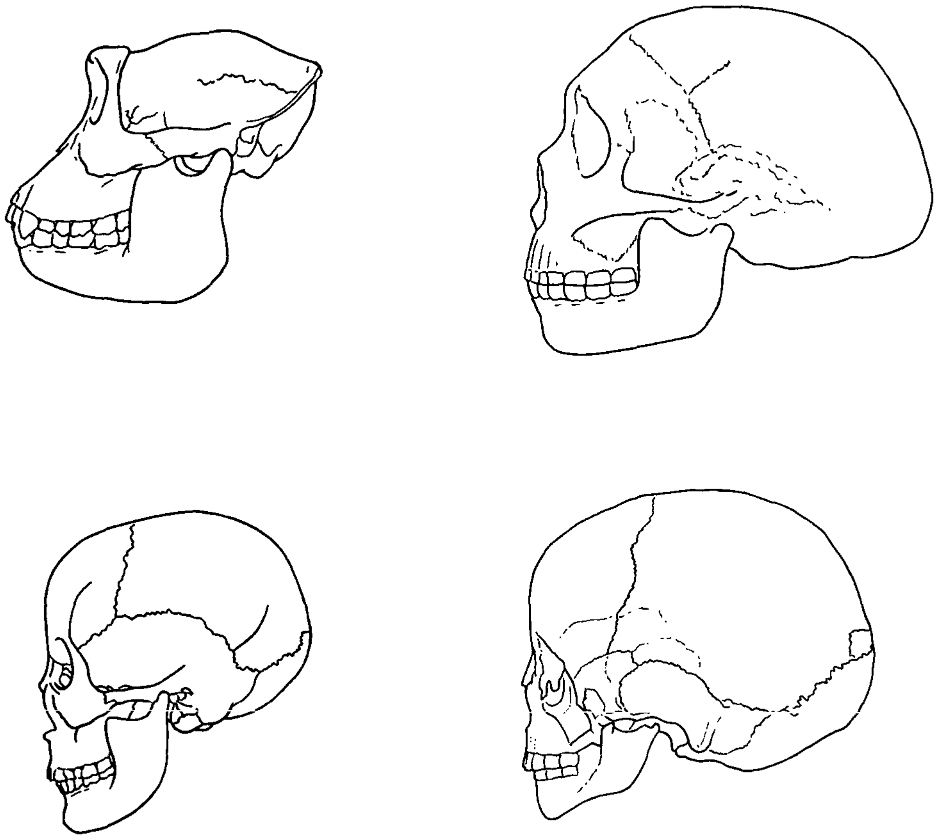


Fig. 6 Developmental stages: upper left, ape; upper right, early man; lower left, recent man; lower right, child.

gether. But why should it? Familiar with quanta and mutations, we are used to the idea that nature does not proceed in a continuous way but by leaps. So the emergence of the chin can be explained as a temporary lack of synchronization in these leaps. One of the next leaps may easily concern the chin which has so far escaped the general reduction trend.

Bolk and The Fetalisation Theory

The above given explanation would also be in conformity with Bolk's fetalisation theory. Bolk has demonstrated that the rise of Man is connected with the fact that conditions existing in earlier ontogenetic stages have become fixed. Apes and men resemble each other in their fetal stage much more than one would expect, judging from their adult state. Thus, while the masticatory apparatus develops into the snout in apes, this development in man comes to a standstill at a much less progressed stage. Another example: in the course of ontogenetic development the relatively high forehead of the child becomes flatter and more receding. This process, too, comes to its end in recent man earlier than in the Neanderthaler or in the ape. Figure 6 illustrates both these phenomena.

To these representatives of developmental types might very well be added a constitutional type, to be inserted between the stages 3 and 4 of Figure 6. It is the *Cerebral Type* of the French school of constitutionalists. This type is characterized by a well-developed cerebral part of the skull with its especially high forehead. In contrast to this the facial part is less developed so the profile is nearly straight, with a small nose, narrow lips and a very flat chin which might be termed "underdeveloped". But this *underdeveloped* chin can be understood as *arrested* in its development at a more juvenile stage. It is well known that the chin starts its developmental career rather late, at and after puberty. The high forehead too can be explained in the same way, (Fig. 7). Comparing the developmental stages in the light of the fetalisation theory, we easily get the impression that the present day cerebral type is the latest form Nature has evolved on Man's way from past to future. And it is just here that the atavistic remnant called "chin" for the first time shows signs of a beginning reduction and thus falls into step with the general trend towards reductions of the whole masticatory apparatus.

