

O O R S P R O N K E L I J K E B I J D R A G E N

ORTHODONTIC METHODS AS APPLIED ACCORDING TO THE TISSUE REACTION *)

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The term tissue reaction, as related to orthodontics, usually indicates histological changes observed in the periodontal structures as a result of orthodontic movement of teeth.

As long as we are dealing with orthodontic treatment, however, the term tissue reaction may also be applied in a broader sense of the words. Then it will primarily include an evaluation of the reaction in the jaw mechanism and alveolar structures as a whole, incident to changes in tooth position. Secondly, as already stated, it comprises the tooth movement proper and, with that, selection of methods best suited for treatment of the individual case.

Tissue reaction in a broader sense will also include an evaluation of possible harmful effects observed in the supporting structures, years after treatment, as a result of not having moved teeth into what can be termed a balanced occlusion and articulation. The purpose of this paper is to discuss some phases of orthodontic diagnosis and treatment, also including an evaluation of how the supporting structures react when teeth are moved orthodontically.

In my own practice, as in other orthodontic practices, patients may roughly be divided into two main groups. Firstly, young patients, seven, eight or nine years old with only permanent front teeth erupted, secondly, patients with all or nearly all permanent teeth erupted, and, in addition, adult patients.

As pointed out in other papers of this meeting, the diagnostic or observation period of the young patient may be considered as very important. The most important decision to make during the observation period will always be, whether teeth should be extracted, and secondly when this should be made.

Early extraction of deciduous teeth as advocated by H a y s N a n c e (1947), K j e l l g r e n (1948), and others, must be considered as a method generally accepted today. For instance removal of deciduous canines, when indicated, is a logical procedure as performed in order to obtain early alignment of permanent front teeth. When dealing with extraction of permanent teeth, it is natural to be more cautious. Other speakers of this meeting have outlined the logical sequence to be followed when it is indicated to remove permanent teeth. It remains then to discuss what should be the guiding principles or definite indications for such extraction.

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The main reason for extracting teeth is very well known. It is often called lack of basal bone. Others would consider the size and position of the teeth in relation to their apical base. It is furthermore stated that the dental arches and their supporting structures develop more or less according to the muscle balance of the individual. All this is quite true, but there is one determining factor to be considered, still more important, namely the reactive forces of the fibrous system of the bone and supporting structures.

The general arrangement of the fibrous system of a cortical plate is seen in Fig. 1. These are not elastic, but collagenous fibres. Nevertheless, their arrangement is such that they will always have a tendency to rearrangement when displaced. This reaction is especially marked when the whole dental arch is expanded, less after intrusion or extrusion of the teeth.

On the other hand, one must also consider the fibrous system of the periosteal side of the bone, connected to free gingival fibres of the teeth. Also these fibres are liable to displacement during tooth movement. This can be shown experimentally by rotating teeth. Fig. 2. This tooth was rotated about 90 degrees. There is stretching of fibres connected to the periosteal structures of the bone, a stretching, that may be observed at a considerable distance from the tooth moved.

A similar stretching, although not as extensive as that just shown, takes place all along the alveolar ridge when the whole dental arch is expanded. As a result, there will always be a tendency to rearrangement of the fibrous system, more or less according to the degree of displacement. This rearrangement of fibrous structures is a natural and biological reaction. It is usually manifested by what is called relapse of the teeth moved. This reaction of the fibrous system explains why the dental arch can not be expanded more than to a certain degree. After too much expansion the relapse tendency may persist for years.

One may ask, how much can a dental arch be safely expanded? Some investigators contend that definite rules for this can be given. It is generally accepted, however, that an expansion causing an increase in arch length up to 2—3 mm. can be performed without much danger of relapse, depending upon the muscular balance of the individual as well as the position of the third molars.

Therefore, measurement of the arch length compared with the linear dimensions of the diameters of teeth, can be a valuable guidance in some cases. But the application of this method alone is hardly sufficient when one has to determine whether to extract teeth or not. A careful study of the case as a whole will be in order.

Some of the important diagnostic points as related to extraction principles, are given in the following:

1. The muscle function, including that of the tongue, cheeks, lips and with that the patients habits and posture.
2. Hereditary growth tendencies, including cases in which there is a tendency to delayed change of occlusion, would contra-indicate early extraction of teeth.

