VOL. VI No. 2

The Angle Orthodontist

APRIL, 1936

A magazine established by the co-workers of Edward H. Angle, in his memory. . . . . .

Biologic Orthodontic Therapy and Reality

PROF. DR. ALBIN OPPENHEIM
Vienna, Austria

(*Continued from* Vol. VI, No. 1)

Periodontal Membrane

"All histologic alterations may be regarded as expressions of adaptions to changed conditions," (H. K. Box[8], p. 576). The destructions that are found are the expression of overloading,—"that we have passed beyond the limits of the reserve force of the cells" (Box). The counter-measures of nature are the expression of reactional ability of cells and tissues which has not yet been lost and an indication of the useful manner in which they work. The maintenance of the normal functional capability of the periodontium guarantees a normal reaction of bone and cementum.

To successfully oppose any harmfulness from the increased pressure, a purposeful measure seen in the periodontium is the formation of a buffer, consisting of increased and enlarged blood-filled vessels and capillaries. This angioma-like formation, lying between the tooth and bone, intercepts the pressure, enabling the vessels to empty themselves like a full-soaked sponge.

However, this buffer forms only as long as the increase of pressure is not excessive,—as long "as the reserve-power of the cells has not yet been exceeded." Therefore we find this formation only upon the application of weak intermittent forces, (Figs. 2, 5, 9, 13, 19 and 28) but never with the application of strong intermittent or continuous forces with the exception of one case in the septum intraradiculare, (Fig. 34).

The non-appearance or formation of the buffer during the relapse-movement has its special explanation. In Case IX, Fig. 41, the "angioma,"

on the pressure-side during the relapse-movement, has not developed in spite of the hastened relapse-movement by the present occlusal-contact, as probably the increase of pressure was not of such a degree as to provoke this protective measure. The movement took place biologically for which also other moments give support, as mentioned on page 241, Vol. V, No. 4, *Angle Orthodontist.*

In Case VI, Fig. 24, the formation of the angioma at the places of the strongest excursion, that is in that part of the periodontal space lying near the alveolar-crest, has not appeared because here the biologic permissable increase of pressu e was exceeded by other moments, in spite of the non-existent occlusal contact. This is corroborated by the great number of osteoclasts on the alveolar-wall facing the tooth and the absence of the normal course of the fibers due to the loss of their insertion in the bone. In the intraradicular periodontal space, (Case VI, Fig. 28), on the other hand, the buffer-formation has appeared quite distinctly. The relapse movement was *not* effected quite biologically, for nature found it necessary partly to produce within the intraradicular periodontal space the "angioma formation" against the pressure increase, while near the alveolar border this formation could not be produced at all on account of the already too strong pressure. The formation of a buffer in the shape of glomerules and meshes of vessels in the periodontal space was hitherto only observed by Schweitzer[57]. Steinhardt[32], who confirms the findings of Schweitzer as morphologic findings, would rather take them as the "expression of local disturbances of circulation and injuries to the vessels" in contrast to Schweitzer, who is regarding them as functional accommodating formations.

The formation of the buffer of vessels in different human organs has been described already by different authors and has always been interpreted in the same way, as a protective measure to intercept, to weaken and to dissipate the pressure.

E. Freund[23] points to the large vessels, which at times are to be found in single strongly developed synovial tufts in the nearthrosis after fracture of the cervix femoris and attributes to them a double importance: (1) a pressure diminishing measure of nature; (2) for compensating the unevennesses of the joint surface by providing a possibility of compression of the stoutly filled vessels.

Fuchs[24] draws attention to "the numerous middle-sized, thin-walled, swelled-up blood-vessels" in the seam between cartilage quadrangularis and maxilla and seems to agree to the opinion of Bernstein[25] who, in the description of these vessel formations in the cranial sutures, sets forth as follows (p. 661): "The connective tissue (of the cranial suture) has dense fibers,

is rich in cells and contains many wide blood-vessels without walls of their own . . . These vessels in the cranial sutures serve obviously a mechanical purpose. In case of pressure on the connective tissue within the sutures, which is present at the probably necessary movements of the suture-borders against each other, they empty themselves quickly, thereby gaining room and thus facilitating the movements of the sutures . . . " Recently Wikblad[64] points out in his work on paradental changes in the vessels "that there exist also in the paradentium physiological, pressure-absorbing widenings of vessels, spread on large stretches."

The finding of increased and widened vessels in the paradentium during increased pressure is given another etiological explanation by some authors (Haüpl, Lang, Bauer). This formation is not regarded as a primary defense of nature against increased pressure, but as a result of stasis. But, just the same, if these have once appeared, they possess a pressure-absorbing or -weakening function.

By thrombosis in the end portions of the periodontal veins and calcification of the thrombi there can, according to Haüpl and Lang[65] and Bauer[66] develop cementicles,—that is, secondary pathologic formations. These, however, cannot be taken into consideration in our cases, as the widening or increase of the vessels presents a passing state only, and the former stage is re-established with elimination of the cause.

It is hitherto a generally accepted and always confirmed finding that the periodontal space during orthodontic tooth movement appears narrower at the pressure side and widened at the traction side. It has been proved under the influence of a continuous force of 3-5 gr. (also Int. Journ. Orth. 1932, p. 342) "that in spite of this minimum of force . . . the periodontal space on the side of pressure is about half as broad as on the side of pull." Such a difference of width of the periodontium on the pressure and traction sides, as well as the absence of bundle-bone on the traction side, as above mentioned, is to be considered as proof of a too strong force, viz., an unbiologic influence.

During self-movements of the teeth there is a difference in width on the pressure and traction side also, but it is so insignificant that it cannot be ascertained in the microscope by mere contemplation, but only by measuring with the hundreth scale. The measurements show that the periodontal width is greater on the traction side, namely, on the alveolar border by 0.06 mm.; in the middle of the root by 0.01 mm.; and at the apex by 0.04 mm., (Stein-Weinmann[21], p. 734). Such a difference of only a few hundredths of a mm. is biologic, but a difference of 50 per cent already effected by the application

of force of only 3-5 gr. cannot claim the right to be considered the result of a "biologic" tooth movement, as is pointed out by A. M. Schwarz.

During natural movement, which means really biologic tooth movement, the difference in breadth between the pressure and traction sides is, as already said, so insignificant that it can only be ascertained by measurement. The pressure side is characterized by destruction and presence of osteoclasts, respectively, while the traction side is marked by the formation of bundle-bone.

During orthodontic tooth movement, where comparative measurements on the respective intact parts of the specimens were possible, we find, strange to say, contrary to the generally accepted opinion, although not ascertainable by mere contemplation but only by measuring, that the periodontal space is some 1/100 mm. *larger on the pressure side* than on the traction side. (Specimen V, pressure side 0.10, Fig. 19; traction side 0.09, Fig. 20. Specimen VIII, pressure side 0.42, Fig. 31; traction side 0.30, Fig. 32.)

In the specimens of self-movement (Specimens VI and IX), the movement is certainly not yet finished, for, on the pressure side are still numerous osteoclasts, (Specimen VI, Fig. 24 and Specimen IX, Fig. 41), certainly more of them than are normally found. In these teeth there is in one case, between pressure and traction sides of the periodontal space below the alveolar crest, no difference at all and, in the other case, only a very small difference of 0.075 mm. which is not ascertainable except by measuring. The difference is a little greater than that of 0.06 mm. stated by Stein-Weinmann, for the teeth are not yet in their original position and the pace of movement is greater than during normal growth. Contrary to Stein-Weinmann, this greater width of 0.06 mm. is, in our case, on the pressure side.

The periodontal width in this Case VI, buccal (pressure) side equals 0.275 mm., (Fig. 24) and lingual (traction) side equals 0.20 mm., (Fig. 25). In the intraradicular periodontal space we measure 0.30 mm. on the pressure side, (Fig. 28) and 0.20 mm. on the traction side, (Fig. 27), again a plus for the benefit of the pressure side. The periodontal width in Case IX, the second case of self-movement, is, as an exception, on the buccal (pressure) side equal to the width on the lingual (traction) side, namely, 0.13 mm., (Fig. 39).

Thus, out of fifteen teeth, only four are suitable for making the comparative measurements.

Perhaps this greater width of the periodontal space on the pressure side is to be attributed to the frequent observation, also made on the material at hand, that the once initiated resorption overshoots the mark (Gottlieb).

It may be that this represents a further remedy of nature for bringing about a quicker and longer lasting reduction of pressure.

The various inevitable damages to the periodontium by orthodontic measures seem to improve to a full restitutio ad integrum. This is supported by clinical observations, showing that even teeth which were strongly loosened and sensitive became firm again and apt for function through removal of the provoking cause.