Fig. 7 Maturation changes of the face. Above, after Gerhardt; below, after Martin.

Phylogenetics, The Teeth and Their Occlusion

After having found that reduction to an essential degree has taken place in the very region of the lower incisors—the chin excepted—it seems necessary to investigate how the reduction of these teeth themselves compares with it. This poses a certain difficulty, since early man is generally found as one specimen, rarely two, at a time. There were, however, two excavations where groups of Neanderthal people were found and which lend themselves to statistical treatment. The one place is Krapina (Yugoslavia), the other on Mount Carmel (Israel). In Table II we shall see that the mean value for upper and lower incisors in orthodontic patients is only about fifteen per cent smaller than in the extremely macrodont Krapina people and even ca. five per cent only in the Mount Carmel people. These reductions are of a rather moderate extent in comparison with the reductions which have taken place in the mandible. (Based on figures published by Hrdlicka, the author once computed the over-all length of a modern mandible to be thirty per cent smaller than that of the Heidelberg mandible and the thickness in the median line, measured midway from above, is reduced as much as even fifty per cent.)

Though this difference in reduction would explain the occurrence of crowding generally, it would not ex-

Table II

Incisor Widths in Palaeolithic people and orthodontic patients

	Krapina	Mount Carmel	Heidelberg	Ortho. patients
	Sum of the four upper incisor widths			
Minimum	34.8	29.4		25.0
Mean	37.6	33.8		31.8
Maximum	39.8	39.6		38.0
	Sum of the four lower incisor widths			
Minimum		21.0		17.5
Mean	27.4	24.0	23.6	23 1
Maximum		27.4		27.5

plain the higher percentage in the lower jaw and for this we shall have to consider the changes in position and occlusion which have taken place during the same period.

Psalidodonty (scissor bite) is today regarded as the "normal" bite; we must, however, not forget that this is a rather recent acquisition and that even at present labidodonty (edge to edge bite) is still the bite of Australian aborigines and Eskimos. It seems to the author that it is this change-over from labidodonty to psalidodonty which is responsible for the high frequency of mandibular incisor crowding. Looking at modern dental arches, we see well rounded incisal segments in the upper jaw; the lower incisal sector, however, is nearly straight, for the lower teeth have to arrange themselves *behind* the upper ones. If we compare these conditions with those of earlier times, we find the lower incisal segment equally well arched. Not confined *behind* the upper teeth but arranged *opposite* them, the incisors can fan out and adapt themselves to their antagonists. It should be mentioned that even in these early times labidodonty was not originally existent but was a product of ontogenetic development connected with the attrition of the teeth. But then, at a very early age, cusps and edges were worn down by attrition and abrasion due to primitive food habits and the admixture of sand and grit to the food. The lower incisors could leave their restricted position behind the crowns of the upper ones and occupy a segment, which was not only wider, but curved like the upper frontal arch. In Fig. 8 an attempt is made to arrive at an estimate of the reduction which has been caused by this change. The curved line A - B measures 26 mm., while the nearly straight line A' - B' is only 21 mm. long, i.e., ca. 20 per cent less. We have, however, just seen (Table II) that the teeth of recent men are on the average only between five to fifteen per cent smaller. We must not overlook the fact that, apart from averages, there crop up in recent man maximum values which almost reach those of

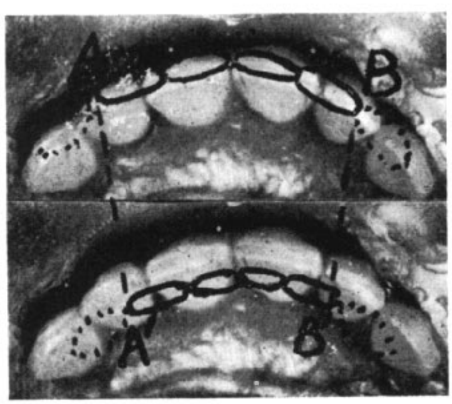


Fig. 8 Loss of space through transition from labidodonty to psalidondonty.

early man, while we shall never find a mandible today which could compare but slightly with that of Heidelberg man, for instance. It seems that here we find the underlying reason for today's mandibular incisor crowding.