3. The tooth size and position. In this connection one must mention the well known fact that the lower dental arch, the mandibular teeth, constitute the basis of a well balanced occlusion. This also applies to the extraction principles.

If teeth must be removed in the lower jaw, frequently corresponding teeth in the upper jaw must be extracted as well. But there are also cases in which the opposite must be done, Fig. 3. This is just one of the cases of retarded mesial positioning of the lower jaw. The patient had been under observation by his dentist for several years, when at the age of 12 the lower jaw began to occlude mesially to the upper jaw. It is noted that there is a narrow apical base in the upper jaw. To get some information about the space required, compared with the available space, one may compare the arch length with the measured mesio-distal diameters of teeth.

By applying a soft wire along the buccal cusps of the premolars and following the incisal edges of the anterior teeth in the upper jaw, one may obtain a fairly accurate evaluation of the space available from one first molar to opposite first molar. By measuring the mesio-distal diameter of each tooth from second premolar to the second premolar of the other side and adding the numbers, one will be able to find the space required for these teeth. Here measurement of the erupted canine will represent the unerupted canine of the other side.

In the present case, diameters of incisors, canines and premolars are 85,5 mm. while the measured arch length is 80 mm. The tooth diameters exceed by 5,5 mm. This indicates that extractions must be performed in the upper jaw. In spite of the fact that there is a fairly good arch form in the lower jaw, the case can hardly be treated without extraction in the lower jaw as well. Very little space can be gained because of the third molars. It will therefore be necessary to remove four second premolars and close the spaces.

The reason why second premolars are extracted is obvious in this case, but there may be one special reason for extracting second and not first premolars, namely the shape of the tooth and its position Fig. 4. If the second premolar has a short crown as in this case, and when the gingival structures has a swelling contour, the combination canine-second premolar may be most unpleasant esthetically speaking. This is one factor frequently overlooked when early removal of first premolars is decided.

The present case represents those cases, in which extraction must be performed in the lower jaw because it is necessary to extract in the upper jaw. But as a rule it is the lower jaw that governs the extraction principles Fig. 5. The patient, whose model is shown here, is eight years old.

A similar method of measuring arch length may be applied in this case, with the exception that one has to consider that the first molars will always move mesially after loss of deciduous molars. According to Black, each first molar will migrate 1.7 mm. mesially on the average. These numbers must therefore be added to the measured diameters of the teeth. The width of the unerupted teeth may be mea-

sured directly from the x-ray, or one may use a table for this. Carey (1949) has worked out a table based on the fact that in every individual a close proportionality exists between the diameters of front teeth and the width of permanent canines and premolars. I have measured a great number of teeth after eruption and found this table quite reliable. Instead of trying to figure out whether to extract or not by sight alone, I find it quite helpful in some cases to measure arch length and calculate the required space by measuring the size of the teeth.

The following numbers are found in the present case: Mesio-distal diameters of incisors 26.— mm., canines and premolars 47.— mm., mesial migration of first molars 3,4 mm. = 76.4. The measured arch length is 74,6 mm. According to the numbers there is a lack of space of 1,8 mm.; extraction of premolars will not be necessary.

When applying this method, one must also consider the apical base area. If it is well developed, the numbers found are occasionally slightly misleading, especially when at the same time deciduous canines are missing. As a general rule, this method is reliable and useful in cases with a narrow apical base.

A rather marked labial inclination of front teeth is shown in Fig. 6. The patient had been under treatment before and her dentist had not been able to obtain a satisfactory alignment of the front teeth, which is quite natural, because of the tooth size and the labially inclined position of the front teeth. The third molars were present. Measurement of teeth and arch dimensions indicate that there is discrepancy of 6 mm. Further expansion of the dental arch will only result in relapse. Therefore, two premolars will have to be removed in the lower as well in the upper arch.

4. In addition to the method of measuring tooth size and arch length, it is also advisable to consider the growth pattern of the jaws.

The well known method of measuring the Frankfort mandibular plane angle has been criticized by some during the last years. In spite of this, it has some value, especially when examining young patients.

A simple instrument may be used, Fig. 7. It consist of a movable arm and a protractor indicating the degrees between the Frankfort and the mandibular plane. It has been claimed that 30 degrees is the borderline. In patients with an angle exceeding 30 degrees, extraction will be necessary. It is hardly advisable to follow this rule too strictly, but it is a fact that it is extremely hard, if not impossible, to treat a patient with a Frankfort mandibular plane angle close to 35 degrees without extraction. Several of these patients have a peculiar type of malocclusion. A great many have a slightly open bite combined with a crossbite in the molar region. In this case there is a Frankfort-mandibular plane angle of 34 degrees. There is no doubt that this case can hardly be successfully treated without extraction.