The Pulp

It is quite impossible to treat, in the compass of this work, the special subject "pulp" even in a halfway exhaustive manner or in a conclusive way, for, above all, the necessary research material is missing and the time of observation is too short. Furthermore, the possible varieties of orthodontic influences have not by any means been attained and made the subject of examination. The late effects of the observed disturbances were not ascertained, and even authors such as G. Fischer[2] and Euler-Mayer[13], who have dealt with the question of pulp damages, relying on a considerable amount of material, have come to quite opposite conclusions. The result of all other researches, also, in reference to the pulp consequently can only be regarded as a supplement, the explanation of which requires still many examinations of various kinds, and, above all, long years of clinical observation.

On account of the stiff mantle which envelops the pulp, and because of the absence of any collateral circulation, which means no support whatever from the neighborhood, the pulp is one of the most sensitive tissues of the human organism. Therefore, it must react to every outer irritation or insult in a special way. Owing to the hard cover, the extremely thin-walled vessels are protected against every compression, it is true, but the least disturbance of the normal circulation increases the pressure by rendering more difficult the back flow of blood, which causes stasis with all the described inevitable consequences.

The least unbiologic influence at the apex, which is not yet ascertainable by microscopic, but which unavoidably happens by *any of our measures,* leads to tugging on the arteries and veins. The immediate consequence is a passive hyperemia, expressed by swelling and expansion of the veins. And therewith, the vicious circle is closed. The least volume-increase of the veins renders more difficult the further flowing back of the blood through the stiff ring of the apex, which increases the stagnation of the returning blood and causes a further rapid increase of the stasis. As a consequence of stasis, seratic liquid richly extravasates into the stroma, producing thereby a compression of the vessels. If this stasis takes place acutely and occupies greater dimensions, then oedema and vacuol formation, hemorrhages and diapedesis

of blood globules through the vessel walls result. By decomposition of the diffused blood-globules, acid develops and the alkalescence of the pulp tissue is annulled. "The arterial afflux loaded with oxygen and blood-chalk, secures a normal working odontoblast-zone; the back running course of blood, situated within the sphere of stasis and overloaded with acid, leads to dissolution of the odontoblast-layer." (Fischer[2], p. 30.)

This disturbance in the odontoblast-layer is not only of a chemical but also, above all, of a mechanical nature, for the seratic soaking of the whole pulp tissue leads to the formation of small but ever larger growing vacuols between the odontoblasts, (Figs. 22, 35, 67, 73 and 74), which thereby are compressed, displaced and finally atrophied. As a result of the confluence of the vacuols, formation of quite big cysts can occur, (Figs. 68 and 73). This vacuolar degeneration, beginning in the odontoblast-layer is, according to Euler, frequently the first step in the general vacuolar atrophy.

The normal regularity in the parallel arrangement of the odontoblast-cells which always exists, has mostly disappeared. It is just this regularity of order that is the morphologic expression that the function of this zone, which is of vital importance to all tissues of the tooth, is performed normally. But this generally accepted statement, which is considered to be correct, has opponents also, who, like Orban[27], (p. 451), assume "that a faultless odontoblast-layer is not necessary for the dentin formation; its presence or lacking is only of importance in relation to the structure of the tissue formed by the pulp."

As a result of the described processes, the faultless function of the odontoblasts suffers both a disturbance in relation to the regular formation of the predentin and also in the deposition of chalk-salts, which disturbance of the calcium metabolism, (generally connected with moments of constitutional and endogenous character and disturbances in the avitaminoses (Fischer[2], Kronfeld-Barker[28]), becomes aggravated by the modification of the circulation. The uncalcified seams of dentine are broader than under normal conditions and the calcification does not take place in a homogenous, regular manner, but in the form of flakes, (Figs. 29 and 35).

In three cases of our young patients, the multiple denticle formations are perhaps to be considered a result of disturbance of the calcium metabolism, (Figs. 7, 11 and 84). Denticles are the usual consequence of longer lasting irritation or chronic inflammation, (fillings, decay), but they can form also after disturbance of circulation or "if the pulp has lost its normal reactive function by regressive changes," (Fischer[2], p. 61). But mechanical disturbances in the development can also cause denticle formation, (Euler[13]).

Therefore, it is not to be denied that our measures, in which the just-mentioned moments are playing a part, favor formation of denticles.

The strong calcification of the vessel walls and chalk deposits in the stroma of the pulp are a frequent finding and are explained according to Euler-Mayer[13] (p. 235) in the following way: "by disturbance of the calcium metabolism the hindrances are removed which otherwise prevent the precipitating of the dissolved chalk."

Marshall[29] also records on denticle formation as a consequence of mechanical irritation.

On complete calcification of the pulp in two young patients after grave trauma, Wenzel[30] reports. In one of these cases trauma had preceded the orthodontic treatment so that it cannot certainly be ascertained whether the calcification must be chiefly attributed to the trauma or to the treatment. But a case of complete calcification of pulp is also reported by Prof. Dieck (Berlin), who observed and declared that evidently the orthodontic treatment was the cause of the pulp calcification. (This deals with a case treated by J. Grunberg.)

The position in reference to the ultimate destiny of a pulp once damaged by circulation-disturbance is by no means made clear and it cannot be determined as yet because, up to now, it was unknown that *every,* even a short-lasting orthodontic influence on the tooth, involves severe disturbances of circulation. The deficiency of this knowledge is founded on the small present human material, and because the animal material at hand, as far as the conditions of the pulp are concerned, does not admit analogous conclusions. For the pulps of dogs and cats show, also, after completion of the apical foramen, "proportionately long, well-built highly valuable pulps" (Fischer[2], p. 100), while, normally, in man, early regressive changes of the pulp occur in perfectly sound teeth. They are brought about by the progressive closure of the apical foramen and the gradual stasis connected with it, and also from the vertical stress resulting from the function of the tooth. So we have relatively more unfavorable conditions in human teeth.

While some authors uphold the point of view "that the given damages can be overcome if conditions of the metabolism improve," (Fischer[2], p. 66), yet, on the other hand, they interpret "a premature age in the hydropic symptoms and chalkrichness of the pulp" (Fischer[2], p. 18). Csernyei (quoted after Fischer[2], p. 88), defends the opinion that "a sudden strangulation of the vessels and the subsequent active stasis involve disturbance of balance between acidity and alkalosis of the pulp . . . which upon longer duration leads to the death of the cells."

Euler-Mayer[13] (p. 224), too, raise the question whether the circulation of the plup has suffered by trauma and say "that even a one-time trauma can be joined by fading away of the pulp . . . From small hemorrhages up to a quick or slow death every damage is possible . . . degenerative changes can spread, the conditions in the pulp being a priori unfavorable for regeneration. Certainly a great part of the pulp calcifications must be reduced to traumatic degeneration." Concerning death of the pulp in intact teeth, the same authors mean that "disturbance of circulation in the narrow root-channel by trauma leads to the death of the pulp." Also Mershon* concedes the possibility of pulp death. He says, "The death of the pulp is not the fault of the appliance but the abuse of it."

The present material proved that by our measures the pulps react *without exception* in a pathologic manner both in cases with not yet closed foramina, where yet a still greater possibility of circulation is given, and, also, in cases in which weakest forces worked, (Figs. 21 and 22). The fact of damage of the pulp is acknowledged by nearly all authors who had human material at their disposal, although none of them report on such a damage as a constant sequel.

So the report of Kogure[9] says that in six out of eight cases of orthodontic movement, patho-histologic changes were to be ascertained. However, Kogure is of the opinion that "the degree of disturbances of the pulp seems to be in direct proportion to the extent of the rate of movement of the teeth." Kogure's report "that after longer retention (60 days) a pathologic change was hardly perceptible" has found no confirmation from our specimens, (Specimen VI, Fig. 29 and Specimen IX, Fig. 49). Notwithstanding the fact that in Specimen VI, for seven weeks and in Specimen IX, for seven and one-half months, no force was applied, there are still signs of pathologic changes.

Gubrich[3] and Herzberg[7] do not give any reports on changes in the pulp. Gubler[4] also does not enter into particular details but only mentions, in the discussion of a case, the deviation of the apex and the resulting "bending of the nerve-vessel bundle," and that, "in spite of hastened dentin-formation . . . the odontoblast-layer has remained intact, (S. 1053)."

On the basis of the ascertained damages of the pulp, Fischer[2] gives the following conclusion, (p. 107): "Some irreproachably observed cases of former orthodontically treated paradontoses emphasize that orthodontic methods are only successful and without disadvantage to the metabolism of the denture, if carried out strictly with biologic points of view. (But these cannot be

*Orthodontic Appliances, Their Use and Abuse. J.A.D.A., 1921, p. 217.

reduced to practice. *Remark of the author.*) The orthodontic measures must be administered much slower and more considerate, that is to say in homeopathic doses."