Now, it might be argued that, when the lower incisors descend, phylogenetically speaking, from their edge to edge position and glide back to arrange themselves behind the upper incisors, they bring the whole lower arch into a more posterior position. But, as a matter of fact, skulls with labidodonty show the same occlusal pattern as exists in modern neutrocclusion interdigitation. Thus, the posterior segments remaining stable, the whole loss of space makes itself felt in the anterior sector which reacts by crowding.

Though we cannot follow DuBrul and Sicher when they speak of an *adaptive chin,* it would be possible to call the mandibular incisors *adaptive teeth.* Crowding is their response to the phylogenetic changes which have taken place. That this kind of adaptation is not an ideal one need hardly be said. Reduction in size or number would bring a real solution, of course, but this process has scarcely started. Table II has shown the modest amount of reduction in size which has taken place up to now, and congenital absence of lower incisors is so seldom and irregular as to be quite a negligible factor.

Dental Disharmonies

The phylogenetic approach shows us there exists an inherent tendency toward disharmony between the mandibular incisors and the space at their disposal. If this fact is regarded here as the primary reason for their so frequent crowding, there should, however, not be excluded the possibility that other causes might be involved too.

Various authors have mentioned the disrelation in the size of the upper and lower front teeth. Neff in 1949 proposed an anterior coefficient: in two hundred cases he found this coefficient ranging from 1.17 to 1.41. In his opinion the "ideal" ratio would be 1.20. Varying the degree of overbite according to the value of this coefficient, he believes in the possibility of a "tailored occlusion". In 1957 Neff has once more taken up the subject. He now introduces an anterior percentage relation (APR) and states that in three hundred malocclusions the maxillary anteriors are between 18 and 36 per cent larger than the lowers. He still recommends compensation for disharmonious segments by varying the overbite and even gives a table showing the "indicated overbite" for different values of APR. However, he also thinks that in some cases the extraction of a lower incisor might be necessary, and that in other cases stripping might be sufficient.

Lundström has treated the problem of anterior disharmonies on different occasions. In 1955 he tested an anterior index in 195 boys and 124 girls and found a range of 73 to 85, with a mean of about 79. He states that the degree of crowding is higher in individuals with big teeth, while those with small teeth tend toward spacing. In contrast to Neff he declares: "An adjustment of the overbite or overjet does not seem to be the method used by Nature for accommodation of disharmonies in the tooth width ratio between upper and lower jaws."

Bolton (1952), according to Neff, investigated fifty-five excellent occlusions and found a range of 74.5 to 80.4 with a mean of 77.2. He, too, could not find a relation between the ratio and the degree of overbite.

Ballard (1956) believes, in addition to disharmonies of upper and lower segments, left-right discrepancies, too,

Table III

Means, standard deviations, coefficients of variability and correlation coefficients of incisors and of molar circumferences

	Mean	St. Dev.	Coe. Var.	Coe. Cor.
Sum of upper incisor widths	31.81	2.24	7.07%	0.70
Sum of lower incisor widths	23.10	1.82	7.88%	
Upper molar circumferences	36.90	1.46	3.95%	0.78
Lower molar circumferences	36.16	1.72	4.75%	

should be taken into account. In five hundred cases he found that in 90 per cent one or more pairs of teeth showed such discrepancies. Ballard regards 75 per cent as the "normal or ideal total of the mesiodistal widths of the lower incisors." In four hundred orthodontic patients he found that this total was larger in 90.7 per cent; in 50.3 per cent it was larger by 2 mm or more, and in 31.5 per cent it was larger by 3 mm or more. On the basis of these findings he recommends stripping or, when the difference amounts to the width of a central incisor, the extraction of such a tooth.

All these publications were concerned with the front teeth, i.e., incisors plus cuspids. As this paper is devoted to the lower incisors, the author thought it opportune to make a special investigation limited to the relationship between upper and lower incisors. It was found that the mean for the Incisor Index was 73 per cent, with a range of 63 to 86 per cent, and therefore not much different from the means found for the anterior indices. It deviates from them by the much greater range which is nearly twice as large. The material for this investigation consisted of three hundred orthodontic patients.