The models, Fig. 8, reveal crossbite in the molar region and a slightly open bite. In fact this case had been under treatment at an early age, but has relapsed. Four second premolars must be extracted in this case in order to eliminate the crossbite and close the bite in the anterior region.

The reason why teeth must be extracted in such cases is also closely related to how the structures involved react during treatment, Fig. 9. In this picture is shown how an evaluation of the jaw pattern may be obtained by applying a transparency, based on average measurements of individuals of the same age, as worked out by Björk (1947). It appears here that the height of the lower face is very large. When moving anterior teeth in order to close the bite in this case, too much stretching of the fibrous system in the apical base area will be the result. The anterior teeth will be wedged against the premolar and molar segments, and there will be too much disturbance of the apical base area. Relapse will take place because of the reactive tendency of the fiber system. Less disturbance of the apical base area takes place after space is gained by extraction of four premolars.

A great many of these cases do not come for treatment until after the age of 11 or 12 years. They are frequently undetected in the school clinics, although a closer examination of the young patient would have disclosed this growth pattern at an early age.

By examining young patients by this method, some predictions can be made with regard to the extraction problem. Models of a boy, seven years old, shown in Fig. 10, illustrate this type of bite. One should believe that this case could be treated without extraction. The profile picture, Fig. 11, reveal some of the difficulties. The Frankfort mandibular plane angle is 35 degrees. Regardless of how early this case is treated, sooner or later it will be evident that four premolars must be extracted. If not, relapse will take place after treatment.

Among my own patients of this type, I had finished one single case with an angle nearly 35 degrees without extracting teeth. I thought this would be a proof of the incorrectness of this theory. But the case did relapse. Moreover the facial lines of the patient were quite unsatisfactory, Fig. 12. This is how the patient looked after some treatment had been performed. One should believe that the muscle tension could have been corrected by myo-functional therapy. But very little change was obtained that way. Finally four second premolars were extracted and the case retreated. Fig. 13. This proved helpful; some muscular unbalance still exists, but as a whole the facial muscles are more relaxed and the occlusion remains stable.

Among these undetected cases there are patients who develop a fairly well aligned dentition, but with a definite lack of muscular balance, combined with a bimaxillary alveolar protrusion. A satisfactory result can not be obtained without extracting four premolars. Several of these patients may develop gingival disturbances and periodontal disorders if not treated. By a careful analysis, using various diagnostic methods, one may be able to decide at an early age whether extraction of premolars will be necessary.

5. Finally, as already stated, in addition to the diagnostic considerations mentioned, the position of the third molars may constitute a determining factor, especially in borderline cases.

As a whole, our diagnostic efforts must comprise not only such methods as just described. It is above all necessary to consider the patient as a living being and rather spend some time on the observation period. A correct diagnosis represents the basis of our treatment procedures.

Concerning the treatment methods of today, one need hardly say that it is natural to treat as many cases as possible with removable appliances. It has been shown in demonstrations this week how successfully cases are treated by appliances such as the activator, *Bimler's* Gebissformer and other types of removable plates. When deciding what type of appliance should be used in the individual case, it is useful to remember one important law of tissue reaction, namely, that the degree of tissue changes obtained is closely related to the time the appliance is used. This also applies to the reaction of muscles as well as to treatment with intermittent forces. If for instance an extreme distocclusion case with muscular dysfunction is to be treated, it will be a great advantage to use a type of plate that can be worn almost constantly.

Special problems may arise in cases with an exaggerated curve of *Spee*, especially when the patient is not quite young. As regards correction of the curve of *Spee*, it is well known that very little intrusion of front teeth is obtained by a plate only worn at night. Nivelation of the occlusal plane occurs mostly by eruption or elongation of premolars and molars. But even extrusion of molars does not always take place when the patient is older. There are for instance cases in which the premolars do not elongate because they are hindered by a too close proximal contact. A typical case is seen in Fig. 14. This patient was 17 years old and could not use the activator more than a few hours every night. The proximal contact prevented the premolars from elongation. The case could not be treated without intrusion of front teeth as well as extrusion of premolars.