The damages to the pulp by our methods are unavoidable and as inevitable as the damages to bone and cementum, for we cannot set in action biologic forces by means of the appliances at our disposal today. We have to acknowledge this fact and make the best of it. *There is no biologic orthodontic therapy.*

According to observations by some authors, also by Fischer, "Oedematic reticular pulps of old people can function like young cellrich pulps" (p. 109). But it is still problematic whether the pulps changed under active stasis by our operations share the same fate. Up to now it is equally a pending question, whether complete restitution of the damaged pulps ever happens. Time alone will show whether pulps damaged in youth possess lesser power of resistance and whether, for the pulp-death of sound teeth, the trauma of an orthodontic intervention, set in youth, must receive greater consideration.

At any rate, the greater possibility of healing of the pulps, even heavily damaged by disturbances of circulation, must be hoped for, than the pessimistic points of view of some authors and the present material would justify or indicate. The demonstrated grave changes were caused by orthodontic operations of relatively short duration and the hypothesis is admitted that after a treatment of several years the changes would become still worse. And in spite of that, the reports of the death of pulps in intact teeth are infinitesimal in comparison with the number of orthodontic treatments that are performed, and which are certainly very often carried out inexpertly. We dispose of numerous cases with absolutely permanent results, in which the individual teeth are perfectly sound and alive many years after completed treatment.

At any rate, the possibility and tendency of regeneration of the pulp is much stronger than it was believed hitherto. Undoubtedly the histologic findings and the clinical experience are standing in striking contrast.

PRACTICAL PART

Situation of Tilting-Axis

Microscopic investigations in my animal material disclosed no pressure- or traction-sphere at the apex after application of gentle intermittent forces. The unaltered condition in the apex and the changes becoming more obvious towards the alveolar crest supported my opinion that in these gradually produced tiltings we have to deal with a one-armed lever, *if the movement of*

the tooth goes on so slowly that it keeps pace with the starting resorption. Under this condition, my supposition was correct, as I stated for the last time in the Int. Journ. Orth. 1934, p. 253. "The fulcrum in a tipping movement is located at the apex, if such gentle forces are applied that bone resorption can keep pace with the movement of the tooth."

The human specimens show the *impossibility to perform tooth movements in such a way as to imitate* the natural movement of the tooth. "Under physiologic conditions the point of entry of the blood vessels and nerves at the apex is never disturbed. Regardless of the changes that may occur in the position during the physiologic processes of growth and movement, the apex will remain stationary." (Oppenheim, Int. Journ. Orth. 1934,. p. 254.)

"If we move a tooth in such a way that we cause a tipping of that tooth, it is evidence that we are moving it more rapidly and producing changes faster than normal development can take place; we are establishing another disharmony in the functional adaptation of teeth and tissues." Mershon*.

No deviation of the apex in monkeys could be ascertained after forty days of force application. In the human specimen, not even after fifty-two days (seven and one-half weeks) of equal force application (Cases I and II) and in Case V, where very gentle force was applied, after one hundred and fifteen days (sixteen and one-half weeks) *no* deviation of the apex was to be ascertained by the microscope. According to such findings, the tilting axis must be located at the apex and for these cases a one-armed lever must be assumed.

But a deviation of the apex can always be ascertained if, in the application of the same amount of force, this period of time has been exceeded and the influence on the tooth has lasted longer than eight to ten weeks. The formation of some kind of fulcrum has occurred. That, as previously stated, cannot be evaded. Finally a two-armed lever is established with visible deviation of the apex to the opposite side of the crown movement.

If no deviation of the apex is discernable in the slides, owing to the lack of corresponding periodontal space and bone, we have in the cementum resorptions, which inevitably occur at points where the physiologic pressure has been exceeded, the infallible indication of tipping.

The development of a two-armed lever could only be avoided if the periods of active treatment were limited to seven or eight weeks and then interrupted for an interval of rest. During the rest period the reparation of the tissues makes such good progress that normal conditions of the tissues can again be reckoned with, which permit a new influence of appliance ap-

*Physiology and Mechanics in Orthodontia. Dental Cosmos. 1922, p. 1204.

plication for another seven or eight weeks. How long the intervals of rest should be, cannot be said today, as we have, as mentioned previously (*Angle Orthodontist,* Vol. VI, No. 1, p. 36-37), no fixed indications as to the time necessary for certain healing processes. The efforts for "biologic treatment" should aim at maintaining the one-armed lever under all circumstances for the deviation of the apex must be considered as a pathologic appearance.

But even in a resting stage of the apex, ascertained by microscope, i.e., applying the weakest of intermittent forces, (Specimen V) a tugging of the entering vessels takes place, which, as we have seen, brings about grave stasis, (Figs. 3 and 21).

A distinctly noticeable deviation of the apex follows always and quickly after the application of continuous force.

Based on the present material my view, held hitherto, that with the application of gentle intermittent forces, (in comparison to continuous working forces), biologic reactions can be expected, has to be changed also in regard to the position of the apex. Some influence upon the apex *always* takes place. The development of a deviation that is noticeable with the microscope depends, above all, upon the kind and intensity of force and its duration. Therefore Korkhaus'[33] view, (p. 101) also cannot further be defended that "by the intermittent forces of the ligature . . . *which does not put under pressure the sphere of the apex* . . . great securities are provided against damages."

Korkhaus defends the lingual appliances and endeavors also to declare that the most gentle forces, which prevent *even small tilting of the moved teeth,* are demanded if we are to solve the biomechanic problem in orthodontia: "not the pain to which the patient gradually gets accustomed is the indicator for correctly measured force, but the movement of the teeth without tilting." All of this, however, is not in keeping with the present material for, even with the application of gentle intermittent forces of longer duration, tilting of the moved teeth follows unavoidably, just as it is always strongly expressed by the application of continuous force. This is proved by clinical observations of my own cases and that of others. I know of no case or have I seen one in the literature, confirmed by X-ray pictures, that the constantly repeated assertion of movement of the teeth *without tilting* by means of the lingual arch, can be considered as a fact. The contrary was demonstrated by several cases in a typical way not only by myself* but also by Rehak[67] (Budapest), a defender of the "biologic orientated orthodontia" (modernism).

*Two cases, Crisis in Orthodontia, Int. Journ. Orthod. 1934, p. 335 and 463.

In spite of stressing the fact that the forces had always been measured correctly in order to gain the biologic optimum, the author demonstrated, as the result of a "biologic" treatment, an exaggerated tilting of the moved teeth, tilted positions that never can, by function, regain a normal angle of inclination. On the contrary, they are always influenced and overpowered by the occlusal forces in a wrong manner and by no means represent a serviceable building stone of the denture. If they do not relapse to a half-way normal angle of inclination, after removal of the retaining appliance, they are lost very soon.

In Fig. 94 (Rehak, Fig. 3) we see the crowns of the second bicuspid and molar strongly tipped towards each other by an attempt to close, by the force of the spring, the gap where the first molar was lost. This cannot mean a biologic method of tooth movement or a permanent condition. In another case we note the position of a lower bicuspid, strongly tipped distally by a spring, (Fig. 95, Rehak, Fig. 6), in order to close the space of the first molar (after symmetrical extraction of the four first molars), by the distal movement of the teeth in front of the gap.

Fig. 94 (Rehak Fig. 3)
For further details see text.

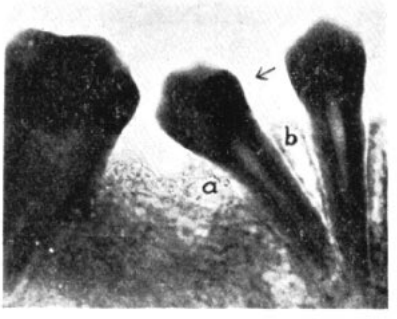


Fig. 95 (Rehak Fig. 6)
For further details see text.

The criticism of Salamon,** "the fundamental fault in the classic Angle expansion arch is the use of ligatures, for from these only a tilting movement can result" is demonstrated in an exaggerated, illustrative way for the lingual arch, both in my cases* and in those of Rehak and in a degree that never can be performed in the use of the expansion arch.

**Verankerungsproblem und dessen Auswirkung. Vjschr. Zahnheilk. 1929, p. 373.
*See footnote on p. 16.

If there is actually a tilting of the tooth when the foramen is not yet closed, then the deformation of the soft, not sufficiently calcified apex end is imminent. The further growth of the root at the Hertwig epithelial sheath is inevitably influenced in a pathologic sense, as was already shown by LeRoy Johnson, Appleton, Rittershofer[7], and was confirmed by our material, (Fig. 57). To what deformities the damage of the epithelial sheath can lead is shown by Kronfeld[18] in Fig. 96, (Fig. 316 of his book).