There was also computed the correlation coefficient for the sum of the upper and lower incisor widths which was +0.70 ± 0.029. To give some interpretation of the meaning of this figure, the author has also calculated the correlation coefficient for the circumferences of the upper and lower first molars: +0.78 ± 0.023. As we know how different upper and lower molars can sometimes be in the same patient and as we see that their correlation, nevertheless, is higher than that between the incisors, we get some idea what disharmonies we may have to contend with, Table III and Fig. 9.

To this might be added that the incisors especially have a rather high genetic variability. This was demonstrated by Lundström in his investigation *Tooth Size and Occlusion in Twins* (1948). Ballard's (1956) obser-

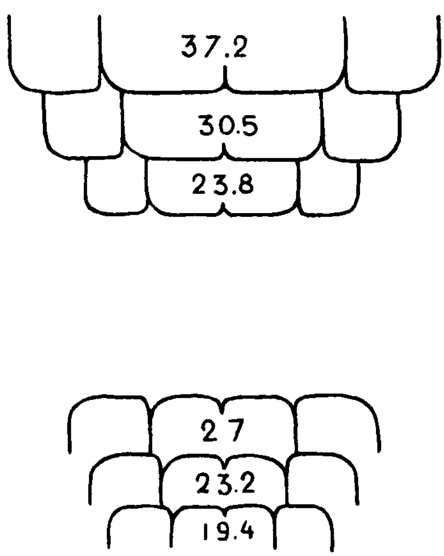


Fig. 9 Comparison of minimum, mean and maximum values of maxillary and mandibular incisors.

vations have been reported above, and only recently Horowitz, Osborn and DeGeorge (1958) in their publication *Hereditary Factors in Tooth Dimensions* came to the following conclusion: "When mesiodistal tooth dimensions are used to establish orthodontic diagnosis ratios, the findings of this study suggest that the anterior teeth be considered as two separate groups, the 'variable' incisors and the relatively 'stable' canines".

Teeth — Jaw Disharmonies

Among the possible disharmonies remains that between the size of the incisors and the size and form of the mandible to be investigated. As the author has repeatedly treated the subject of disrelations on a constitutional basis, it might suffice here to mention that crowding can result from the appearance of large teeth in relatively small or narrow mandibles. The importance of such disrelations was first stressed by Axel Lundström and this problem has since been dealt with under the term of "apical base". There was, however, always a certain vagueness about it, and the author has tried to put the teeth-jaw relationship on a more concrete basis by his Zygomatic Method. This method has been sufficiently described in earlier publications, so that there seems to be no need to go into it once more. This might, however, be a good opportunity to mention some recent investigations concerning the validity of this method.

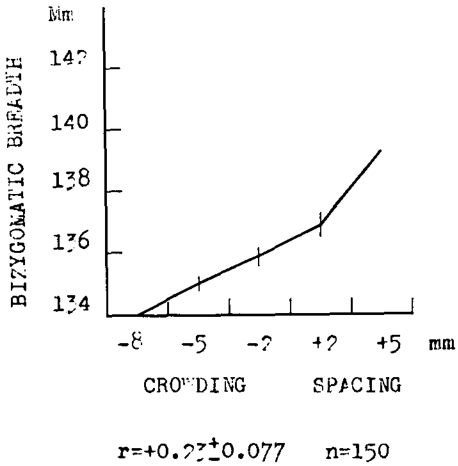
Markowitsch of Basle University (1957) has confirmed the zygion-molar relationship in an investigation of twelve hundred children and adults. He thinks, however, to get still better results by replacing the bizygomatic measurement with the bitragial breadth.

Another and especially interesting test of the author's Zygomatic Method has been made by Moorrees in his investigation of the *Aleut Dentition* (1957). In this Eskimoid people, he found the index: bizygomatic breadth over bimolar width to be 33.2 as against the required 33.3. Commenting on this result and comparing it with investigations by Meredith and Higley, Moorrees writes: "These authors from their own data and those of others reported a wide range of variation (0.18 to 0.88) for this correlation coefficient. It should be noted, however, that the different samples reviewed varied in age, in methods of measurements and in the manner in which growth increments for bizygomatic breadth in children were taken into account, a fact which explains the highly variable findings reported by different investigators. For thirty-four Aleuts the coefficient of correlation between arch breadth and bizygomatic breadth is $+0.74 \pm 0.076$ which indicates a rather high degree of association between these two measurements".