Because so many cases can be treated by plates alone, it seems natural to spend a little more time on some of these older cases. For such treatment I have been using a combination of plates and fixed appliances. The fixed appliances are all placed labially and they can be easily combined with for instance the activator. When the tooth movement is completed, the fixed appliances are removed and the treatment continued with the plate.

According to my opinion, certain types of tooth movement in patients, 14 years old and upwards, require such additional treatment with fixed appliances, of which the main points are listed in the following:

1. Correction of the curve of *Spee*.
2. Certain types of crossbite.
3. Closure of spaces after extraction, especially in the lower jaw.
4. Correction of the axial position of teeth.
5. Closure of the open bite.

Something in general ought to be said about fixed appliances. Their reputation has been very bad for many years, which depends much upon how they are handled. Fig. 15 illustrates one of the appliances

used for correction of the curve of *S p e e*. Only four bands are used to start with, while a continuous ligature takes care of the four anterior teeth. The width of this band is four mm. This leaves an open space towards the gingiva, which is an advantage in many cases. The arch is highly resilient, but only four mm. thick, in adults 0,35 mm. It gradually depresses the anterior teeth with a light continuous force, while the first premolars are elongated. After a while the canine need to be depressed too, and a new band is cemented on this one. This band is three mm. wide. Such appliances may be recemented after five months. They are seldom used more than 10 months. In order to keep the gingiva in shape, every patient is given a small brush to be carried in the pocket, and is instructed to use this after each meal. By brushing along the gingival margin, food debris are removed and the gingiva stimulated. By such home care, most of the inconveniences by using fixed appliances are overcome.

The principles of the correction of the curve of *S p e e* is schematically illustrated in the next drawing, Fig. 16. If the patient is 12 years or more, it may be necessary to start with the combination second molars — second premolars, but this is not always necessary, one may frequently band only first molars, first premolars and finally the canines, Fig. 17. This drawing indicates how the arch is formed according to the horizontal plane. While passive to start with, gradually the arch should be curved and a slight tip back bend incorporated in the molar region. By this method, the teeth will attain an upright position. The first arch, 0,35 or four mm., may be changed later on to 0,45 or five mm. Occasionally a band with a spur or hook is placed on the first premolar of the upper arch, from which an elastic may be placed to a corresponding hook on the inside of the lower band in order to stabilize the occlusion. This method is especially useful in older *Cl. II* cases and borderline cases with an increased curve of *S p e e*. An adult case is shown in Fig. 18. Some orthodontic treatment was performed in order to have bridgework constructed later on. It may be of interest to examine the x-ray of the first molar, Fig. 19. It is noted how new bone layers are added in the apical region of the first molar and even in the marginal region new bone has been formed. As these layers calcify, the bite will be stabilized. It is practical to combine activator and fixed appliances in these cases, in order to complete such types of tooth movement as otherwise could not be performed with plate alone or after a too long treatment period.

The next to mention is certain types of crossbite. The combination removable and fixed appliance may be practical to use in order to correct crossbites in the molar region. While the treatment as a whole is performed with the activator, a crossbite in the molar region, unilateral or bilateral, may be corrected by sectional arches. If a plate is worn constantly, such a crossbite could be corrected within a reasonable period of time with the plate alone. Nevertheless, movement of deciduous molars and tooth movement of molars in somewhat older patients where the crown portion of the tooth must be moved nearly three mm.,



Fig. 1. The fibre system of a cortical plate. There is a tendency to rearrangement after displacement of these fibers



Fig. 2. Free gingival fibres stretched after the tooth was rotated 90 degrees. This stretching of fibres is perceptible at a considerable distance from the rotated tooth

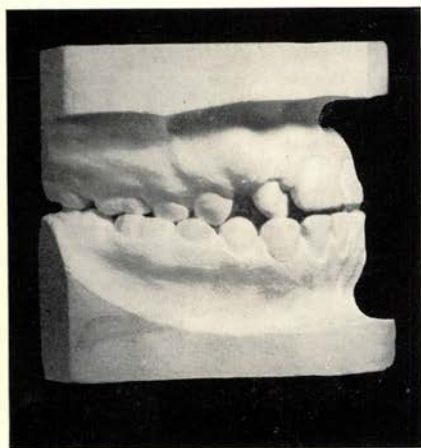


Fig. 3. Models of a twelve year old patient whose jaw relationship gradually changed from neutral to mesiocclusion