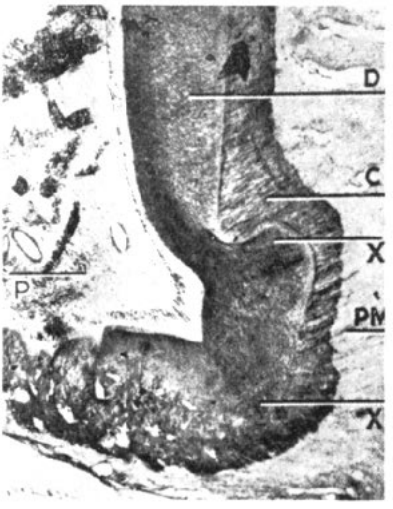


Fig. 96 (Fig. 316 of R. Kronfeld)

Deformity of the root end due to heavy occlusal stress at the time of root development. Apex shortened and blunted. Molar, dog. C, cementum; D, dentin showing at X folding and compression of the root surface, (see Fig. 315); P, pulp; PM. periodontal membrane. (From the experiment of Gottlieb, Orban and Kronfeld.)

This is warning enough and emphasizes at the same time the need for ascertaining by X-rays, before every orthodontic treatment and especially before active shortening of the front teeth, still recommended for the nivellisation of the compensation curve, whether the formation of the apex is already completed or a still open foramen exists. If the latter condition is found to exist, this should be sufficient reason for postponing any active shortening of the teeth, whereby the apex is put under special pressure.

In regard to this question, the X-ray status must be considered just as obligatory before every treatment as it is generally regarded to be imperative from the point of view of root resorption.

Root Resorption

Relative to the biologic or non-biologic efficacy of the different orthodontic appliances this question appears today in another light.

In the use of gentle intermittent forces there can be observed, microscopically, only after several weeks, a deviation of the apex. In the use of continuous force this is observable in the shortest time. The extent of this deviation depends on the amount and the rapidity of the tilting of the crown. In those quickly produced changes of the axial position of the tooth when a spring is used, we find severe pathologic conditions on the pressure and traction side, in the bone, as well as on the tooth and in the periodontium.

In case the buccal teeth are in occlusion, on account of the great incongruity of the masticating surfaces brought about in quickly performed buccal tilting, the teeth are pushed back towards their original positions at each closure of the jaws. The constant jiggling movements caused thereby create at the alveolar border as well as at the apex, alternately, areas of pressure and traction, for the spring, even if it is in contact with the tooth, does not offer sufficient resistance to counteract successfully these backward movements. It (the spring) will simply be compressed.

These jiggling movements must not necessarily be of such a high degree as those brought about on the buccal teeth through the occlusal forces. For instance, in the front teeth, the accumulative effect of the little excursions, as they occur unavoidably, when a hard morsel impinges on the main archwire or on the tiny springs, deviating them, thereby, out of their original position, to which they return immediately, if the limit of elasticity has not been exceeded, is sufficient. But even if there are not such traumatic deviations, the active springs do not remain for a long time in their original positions, for they tend to relax by sliding along the inclined lingual surfaces towards the cutting edge, viz., towards the thinner diameter of the tooth and this especially in the upper jaw. When this occurs, the molar tilts downward with its mesial margin, in the upper jaw, and upward in the lower denture. By each occlusal contact this margin, elevated out of the line of occlusion, is pressed back again into its original position, whereby the anterior part of the archwire and the springs are pressed again against the thicker diameter of the tooth,—against the tuberculum. This means a continuous up and down movement of the anterior part of the archwire, effecting a jiggling movement of the front and anchor teeth. Owing to the resorptions on the cementum and bone, caused by these jiggling movement, the apex of the tooth is finally surrounded by a large periodontal space. Even if the excursions of the crown may be of a larger degree, the apex does not impinge on

the bone, and if so, only in an inconsiderable degree and for a relatively short time, and so it is at any rate spared of the preludial conditions that bring about somehow a root resorption.

Though the immediate cause that is responsible for root resorption is as unknown today as at the time of its first observation by Schwartzkopff[73] (1887) and also by Ottolengui[74] (1914), yet the more or less continuous pressure of the apex towards the bone must be considered as a preludial or participating factor. Since Ketcham's[35] publication (1927) we find, therefore, the constantly repeated, homologous and, on account of the numerous clinical observations, justified statement that the frequency of root resorption is dependent on the more or less rigid guiding of the tooth by the appliance. In using the lingual arch and the tiny springs, there is no question of a rigid guide. The more or less, but constantly present jiggling* takes place unhampered and results, finally, as already mentioned, in the creation of a wide periodontal space around the apex, too. And *this is the reason why in this kind of tooth movement root resorptions are relatively seldom* observed and *not* as is generally believed today, because the movement with continuous acting tiny springs is more biologic or, in comparison with other appliances, the only means of biologic action. On the contrary, apart from the unavoidable cementum resorptions caused by the tilting, the root-end is protected against genuine root resorption because of the enumerated reasons, while all other tissues constituting the paradentium show such a degree of damage as is never observed in the use of gentle intermittent forces, effected by the application of the expansion arch and ligatures. The movements of the tooth, unbiologic in the sense of jiggling, are the protection for the apex, but only for it (the apex). The movements by other appliances, unbiologic again in another sense, endanger the apex to a greater degree. A biological movement, in the strict sense of imitating nature's procedure, is, as already several times mentioned, not at all possible.

Root resorptions are commonly the most often observed on the upper four front teeth, no matter which kind of appliance is used. Yet their greater disposition to resorption cannot be made responsible for this, as Ketcham believes: "as all teeth react in the same way to the same forces one is entitled to believe that all teeth, if influenced by the same noxiousness, will show the same reactions as an expression of it. Therefore one cannot make the greater disposition of the four upper front teeth responsible for the disproportionate frequency of root resorption but rather the fact that these

*Should this jiggling be prevented by spurs on the main archwire or by spurs on cemented bands, the force of the spring still remains operative and becomes visualized eventually either in tilted molars or in the lengthening or shortening of the banded teeth.

teeth, sometimes for cosmetic reasons, or perhaps for functional reasons,—often because of both reasons, in all malocclusions are the most often influenced by our measures and, furthermore, the movements performed are also usually the most extensive ones. Possibly the anatomical form of the roots of the upper incisors may be made responsible. On account of their round cross section, these teeth offer relatively the least resistance, so that each 'orthodontic trauma' is transmitted, the easiest of all teeth, to the apex." (Oppenheim[10], p. 617.)

But if there finally occurs also, in the use of the lingual arch, a root resorption, then, in these rare cases, as an exception, the action of the spring was exact. The jiggling was not, or only in an unessential degree, present on account of favorable occlusal conditions or flat formed lingual surfaces of the front teeth or a particular stability of the lingual archwire and lock, and therefore the premise for bringing about root resorption, the continuous pressure of the apex against the bone for a longer time, was present. The intermittent change of the involved pressure area into an area of traction was eliminated. If, coincidently, the other still unknown factors supervene, then a genuine root resorption develops.

The findings and conclusions of Ketcham are based on X-ray investigation. A histological complemental testing of the clinical observations has not taken place. Also the research work of J. A. Marshall, on which Ketcham placed his hopes, has contributed nothing to clear up the question of root resorption. (Oppenheim, I. Jour. Orth. July, August, 1935.)

Therefore, the statistics of Ketcham cannot be considered anymore as a basis for the assumption that the appearance or non-appearance of a root resorption is dependent on a less or more biologic action of the appliance, for, apart from the quite technical side, the efficacy of each appliance is first of all dependent on the orthodontist. The ten fingers of one orthodontist can bring out many or all possibilities of an appliance in which other ten fingers fail more or less. As was already said elsewhere it is not the name of the appliance but the name of the orthodontist upon which depends the effectiveness of each appliance.

No longer can the deduction, based on the statistics of Ketcham, be accepted that the mode of action of the lingual arch, with its continuous forces, be considered as the sole biological one, and, for this reason, in its use, there are observed relatively the least number of root resorptions. According to my present view, the jiggling movement, unavoidable in the use of this appliance, acts *in preventing root resorptions.*

As it has been impossible, hitherto, to produce a root resorption with the *means allowed from the clinical standpoint* (and only such ones can be

taken into consideration), we must content ourselves, for the moment, with clinical observations. As, in the use of the lingual arch, on account of the continual jiggling movements, root resorptions do not occur (the rare cases of exact efficacy excepted), the jiggling movement, hitherto considered as responsible for root resorption, also from my side, has to be eliminated from the etiologic factors.