It seems that these rather critical remarks by Moorrees also hold good for the latest publication by Hixon and Meredith (1957). Regarding this paper the author cannot but point out one rather astonishing inaccuracy. In describing the Disrelation Table which is an off-shoot of the Zygomatic Method, Hixon and Meredith write: "The chart is diagnostic in that it is partitioned into zones designated 'lack of space', 'harmony' and 'excess of space'. The major interpretation made is that for those patients falling in the 'lack of space zone', the only solution for successful treatment is extraction . . .". Now, as a matter of fact, the original chart has not three zones as reported above but five, i.e., besides the zones mentioned above there is a zone of "extreme excess of space" and one of "extreme lack of space". And the author's remark about extraction as the only solution as quoted by Hixon and Meredith did refer to this latter zone of extreme lack of space. It might well be stated here that the author never thought of the Disrelation Table as the one and only criterion of extraction therapy. It was proposed as an addition to existing diagnostic procedures in order to facilitate a sometimes difficult decision.

Returning to our problem, it will not seem astonishing after the preceding discussion that the author tried to demonstrate the occurrence of teeth-jaw disharmonies with the help of the bizygomatic measurement, though the outlook was not promising. For even in the upper jaw the relation between the bizygomatic breadth and the anterior parts of the dental arch had proved to be rather weak in contrast to that existing in the molar region. The correlation coefficient of +0.23 ± 0.77 for the relation between crowding and the bizygomatic breadth did not come as a surprise; it is low and just at the level of significance. As a kind of surprise, however, there appeared a coefficient of practically nil for the correlation between crowding and the bigonial breadth, which was computed at the same time and with the same material (one hundred fifty orthodontic patients). On the other hand, a correlation coefficient between crowding and the sum of the lower incisor diameters proved to be as high as —0.56 ± 0.56, which means that the bigger the teeth, the greater the lack of space as expressed by amount of crowding, Figs. 10 and 11.

Though we cannot directly prove teeth-jaw disharmonies, the very fact that crowding is so strongly correlated with incisor size makes them very probable. As a matter of fact, the disharmonies produced by the greater reduction of the mandible and the lesser one of the teeth during phylogeny—described above— would already fall into this category of teeth-jaw disharmonies. To these would now have to be added those where big teeth appear in constitutionally small and/or narrow mandibles as connected with leptosomic or cerebral types.



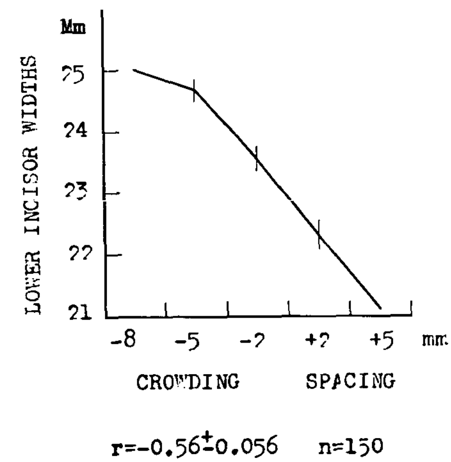


Fig. 10, above. Correlation of bizygomatic breadth with crowding and spacing of the lower incisors.

Fig. 11, below. Correlation of the sum of the lower incisor widths with crowding and spacing.

Dynamics

Having up to now and at some length treated what might be termed static conditions concerning the lower incisors, we shall now have to consider some aspects which might constitute their dynamics.

First among them is growth and development. The spacing of the deciduous incisors is a good indicator of the growth taking place in this region between the ages of three to six. If there is not enough room at that time, the lateral incisors erupt lingually. But they may still find their normal places —under the influence of function and muscle pressure—if more space will accrue by local growth at this "late" age. To understand the meaning of "late" in this context, it should be remembered that, as far as addition of space is concerned, growth in this particular region stops at that time. In an investigation of twenty-eight individuals from 3 to 15 years of age, Woods found that the canine width, measured between the tips of their cusps, increased on the average by 0.9 mm. in boys, by 0.6 mm. in girls, i.e., remained practically stable. Therefore, hopes for the relief of crowding by later growth are doomed to disappointment. Space gained by the replacement of the deciduous molars through their smaller successors is generally taken by the mesial drift of the six-year molars.