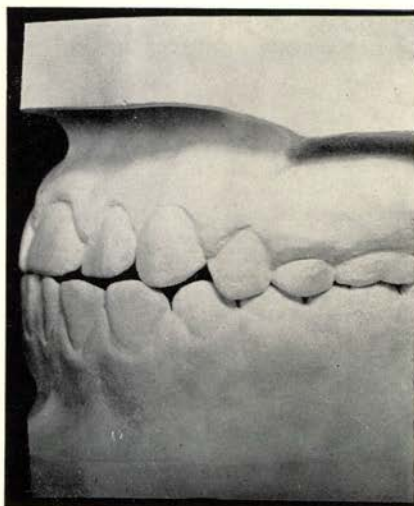


Fig. 4. Illustrates a case where extraction of second premolars is preferable. The combination canine second premolar will be unsatisfactory due to the short crown and the contour of supporting structures of the second premolar

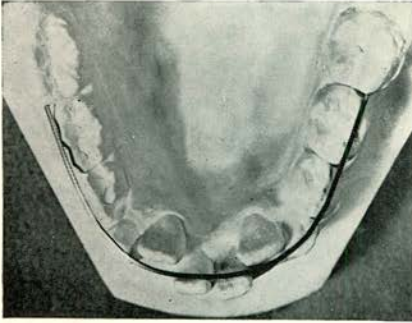


Fig. 5. Measurement of the arch length in the lower jaw of an eight year old patient. There was 1,8 mm lack of space. Extraction will not be necessary

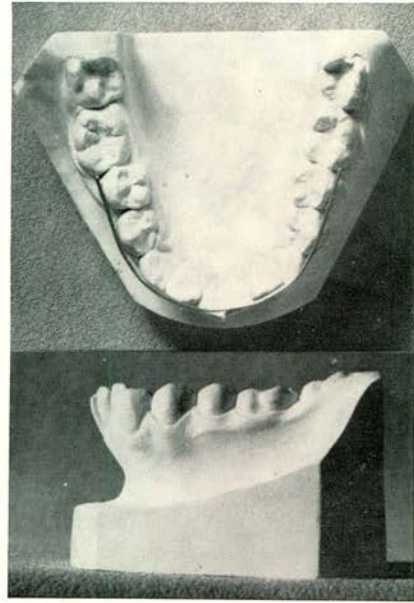


Fig. 6. Illustrates a case for which the method of measuring arch length is highly reliable. Space deficiency 6 mm.

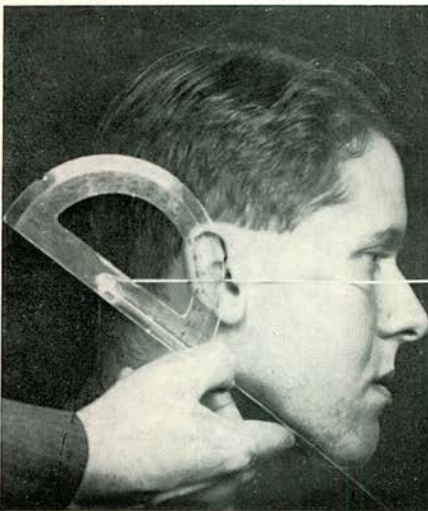


Fig. 7. Measurement of the Frankfort mandibular plane angle, here 34 degrees

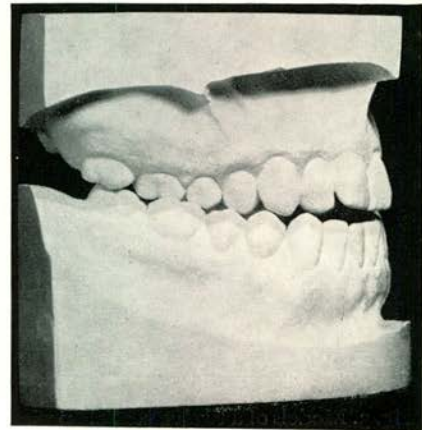


Fig. 8. Models of the patient shown in fig. 7

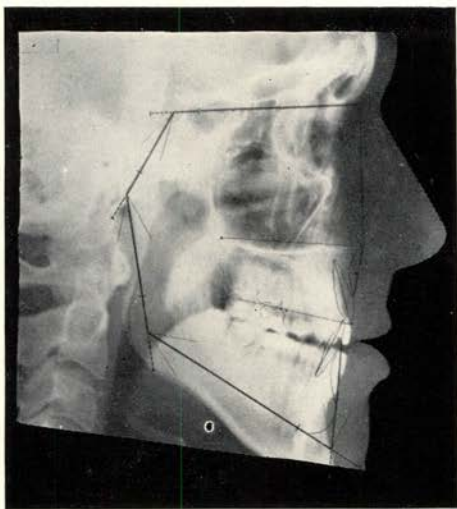


Fig. 9. Profile x-ray of the patient Fig. 7. By applying the transparency, it is shown that the height of the lower face is very large