Accordingly we know now two factors that can be eliminated as casual for root resorptions: 1, the jiggling and 2, strong intermittent forces (chewing forces). The latter were eliminated on account of the investigations of Gottlieb-Orban[12]. Though very strong intermittent forces (chewing forces of the dog) were acting, the relief from pressure that always and often took place, was sufficient to prevent a root resorption. The fact that in no case of this large amount of material was a root resorption found, was the only thing given to orthodontia by these investigations, as mentioned already in the "Crisis in Orthodontia"[36], (Int. Journ. Orth. 1934, p. 1181).

Today we understand that *only the lack of the continuous pressure is responsible for the non-appearance of root resorption.*

Expansion Arch—Lingual Arch

Since the classic Angle era very different methods and appliances for treatment were suggested which, replacing the "old," were supposed to represent an improvement, perhaps in relation to simplicity of adjustment and treatment; conciseness of efficacy or certainty of success; better permanent results; less inconvenience to the patient and the physician; or less damaging to the tissues, etc.,—the last novelty was the lingual arch.

From none of these new suggested methods exist *proofs* or at least sufficient proofs, that they can in even one point show a superiority over the Angle archwire. All the literature pertaining to these innovations contents itself with *statements* or the discussion of technical details. These are *novelties,* replacing each other, without waiting for proofs of reliability or limitations. And an uncritical optimism is expected always from the new limitations. Optimism always anticipates great "blessedness" from anything new, (Körbitz[50], p. 101).

The old Angle School, praiseworthy so far, as she is, differs from all the new-born methods, as Körbitz points out also in the just quoted article, being "the only school which has made reports on the finished treatment of many typical cases."

One thing is certain, that in the literature of the past few years the use of the lingual arch appears in the foreground in the defense of the principle

of continuous force, and it is considered as self-evident that, in its use, only successes are achieved, for the word "failure" is hardly ever to be found in all the extensive literature. The easy method of construction and the conciseness of the efficacy are always emphasized, though this is in contradiction to the real conditions. This is several times emphasized by Mershon[41,42] himself,* the originator of this method.

But we find also in the literature already several scattered correct statements. For instance, Winkler[51], p. 194, says "The proper adjustment and calculation of the right efficacy of the springs is exceedingly difficult"; Tryfus[52], p. 1315, writes "Especially should one not decide on the use of the lingual arch in the belief that to exchange it is a simplification in comparison with other methods."

In addition, leading men also venture to raise their voices in a refusing sense trying, thereby, to show a way "out of the present tragically chaotic situation." (Körbitz.) I will only mention a few names: Barthelmae[31], Berger[53], Tryfus[55], Hemley[14].

Instead, we never find any statements in the numerous publications, not even in the textbooks, which emphasize the often observed surprises in the use of the lingual appliance or call attention to the embarrassing situations resulting therefrom and, based on actual experiences, point out the ways in which they could be avoided or repaired. Problems of this kind may be enumerated as follows:

1. On the tilting of the lingual arch by the slipping occlusally of the finger springs on the lingual surfaces of the front teeth and the tilting and loosening of the molars, caused thereby.

2. On the slipping of the springs deeply into the gum and the damages caused thereby to the circular ligamentous apparatus of the teeth.

3. On the frequent breakage of the finger springs and all the dangerous situations sometimes evolving therefrom.

4. On the frequent failures of the lock.

5. On the fact that on account of the infrequent appointments and because of the unstable position of the springs, undesired movements take place such as rotations or sometimes very pronounced tilting of the teeth, which must then undergo again a retrograde movement.

6. On the inexact transmittance of the force and the frequent formation of gaps caused therefrom.

7. On the failures during expansion to produce the flattening of the

*41 p. 704: "The making and using of the lirgual arch are most difficult . . . " 42 p. 1022: "The lingual arch is an exceedingly difficult appliance to use and much harm can be done with it and much harm has been done."

anterior portion of the dental arch (that is performed according to Lourie by a second high labial arch) which never takes place and cannot take place in association with the expansion,—a condition which carries already the seeds of failure.

8. On the frequently observed relapses, which could not have happened if the treatment really had been performed in a biologic sense. For this we find the best proof in the fact that all movements and rotations performed spontaneously, therefore really biologically, (after the space for them was once gained) never relapse.

9. About the exaggerated tilting which follows to a great extent and is in contrast to the always emphasized mode of efficacy (non-tilting movement); and on the non-regaining of the normal angle of inclination by function. Yet this is likewise always pointed out as being justified.

10. The difficult and sometimes uncontrollable conciseness of the efficacy, caused by the multiformity of the springs and the great difficulties in changing their shape.

All these points are nowhere mentioned, though everyone who practices this method must confirm these often happening inconveniences. All this, notwithstanding my practicing this method through years, has been passed over silently, too. But the statement of real failures, for which *only* this method is responsible and which never could have happened with the expansion arch or any other appliance, was reserved for me to make, (Int. J. Orth. 1934, pp. 334 and 462).*

In addition to the one case reported (Int. J. Orth. 1934, p. 462, Figs. 15-24), I will communicate a further detail as proof that once strongly tipped teeth cannot at times regain their normal angle of inclination and also, on account of the peculiar circumstances caused thereby, may become victims of the forceps. I will show here only the X-ray picture. In Fig. a, 97, we see that the space for the second upper left bicuspid is closed partly by a forward wandering of the molar and partly by a distal movement of the first bicuspid. This space had to be regained by the corresponding distal and mesial movements after which, as could be judged by the correct axial position of the second bicuspid between the first bicuspid and molar, a spontaneous eruption of this tooth could be expected. The necessary movements were performed with the lingual arch and springs. Thereby the crown of the molar was strongly tipped to the distal and that of the bicuspid to the mesial, with the corresponding contrawise tipping of the roots, which came

*In the meantime an article of Rehak[67] was published wherefrom some pictures were reproduced in this work, (Figs. 94 and 95).

into broad contact, (c. Fig. 97). Thus the eruption of the second bicuspid in its correct place was made impossible. In this condition of tooth position a vulcanite plate was made which retained the space by two spurs lying in contact with the approximal surfaces, leaving ample freedom to the teeth in order to see whether these teeth would regain their normal angle of inclination by function, thus opening the space between the roots, which alone would have made possible the eruption of the second bicuspid. This was made one and one-half years ago. I said at this time "that it is scarcely to be hoped that such a strong deviation of the roots can still be corrected by function and that later measures depend on the final outcome." The X-ray picture, (c, Fig. 97), taken in October, 1934, proves that the tilting was not corrected and that the root of the first bicuspid became resorbed by the crown of the descending second bicuspid. The first bicuspid was therefore extracted in order to make possible at least a right eruption of the second bicuspid. After five months its crown is already visible and the molar regains slowly its normal angle of inclination. With this the treatment of this case is finished.

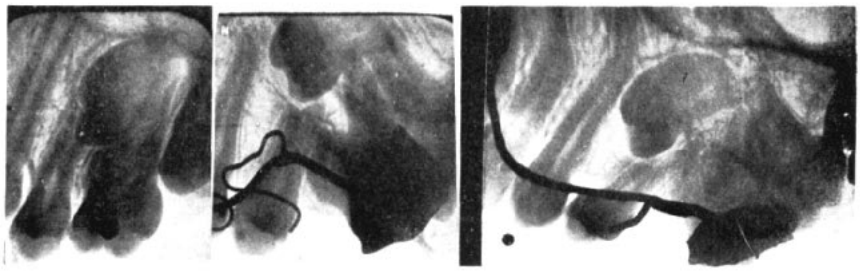


Figure 97

The fate of an impacted upper second bicuspid; a, before treatment; b, after "gaining space" by spring force; c, eruption in the wrong place; for details see text.

The second case, reported at the same time in the same place, shows the failure in opening the space for both upper canines with the same appliance, and finally the two first bicuspids had to be extracted in order to make possible the alignment of the cuspids. This case is still under treatment.

As I could now, in practice, gain the conviction that the lingual arch was *not* that exact working appliance, in the use of which, as with other appliances, the expected changes are really to be ascertained from appointment to appointment without any unfavorable accidents, I tried to take into

closer consideration, by histologic research, the question whether the executed movements are really, as always emphasized, performed in a biologic manner.