There have been interesting investigations with respect to changes in place and inclination of the lower incisors. Schaeffer as well as Björk and Palling found that such changes do not occur in one direction only. Some incisors increased their labial inclination, others their lingual one, and some did not alter their inclination at all.

Occasionally one reads that besides changes of inclination, the over-all position of the incisors is changed into a more lingual one. Such statements are accompanied by pictures where the backward movement is measured from pogonion as the point of departure. But pogonion is in an especially vehement developmental stage during and after puberty. Gerhardt in his monograph about *Maturation Changes of the Human Physiognomy* has found that not only the inclination of the chin alters, but also changes of its configuration. He distinguishes three basic shapes. Meredith reports changes of up to 2.6 mm in the depth of the anterior concavity, reflecting upon the development of the pogonion, even during the prepubertal period (4 to 14 years). It would, therefore, seem that we have to observe extreme reserve when meeting with conclusions regarding the incisor position in relation to pogonion. (See also Fig. 7.)

The influence of the muscles must be mentioned among the dynamics of the lower incisors, too. One is inclined to think that an equilibrium between the pressure of the tongue from within and the buccal and labial musculature from without is conducive to a stable position of the teeth generally and the incisors in particular. These, however, are general considerations and the recent investigation of a special instance of muscle behavior might be of interest in connection with this problem. Sims measured perioral and lingual muscle pressure exerted upon the maxillary and mandibular central incisors and came to the conclusion that there exists no relation between the inclination of the incisors and the amount of pressure. We should, therefore, for the time being still use a certain caution when speaking about the influence of the muscles on the lower incisors.

Another question to be considered in this context is that of *bite raising*. This was regarded rather optimistically until a few years ago. But Thompson's investigations brought about a more realistic approach and the limiting influence of the muscles is now recognized. It should be with extreme caution that we try to get more space for the arrangement of the lower incisors by bite raising, as, for instance, envisaged by Neff in his *tailored occlusion* or *indicated overbite* proposals.

Related to the influence of muscles is that of habits, part of which is but a perverted muscle action. It seems rather superfluous to state that the lower together with the upper incisors are the teeth most of all exposed to displacement by habits. Differences in the resulting anomalies are due to the varying combinations of duration, frequency and intensity, as has recently been emphasized by Graber. It might, however, be added that these habits will superimpose their influence on the existing pattern only and will not change an originally existing tendency towards crowding or spacing.

Diagnosis

On the basis of the above theoretical considerations we shall now see what conclusions we can draw for the practical application in diagnosis and treatment.

Newer diagnostic procedures following the lead of Tweed are centered around the lower incisors. At the start came the postulate of an angle of 90° between the axis of the lower incisor and the mandibular plane. This was later complemented by the introduction of the Frankfort mandibular plane angle; and finally the Frankfort-lower incisor angle was arrived at. Thus, all the angles of the Frankfort-mandibular plane triangle have successively come into play and, if one is inclined to say so, one could state that this triangle has now run full circle. As the angles of a triangle add up to 180° and two angles were already fixed at 90° and at ca. 25°, this new relationship does not mean anything essentially new, but simply follows as a mathematical consequence.

The question now arises whether the angulation of these teeth is really as important as these continual diagnostic endeavors would have it appear. To a certain degree this question has already been answered. Wylie (1955), testing cases treated by Johnson and by Tweed himself, found no correlation between the uprighting of the lower incisors and changes in the angle of convexity. The greatest change (16°) actually occurred in a patient where the lower incisors were tipped even 1° forward while the greatest amount of tipping (24°) produced a change of 9° only in the convexity angle. Wylie therefore, comes to the conclusion that "all these years orthodontists have been attaching exaggerated importance to the angulation of the lower incisors, so far as it is concerned in orthodontic diagnosis and treatment planning." Essentially the 90° angle was a prosthetic principle taken over into orthodontics, and its usefulness there has been doubted. Wylie's investigation proved that these doubts were absolutely justified.