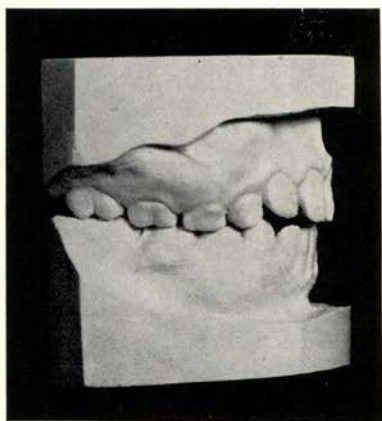


Fig. 10. Models of a patient, seven years old



Fig. 11. The patient, whose models are shown in fig. 10. Due to the jaw pattern one may predict that extraction will be necessary



Fig. 12. A patient, whose jaw pattern indicates extraction of premolars



Fig. 13. The patient, shown in fig. 12, after treatment with extraction of four second premolars

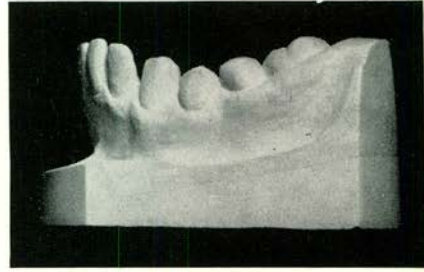


Fig. 14. Illustrates a case where extrusion of molars and intrusion of front teeth are desirable

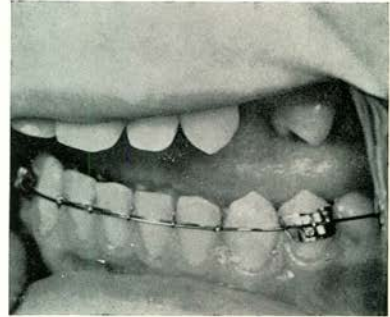


Fig. 15A. The lower fixed appliance to be used in conjunction with activator. After intrusion of front teeth, bands should be placed on canines. The space left between bands and gingiva ought to be brushed after meals



Fig. 15B. The combination second molars, second premolars are used in adults; in other cases first molars and first premolars are banded

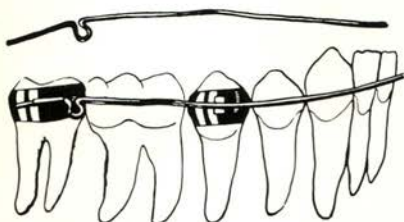


Fig. 16. Appliances used for correction of the curve of Spee. In several cases the combination banded first molars, first premolars, later on canines, is sufficient. Continuous ligature is used for incisors

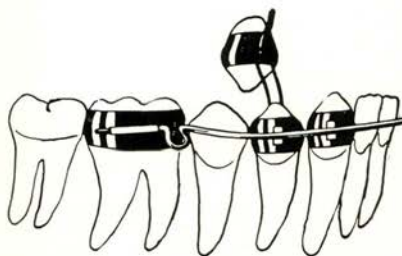


Fig. 17. The arch, 0,4 mm., is gradually formed with a slight tip back band for molars. Occasionally an elastic is applied from spurs welded to bands. Activator is used at the same time

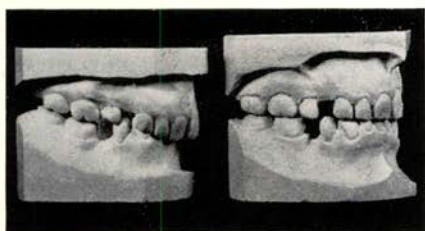


Fig. 18. Adult case treated orthodontically before bridgework was constructed

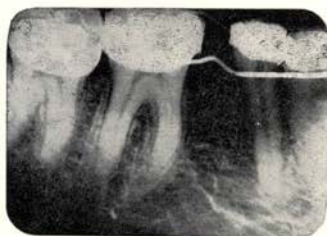


Fig. 19. Extrusion of first molar, case shown in fig. 18. Bone formation has taken place in the apical and marginal region