Now the material obtained revealed the sad but undeniable fact that we are not able with the expedients at our disposal today to create biologic tissue reactions.* All that can be done is only to reduce to a minimum the inevitable damages. And this can be done in a brilliant way with the expansion arch in the use of intermittent elastic and most gentle forces. A tilting of the archwire in a vertical direction and thereby tipping the molars (except where a wrong dosage of force is used or there is negligence in reinforcing the anchorage in cases of "elongation" of the front teeth) is never to be observed nor are any of the other inconveniences just enumerated (p. 24, 25, 26) in the use of the lingual arch.

If the "nearly omnipotent Angle expansion arch" (Salamon[68]) would have been given by Angle to Orthodontia only for the one purpose, to accomplish, in a physical way, the expansion of the V-shaped or evenly narrowed and therefore elongated dental arch, this alone would have been a heroic deed. For the expansion is accomplished in a physical way, which means that to a certain expansion *must* and *can only* correspond quite a certain degree of flattening. It cannot happen (taken for granted the right understanding of the efficiency) that there is too much expansion and too little flattening or vice versa. Both movements can only occur hand in hand. There cannot exist any guessing as to how far the one movement and how far the other movement has to be conducted. And therein lies the seed for the permanency of the success. But, in the combined use of the lingual arch for the expansion and of the high labial arch for the flattening, there may be too much expansion and too little flattening or too little expansion and too much flattening, as the result of the respective movements is always left to the decision of the orthodontist. Hence the shape of the dental arch, moulded in an unphysical way, even if retained for a long time, cannot be regarded as a permanent result.

Anyhow, the expansion with the lingual arch is more quickly performed, as the resistance of the front teeth, which they offer to the flattening, need not be overcome.

But it must not be understood that the physically performed expansion

*Mershon[41], p. 703: " . . . we should not undertake to stimulate development and tooth movement faster than normal growth would take place . . . otherwise we will undoubtedly destroy the harmony of function between tooth and its supporting bone and establish an unbalanced functional force which is very difficult to correct; and we wonder why our cases relapse."

will represent an absolute security of the obtained success. It goes without saying that, by such a kind of procedure, failures do occur, as we have to deal also with artificial tooth movements, in which we never can prophesy, altogether, whether the success will be a permanent one or not. But the permanent results of the expansion, performed with the expansion arch, seem to be proportionally more favorable, as such a procedure is in keeping with physical laws and the width and the height of the arch are not formed arbitrarily.

None of the inconveniences attributed to the Angle arch, which are repeatedly enumerated and always copied as actually existing, are really present. The whole method is simplified to such a degree, and the conciseness of the efficacy is so potentially increased by this simplification, that the treatment can be declared, today, as an absolutely reliable and economic method of working. By using oval molar tubes, placed in the horizontal plane, each tooth can electively be influenced by the archwire. These oval tubes usually have a length of 8 to 10 mm. and their bucco-lingual diameter is about three times as great as the diameter of the archwire. The vertical height of their lumen is just a trifle larger than the diameter of the archwire (10 mm.) in order to reduce to a minimum the friction between the tube and the archwire. If the two points of attachment of the ligatures, on the archwire and on the tooth, lie at the same horizontal level or if the ligatures are used as shown in Fig. 98, any fractional resistance is eliminated and the force of the archwire will work quite effectively on the buccal teeth without any accompanying influence on the molars.

Apart from those cases in which individual movements of the teeth must be performed, (Class I), the adjustments take place at intervals of two to three months, and for the ordinary cases of Classes II and III, during the active treatment, an average number of ten to fifteen appointments will suffice for the majority of cases. After placing the appliances on the teeth, the work of the orthodontist is essentially finished.

All the pretended inconveniences, again and again mentioned to result from the presence of bands, do not really exist. If the bands are technically well made and of a corresponding thin material, (0.07 or 0.08 mm., 10% Platinum-iridium), and if every band is cut out on *one* side at the contact point, so that only the thickness of one band is present at each contact point, then the extent of all the separations on the six front teeth, (from the mesial contact point of one canine to the mesial contact point of the other canine), only amounts to 5 x 0.07 mm. or 5 x 0.08 respectively, which means 0.35 or 0.40 mm. altogether.

Frequent decay of the teeth is not observed if, in addition to the indispensable mouth hygiene and a complete radiographic examination*, *the fundamental principle is observed* of using ligatures only on banded teeth. With such precautions, decay is more rarely observed than in the use of the finger springs which impinge against teeth that are not banded on principle. Between these springs, which often intercross one another in a peculiar manner, are superabundant retention places for food debris and the mechanical removal of this food very often causes bending or breakage of the springs.

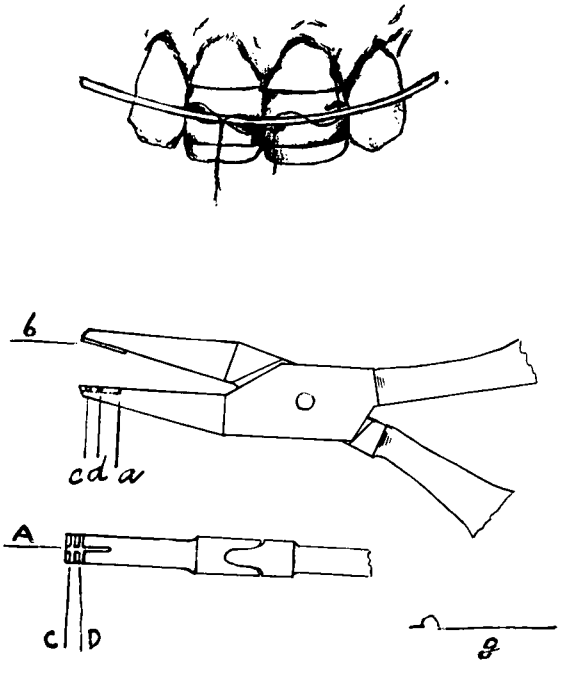


Figure 98

New form of ligature; forceps to form the staples; g, form of staple, pinched by the forceps.

*A careful radiographic examination will reveal the initial lesions of caries on the proximal surfaces which are frequently undetected even by careful inspection with instruments. If they become apparent during treatment by their enlargement they are apt to be attributed to the appliances or to the use of ligatures.

Owing to the fact that the use of ligatures is restricted today to the utmost and eliminated altogether in many cases, injuries to and swelling of the gums by the ligatures are out of the question, for they are not any more carried through the interproximal space, but, encircling the archwire, are ligated in two staples on the buccal side of the band. Such ligatures remained unchanged for weeks and months, as the renewal of force is brought about only by tightening the nuts, the position of which is made secure by a second nut in front of the one that is in contact with the molar tube*. The new ligature suggested by the author for this purpose (to avoid carrying the ligatures through the inter-proximal space) has stood the test beyond all measure during the two years of its use, for a loosening or breakage of the thinnest used ligature was never observed at all. The use of the thinnest ligature is permitted without any danger of its early breakage, as "it serves only the purpose of transmitting the force and not of creating it", (Winkler[11]). As can be seen in Fig. 98, the ligature is ligated like a figure-of-eight bandage. Consequently, the staples, complying with the requirements of the location of the archwire, may be soldered either both above or both below or one above and one below the archwire. In order to avoid having the leg of the ligature which is carried underneath the archwire, lying between the archwire and band and thus separating the archwire from the band the thickness of this ligature wire, which will cause a "riding" of the archwire and make it unstable, attention must be paid that the staples are placed far enough mesially or distally as to locate them on the surface of the band which slopes towards the approximal space.

To avoid any danger of having the staples tear off, which frequently happens if the wire, forming these staples, is only soldered at its cross-section, these attachments are moulded by special pliers designed by the author. A longitudinal groove, 1mm. deep, is cut into one beak of an ordinary pair of pliers, (a, Fig. 98), into which an elevation, placed on the other beak, interlocks. This elevation, (b, Fig. 98), is made of wire of extremely hard material, ½ mm. thick, placed in a groove cut into the pliers and soldered into this with tin, so that it projects ½ mm., which corresponds to the inner diameter of the staple, and interlocks well with the groove "a" on

*This means of safeguarding the screw-nut has proved itself without exception. However, care must be taken that the two surfaces of the nuts which face each other and are only 1 mm. wide, are actually ground plain so as to furnish broad contacting surfaces. Then, after tightening the "activating" nut, (that one that lies in contact with the molar tube) the second one is brought into firm contact with it; there can be no loosening any more. It is often impossible to again tighten the "activating" nut, as the two nuts have so wedged one into the other, until the locking nut in front of the "activating" nut is first loosened.

the opposing beak of the pliers. The groove "a" is made ¾ or 1 mm. deep in order to avoid crushing the staple-wire, (0.50 mm. platinum-silver), when the forceps are locked. Two transverse grooves are made on the lower beak of the pliers for the same reason, (c, d, Fig. 98). The groove that is behind, "d", is cut a little deeper. The anterior groove, "c", corresponds exactly to the thickness of the wire. The staple-wire, after having been made soft by heating to redness and chilling in water, is placed for primary stamping into the wider groove "d" and the forceps are closed. It is then placed for final stamping in the groove "c" and the staple gets its definite form with sharply marked angles. The form is like the letter omega, (g, Fig. 98), and the long wire-end of any length you wish, serves as a handle for holding the staple while soldering it onto the band. The handle prevents the staple falling down during soldering. The staple is safely soldered in two places on a relatively broad plane. After soldering, the handle is nipped off and the two wire-ends are smoothed.