Another point should also be considered: in the introduction it was remarked that apparently the six year molar had lost its position as key to occlusion and has been replaced, at least to a certain extent, by the lower incisors. Massler and Frankel, in an investigation of 2758 children, came to the conclusion that the lower incisors were the most frequently displaced teeth, the upper first molars the least ones. There does not seem to be much advantage in replacing the relatively stable teeth by such unstable ones in diagnostic procedures. How unstable these teeth really are, the author hopes to have shown in the earlier part of this paper. There the teeth have been characterized as "adaptive", because they adapt themselves to the reduced space at their disposal and according to their size. Their position is basically a resultant of these two factors, and the correlation coefficient of -0.56 shows that size is the more important one.

Now, following up the idea of adaption, we should have to ask: to what special condition have the incisors to adapt themselves? The answer would be: to the position of their neighbors, the cuspids. Earlier in this paper it was reported that the bicanine width remains practically stable. So it seems that it is this width which determines the fate of the incisors. If the incisors are small, they will arrange themselves well within this space; but they will have to crowd into it, if they are big. When they are very small and there is much room at their disposal, there will be spacing.

We are led to believe that rather than to center our interest upon the incisors and their angulation, we should consider the cuspid position as the point of departure. There is, however, no action without reaction, and we have learned from our anchorage problems that a tooth cannot be moved without to some degree influencing the anchor tooth or teeth. Consequently, the retention of the incisors produces some reaction in the cuspids. This reaction in the cuspids expresses itself by tipping. And, if just now the position of the cuspids was proposed as a point of departure, we will have immediately to correct ourselves and to add that in the last instance it is the cuspid apex position which is decisive. The same action - reaction mechanism is, of course, at work in the cuspid - bicuspid relation, too, and thus the tipping of the cuspids may also come to some degree under the secondary influence of the bicuspids. Though this need not concern us here, a careful analysis will have to be made when planning treatment.

Treatment

If one accepts the foregoing argumentations, one of the first practical conclusions would be: not to base diagnosis and treatment planning upon the four lower incisors and their angulation mainly. Taking into account the reduction of the anterior part of the mandible and the possible disharmonious size of the teeth, our main concern would be to find a solution which would disturb the position of the lower cuspids, i.e., their apices, as little as possible. This means that we would first of all have to imagine them in a upright position and to calculate how much space would then remain available for the arrangement of the incisors. If there would be lack of space of more than about 3 mm, the best solution would be to extract an incisor. Such a procedure has occasionally been advocated by Neff, Ballard and others. It is, however, apparently not accepted as a routine measure for Salzmann recommends: "Incisor teeth should not be extracted unless damaged beyond satisfactory repair".

The author thinks that the recent tendency to use these teeth as a kind of "keys" to diagnosis and treatment planning has elevated them to such a state of importance as to make the weakening of the "key ring" as something not to be thought of. The approach to the problem, however, as pursued here, would make the reduction of tooth material between the cuspids the logical solution. And to translate this into practice is rather easy, if, as has just been stated, there is a lack of space of 3 or more mm. The author prefers the extraction of a lateral incisor as he finds that the distal side of a central incisor fits rather well the mesial part of the cuspid, whereas the extraction of a central brings the mesial side of a central

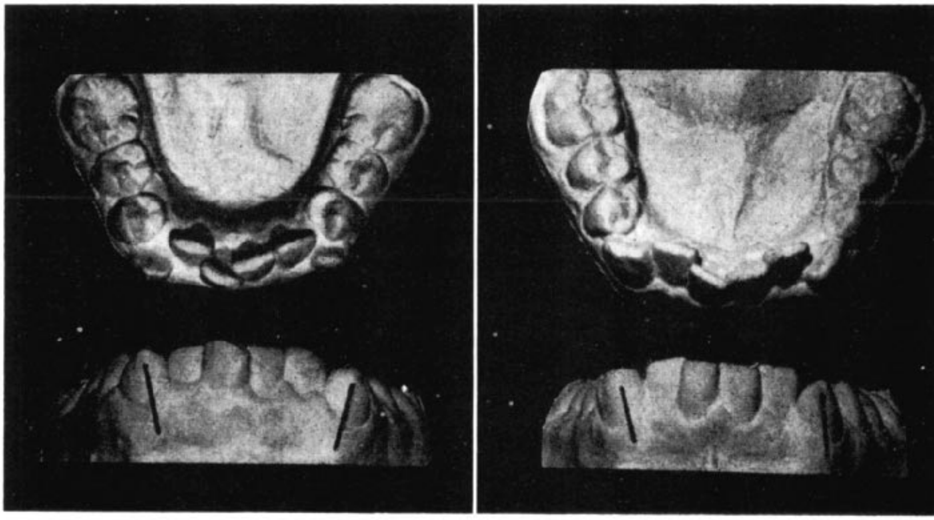


Fig. 12, left; Fig. 13, right.