Fig. 20. Appliance applied for elimination of a crossbite in the molar region. One or two elastics may be placed from the outside of the lower first molar to the inside of the upper molar. Arch form is maintained by the activator

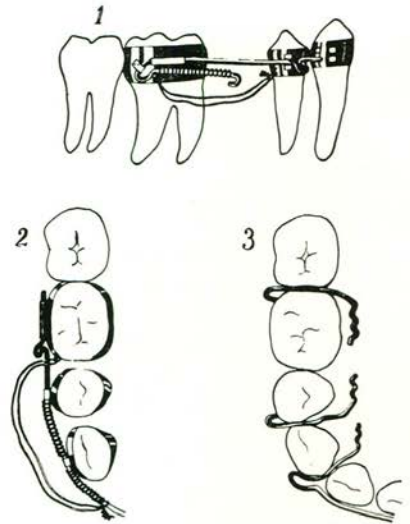


Fig. 21. Closure of spaces after extraction. The sectional arch may be changed to labial arch without removing bands. To the right, the retention plate



Fig. 22. Profile x-ray of a patient with unfavorable jaw pattern. Due to the narrow tooth position, first premolars were extracted in the lower, second premolars in the upper jaw



Fig. 23. Same case as shown in Fig. 22 after closure of spaces

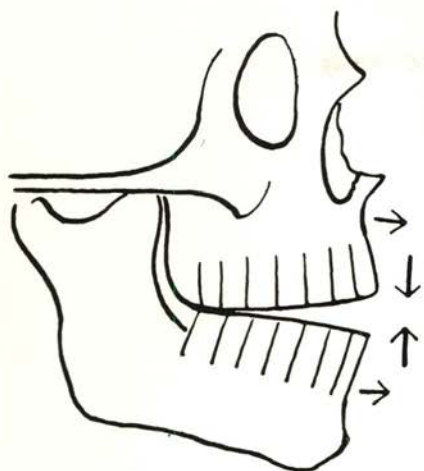


Fig. 24. Drawing illustrating how anterior teeth will cause widening of the apical base area when moved occlusally



Fig. 25. Typical open bite case with crossbite in the molar region, 17 year old patient

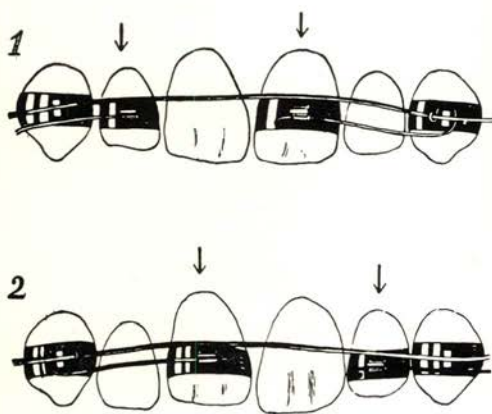


Fig. 26. Closure of the open bite by moving two anterior teeth first. After a few weeks these two teeth are left while proximal teeth are extruded, a tooth movement that must be performed carefully with measured forces

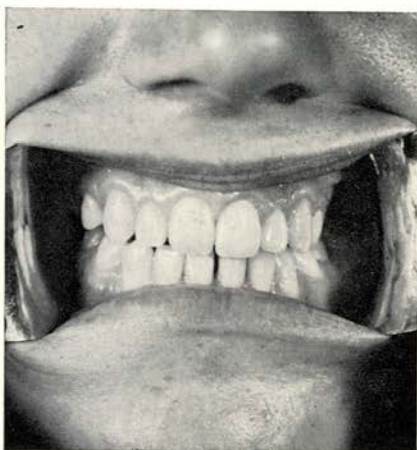


Fig. 27. A case completed with the appliance shown in fig. 26, same patient as shown in fig. 25

is often difficult to accomplish that way. In order to move a tooth over such distances, the supporting fibres must be held under tension for some time. Then the fibres will be transformed and new bone formed at the tension side by which the tooth will remain in its new position. It is therefore logical to apply a light continuous force combined with the activator. Several constructions can be used, of which a typical one is seen in Fig. 20.