With this kind of ligature attachment a frequent change is precluded. When renewing the ligature the direction of force undergoes no change whatsoever and this is an essential point. The tooth is not rigidly fixed to the archwire but retains a very small amount of mobility, which is necessary to but a hundredth of a mm. *Furthermore, and this is most important, while, with every ligature-connection of the teeth to the archwire,* especially in the buccal areas, *the teeth are removed from their original positions, yet, notwithstanding the incongruity of the masticating surfaces which is thus created they are not constantly pushed back* towards their original positions by the forces of occlusion. The incongruity is never produced as great as that which is present when using the lingual arch and finger springs. Jiggling, which results in the creation of resorptions at four places in single rooted teeth, cannot possibly happen, as has been previously mentioned. The clinical symptoms of persistent firmness and painlessness of the teeth are accounted for by these ligature-connections which protect the teeth against back-lashing movements. Although exposed to the incongruity of the masticating surfaces created during active movement, the tooth is only subjected to the unfavorable influence of the occlusion-forces by a breakage of the ligature. In the use of an archwire and ligatures, no jiggling can take place, contradictory to the opinion of some authors. That which I stated in the Int. Journ. Orth. 1934, p. 137, without knowledge of the present findings, is absolutely correct and irrefutably proved by the actual histological material. "The Angle arch, which is doubtlessly more stable than the lingual arch, permits, if it is used correctly, nearly always a treatment

without jiggling. The teeth can, and—if the arch is used correctly—must remain painless and serviceable."

This stability cannot be obtained in the use of the lingual arch. By the action of the continuous forces the firmness of the tooth is weakened as a result of the acutely developed injuries of the periodontium on the pressure and traction sides at the alveolar crest, and also at the apex on account of the constant "jiggling" movement. Therefore, authors working with continuous force have often reported the sensitiveness of teeth and indicated the "necessity to put out of function orthodontically moved teeth." Among others also is Simon[59], p. 277*. When teeth are in this condition, even normal function (pressure, traction), and especially any vertical stress, has traumatic effect because such teeth have lost a great part of their mechanical support. *Any further "biological" influence upon such teeth is quite out of question.*

Now it must only be considered what would be more advantageous—relative avoidance of resorptions of the apex by applying continuous force, with the probability of much greater damage to the tooth, bone and periodontium, or risking relatively more frequent root-resorptions by using the archwire and ligatures, with probable less damage to the tissues above mentioned, which, it must be admitted, cannot be avoided. Let us pass over these unavoidable damages in the bone, cementum, periodontium and pulp and reciprocally discuss those damages which result from the application of continuous and intermittent forces; in other words, compare the reactions to the lingual and the labial archwires.

A Comparison of the Tissue Reactions Noted in the Use of the Lingual and Labial Archwires

The Lingual arch; continuous force.

1. Extended** and deep cementum resorptions, buccally *and* lingually, on the pressure *and* traction sides, and, owing to deviation of the force, frequently approximal; they are scattered over almost the whole root-surface and can produce occasionally a perforation into the pulp.
2. Great changes in the periodontal space caused by "passing beyond the limits of the reserve force of the cells" whereby the formation of the angioma-like, pressure-reducing buffer also becomes impossible.
3. Likely bendings of the not yet completed or not sufficiently calcified root-end.
4. Disappearance of the alveolar crest, buccally and lingually, owing to the inevitable jiggling movement.

*Very hard food during the actual time of treatment must be "avoided as much as possible."

**See footnote p. 32, Vol. VI, No. 1.

5. For the same reason, (the jiggling), on account of the great width of the periodontal space near the alveolar crest and at the apex, the teeth were loose, sensitive and less applicable for use.
6. From the clinical standpoint it is impossible to be sure of the verification of a single cardinal point for it is a rare exception to note, from appointment to appointment and the chance is less if long intervals intervene, the expected progress without some undesired accompanying occurrences. There is not the certainty or reliability of efficiency as is planned and desired.

The Expansion arch; gentle intermittent forces.

1. The cementum resorptions never reach a high degree and are mostly on the pressure side if the breakage of the ligature can be avoided. But if they also occur, as a result of such an accident, on the lingual side, their extent is quite limited*. Relatively seldom, by deviation of the force-direction, do they appear on the approximal sides. The danger of having this occur can, as above mentioned, with great certainty, be avoided by using the new ligature.
2. The periodontal tissue maintains its vitality so far as making possible the angioma-like buffer formation.
3. No bendings of the not yet completed root-end could be ascertained.
4. Disappearance of the alveolar crest occurred nearly always on the pressure side only, on account of the impossibility of the jiggling movement.
5. For the same reason, (the absence of jiggling), the periodontal space is not exceedingly wide at the alveolar crest and at the apex; the teeth remained firm, insensitive and fully applicable for use.
6. It is a rare exception, the correct use of the expansion arch presupposed, to find from appointment to appointment, even if intervals of months lay between, anything taking place other than the expected changes, and there are no undesired accompanying occurrences. The absolute certainty and reliability of the efficacy in the desired sense is the rule.

"The plain labial arch, if properly mastered, equips the orthodontist with all the mechanical appliances he needs and frees him from the perplexities of mechanics . . . " (Hemley[14], p. 556).

The essential and indispensable qualities of an orthodontic appliance, (according to Angle, simplicity, delicacy, stability and efficacy), are united in the expansion arch and have been brought to highest perfection since the

*See footnote p. 32, Vol. VI, No. 1.

introduction of precious metals. As a result, considerable reduction and refinement of the dimensions were possible and, hand-in-hand with these improvements, the application of delicately dosed forces, active over a short period of time and efficacious in any direction and in any manner, was made feasible. Accordingly, the intervals between treatments were lengthened and, thereby, the possibility of a change in the direction of the force was also diminished.

The Angle expansion arch, in its present shape, is by no means that "crude, clumsy, unreliable in its efficacy, and inexact appliance" as was characterized by a follower of the biologic school. It is just the opposite of all that. It is the most reliable and, in its efficacy, minutely weighable. Therefore, it is the most exact appliance at our disposal today.

The experiences with the expansion arch impose on the author the duty of continuing in its defensive and impressive recommendation, and all the more so because, in comparison with the "biologic working" appliances recommended within the last years, it has stood the test in a splendid way.

As a result of a comprehensive knowledge of the method of manipulation and the mode of efficacy of the expansion arch, which physical properties can as easily be taught as learned, the basis is laid for a successful therapy, which, of course, as in any other physical therapy, insure security only by practice and experience. If, by occasional improper handling, the archwire is brought to faulty efficacy, this wrong component of action (which can easily be ascertained by some precaution), can be eliminated by correct remolding of the archwire, so that the treatment again goes on safely and undesired interruptions are avoided and the success not retarded.

In addition to the numberless excellent clinical experiences in the use of the intermittent force of the expansion arch, we find doubts in the literature as to "whether continuous forces of an appliance or its finger-springs are altogether to be regarded as a trophic stimulus to the tissues in a biologic sense." (Grude[40], p. 151). This thought is still more precisely expressed by Franke[43]. In his writing we read, p. 161: "The pressure, as a tropic stimulus in the sense of Roux, must always be an intermittent pressure, which . . . asserts itself in numerous little jerks . . . Whereas the *permanently standing* pressure . . . cannot exercise (create) stimuli to growth, but produces regional death or atrophy of the bone . . . "

Based upon his researches, Jores came to conclusions, which I quote from an article of Rebak[67]: "The use of intermittent pressure favors the formation of new bone, for in the intervals free of pressure, on the one hand the resorption ceases, while on the other hand, on account of the stimulation

that is given by the cessation of pressure, the formation of new bone sets in in an intensified manner. According to Jores, there must exist an optimum in the relation of the periods of pressure and the periods without pressure, where the formation of new bone takes place in the most intensified manner."

The most important thing is how to reduce these damages to the best possible minimum, as we are not able to avoid them. In reference to this I can only repeat that which I already said in the Int. Journ. Orth. 1934, p. 141, and more comprehensively in Z. f. Stom. 1933, p. 474: "We should give nature, through the use of intermittent forces, through shorter and longer intervals, sufficient time to compensate for the trauma caused by *every* orthodontic interference. In such a way the functional stimulations will exceed the appliance stimulations and our interference will be reduced to the lowest possible level of unfavorable influence."