and the mesial of a lateral together and, even when the teeth are perfectly uprighted and parallel, there sometimes persists an awkward empty triangle between the lower half of the teeth and the gingiva.

Extraction of this kind is easily decided upon when there exists a certain asymmetry, one lateral in a lingual position and the adjacent cuspid tipped outward or backward. If there is more lack of space than that of an incisor width, the extraction of two premolars is the best solution. There may, however, be cases where both cuspids are tipped backward to a considerable degree. To bring them back into the premolar space would not only entail uprighting but also a consecutive extensive bodily movement. In these rare cases extraction of both laterals seems, if not ideal, still the relatively best solution. (Fig. 12).

The direction of tipping may also become decisive when the incisor position is symmetrical, both laterals being lingually displaced, of which, however, only one need be extracted. If in such a case one cuspid should be tipped forward and one backward, the lateral beside the latter should be extracted for uprighting this cuspid is already half the treatment, while on the other side bringing the forward-tipped cuspid into the extraction space of the lateral would require moving it farther in the direction of tipping and would necessitate extensive bodily movement (Fig. 13).

If the lack of space is less than 3 mm, the decision might become rather difficult. One just can resign oneself to the situation and take a certain amount of crowding into account, as advocated by Howes; or one could resort to stripping. Up to now the author has never practiced it, but he remembers certain cases where the peculiar form of the incisors, wide at the edges and strongly tapering towards the gingiva, posed a real problem and stripping might have been the solution. Progress in impregnation techniques, like fluoridation, might overcome one's still existing reluctance. Finally, in these cases of not-so-pronounced lack of space, there still remains the conservative treatment by widening, especially if this would be in conformity with the need of some expansion in the upper jaw.

Needless to say that these are elementary points only, to be considered in lower incisor treatment. There certainly is room for further improvement in differential treatment planning. Besides there is a possibility for a wide range of combinations as extraction of a lateral on one side and of a bicuspid on the other, or extraction plus widening, when just a little more space than one incisor width is lacking, etc.

Summary

Considering the lower incisor problem from different points of view, we are led to the conclusion that the crowding of these teeth is mainly a result of an evolutionary process. It can also be caused or may be aggravated by disrelations either with the upper incisors or with the bony base. Consequently, crowding has to be understood as an adaptive response to changed conditions, as the incisor's contribution to an equilibrium of static and dynamic forces which it would seem unwise to disturb. Therefore, for practical purposes, the position of the lower cuspids, or still more exact, the position of the lower cuspid apices should be regarded as stable and the treatment of the incisors should be planned in such a way as to arrange them within the given limits, if need be, by reduction of tooth material. It goes without saying that though the treatment of the lower incisors should be planned in each case individually and on its own merits, it should fit into the over-all treatment, but it should be regarded there as of secondary importance only.

Of recent years it has become accepted to speak of the science and art of orthodontics. So we might do worse than to go to the world of art in order to find a simile for lower incisor treatment. The author likes to compare the lower incisor treatment to the cadenza in a concerto. The cadenza has its place at the end of the first movement, after the principal themes have been played and developed; it is here that the artist has the possibility to improvise, keeping himself only loosely to the theme or themes. In the same way treatment of the lower incisors should be initiated when the case has progressed for some time along the principal lines, and the play of the appliances and the counterplay of the patient and his tissues has sufficiently developed to reveal the character and peculiarities of this special case. Then the treatment of the lower incisors may become a rather short, though important, episode within the entire treatment as also is the cadenza within a concerto. And, as the cadenza will tax the performer's artistic skill and musical understanding, so the handling of the lower incisors calls for the happy combination of the orthodontist's clinical experience and his scientific knowledge.

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