A thin spring is coiled around the bracket of the second deciduous molar. This spring should be 0,25 or 0,3 mm., by which a force of 25—30 g is obtained automatically. It is often helpful to place one or two loose elastics from time to time, from the outside of the antagonist in the lower jaw to the inside of the upper molar. The elastics will act as a cushion, slightly opening the bite. After the tooth movement is accomplished, the fixed appliances are removed and the plate rebased with a selfpolymerizing acrylic. As to be mentioned later on, there is very little tendency to relapse, because only one tooth is moved.

Another type of tooth movement is closure of spaces after extraction. Especially after extraction of second premolars, it may be practical to use fixed appliances combined with activator for this purpose. A sectional arch used for distal movement of first premolars is seen in the drawing, Fig. 21. After a while, labial arch is inserted for the final closure. It is important to use a type of bracket by which the tooth is moved bodily. As shown by my own investigations (1947), the tissue reaction is favorable when teeth are moved bodily by light continuous forces.

Fig. 22 illustrates one case after extraction and before treatment is started. It is logical to extract first premolars in the lower jaw because of a more narrow tooth position here than in the upper jaw. The patient is 15 and just one of the undetected cases, mentioned earlier. Fig. 23 shows the same case after the spaces were closed with a continuous bodily tooth movement. This method has the advantage, that the teeth finally attain an upright position.

The next point to be mentioned, deals with the axial inclination of teeth. For instance when premolars and canines are all tipped forward, it constitutes a tooth position that will remain unstable in the years to come. By using a light labial arch, the teeth can gradually be moved to an upright position. This also applies to front teeth, inclined mesially or distally. As all know, not to treat such irregularities may lead to disturbances of the periodontal structures years after treatment is completed.

The last group of patients, for which additional fixed appliances may be used, is found among the open bite cases. A good many of these patients appear to have a Frankfort mandibular plane angle of up to 34—35 degrees, and hence belong to the extraction cases. As pointed out previously, the reason why premolars must be extracted, is found in the fact that, without extraction, too much stretching or widening of the apical base area will take place as the teeth are moved occlusally, Fig. 24. The front teeth will be wedged against the lateral segments, by which their apical portions move labially. Such cases can therefore

very seldom be treated unless for instance second premolars are extracted. Several open bite cases can be treated early without extraction, but not this type, which is closely related to the development of the jaw pattern.

Fig. 26 illustrates one of the patients with an unfavorable jaw pattern. He had some treatment at the age of ten, but as the jaw pattern was not recognized, the case relapsed. After extraction of four second premolars and correction of the crossbite in the molar region, the anterior open bite must be closed. Some practitioners would band all anterior teeth and with elastics try to close the bite. This method may work, but will often result in relapse because of the fact that the whole fiber system of the anterior region is disturbed simultaneously. The fibre system reacts as an elastic band, rearranging itself. In difficult cases, therefore, it is more logical not to move all teeth at the same time. Fig. 26 illustrates an arrangement that may be used. As seen here, as a first step, two teeth are extruded by light forces, 20—30 g. The springs are coiled around brackets of the canine or first premolar. One may claim that this is an unstable appliance, because the springs are as thin as 0,25 mm. That could be admitted if these springs were to be left on for a considerable period of time. As it is, they should be changed already after a few weeks to the proximal teeth as shown below. The same procedure may be applied for the front teeth of the lower jaw.

By the application of this method it is found that uncalcified tissue already formed in the apical region of the teeth first moved, will calcify while the proximal teeth are extruded. Very little relapse takes place after extrusion of one single tooth. By changing springs from one tooth to another, the bite will finally be closed within a not too long period of time. Relapse would have taken place if premolars had not been extracted and if all front teeth had been moved simultaneously. Fig. 27 shows the final picture of the open bite case, after this type of appliance was used.

Such cases must be retained for some time. For this purpose, an elastic tooth positioner may be a great help, because it has a tendency to further intrude teeth in the molar region and at the same time retain the extruded front teeth.

The examples given in this paper are intended to show that many of our problems are found in the alveolar structures and their reaction. While a great many cases can be treated with removable appliances alone, it must be considered practical to combine the advantages of various orthodontic methods in other cases. In closing this paper I like to quote a line written by H a y s N a n c e some years ago, and which I believe should be remembered even today. He says: „It is my feeling that orthodontic treatment is beneficial only in the results it produces.”

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Orthodontic methods as applied according to the tissue reaction

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