An Analysis of the Compensation Curve

Many authors are, up to now, of the opinion that a strongly developed compensation curve, such as is found especially in Class II cases, (Angle), must be understood as a lengthening of the incisors through lack of occlusion. This assumption is based upon the analogous observation that every tooth without an antagonist eventually lengthens. This assumption, however, as to the "anomaly" of the lower front teeth, is not correct. The strongly developed compensating curve seen in certain anomalies is inherent in their kind, and the high-standing lower incisors are not to be considered as a secondary appearance, brought about by lack of occlusion. These teeth erupt continuously in a relatively short time to the height determined by nature. We can also regard the strongly lingual tilted lower front teeth in Class III or the front teeth in open-bite cases, which are sometimes below the line of occlusion of the buccal teeth, as only an appearance belonging to this form of anomaly and not as a secondary conditioned formation. Even in cases of open bite, (in spite of lacking occlusion), the position of the lower incisors below the normal occlusion-level is sometimes characteristic; (bogenförmige Halszahnlinie; "arch-like line of the neck of the teeth" Kantorowicz).

That the state of a strongly developed compensating curve in Class II cases does not in any way deal with a secondary deformation of an originally normal compensating curve through lengthening of the front teeth by lack of occlusion, is illustrated best by the Class III or open bite cases, in which the lower incisors, in spite of lack of occlusion for decennial periods have suffered no lengthening and therefore do not show an exaggerated compensating curve as a consequence.

A strongly developed compensating curve is not an inherent characteristic in the anomaly of Class III or in open-bite cases. Consequently we find,

nearly always, a quite normal compensating curve in spite of lack of occlusion.

Time and time again we can find illustrations justifying our assumption, both in the literature and in our own cases. Purposely only certain previously published examples of Class III and of open-bite cases will be shown (both anomalies in older patients, too), and not cases from my own material. The absence of occlusion for years would certainly have produced an excessive lengthening of the lower front teeth as a consequence, if previous viewpoints were true.

Thus Fig. 99, (Strang[58], Fig. 457), shows a Class III case, patient nineteen years old, and Fig. 100 ,(Angle[61], Fig. 606), the case of a certainly still older patient, where the lower front teeth, in spite of lacking occlusion for years, have not suffered a lengthening. Strang[58] writes with regard to the incisors, (p. 566): "they are slightly displaced lingually, although it would seem to the author that these are the most normally located teeth in the mouth."

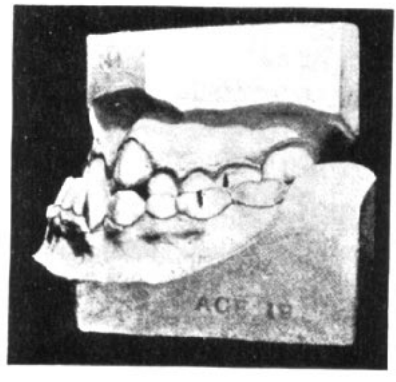


Fig. 99 (Strang Fig. 457)
Class III case; normal compensating curve.

In Fig. 101, (Angle, Fig. 415), and Fig. 102, (Kantorowicz[71], Fig. 707), we see open-bite cases with likewise a normal compensating curve. In the latter case the incisors are below the level of the normal line of occlusion in spite of the lack of occlusion, (arch-shaped line of the tooth neck).

In further opposition to the assumption that a strongly developed compensating curve is brought about by the lengthening of the front teeth, is the short space of time elapsing between the loss of the milk-teeth and the development of the permanent incisors high above the line of occlusion of

the molars, a space of time that is in great contrast with the time required to cause teeth without antagonists to protrude so far beyond the occlusion-level.

Furthermore this assumption is contradicted by the *frequency, and that almost without exception,* of the relapse of actively shortened incisors, if they are not permanently retained, which, for our orthodontic cases, cannot be taken into consideration. It proves that we have treated not casually but symptomatically, viz., the wrong symptom. In further contrast with this assumption is the universal *success* resulting from the nivellisated compensation curve through growth of the buccal teeth*. *For the under-development in this region (buccal areas), is the cause of the strongly developed compensating curve.* The front teeth only seem to be lengthened. The unexceptional success in nivellisating the compensating curve through growth of the buccal parts proves sufficiently that we have treated rightly causally

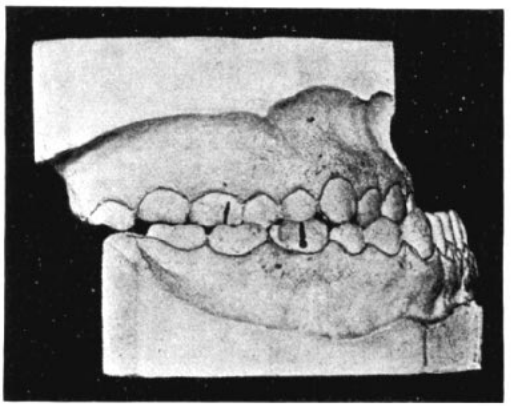


Fig. 100 (Angle Fig. 606)
Extreme case of Class III; normal compensating curve.

and not symptomatically. Thereby we have attained, too, the best possible cosmetic result. The deficient short profile has reached normal height. The general success is to be attributed to the fact that teeth lengthened by

*Izard[65] too could state the same observation, (p. 743): "An underdevelopment balanced by natural forces cannot relapse." (L'infragnathie posterieur, quand elle est reduite par les forces naturelles, ne récidive pas." In opposition to this statement, however, is Grieve's observation, (I. Journ. Orth. 1933, p. 151) that if such growth proceeds, we are not able to maintain a lasting success. ("This growth cannot be retained.")

growth cannot be pressed again into the jaw by the normal bite whereby finally the pathological form of the compensating curve would present itself again.

Yet it must be admitted that here, as well as everywhere, we must reckon with failures due to the possibility that such a growth of the buccal teeth does not take place in spite of lacking occlusion for years, which justifies the opinion that we cannot expect, (also not for this procedure), the same reaction to the same measures in all cases.

The under-development in the sphere of the buccal teeth is inherent to Class II cases and is bound up with the general under-development of the lower jaw, which was ascertained by X-rays, by anatomic studies and anthropologically by different authors, (Broadbent, Hellman, Oppenheim, Sicher-Krasa, etc.).

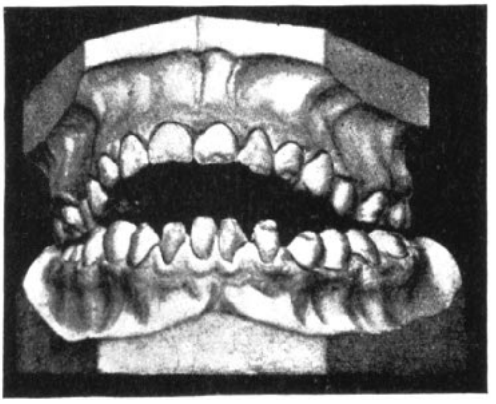
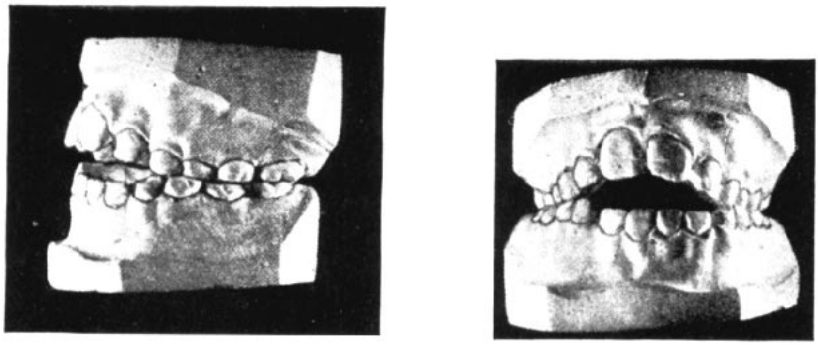


Fig. 101 (Angle Fig. 415)
Open bite; normal compensating curve.

A plausible mechanical-biologic explanation for the under-development of the lower jaw in the vertical direction is given by Strang[38], (p. 120): "The constant backward pounding, combined with the backward or distal muscular pull on the mandible, not only prevents the body of this bone from growing forward, but also retards its vertical growth, so that the ultimate result is an undergrown body of the mandible upon which is a dental arch that is in distal relationship to the anatomy of the skull and in which the molars and premolars are often in infraocclusion from lack of vertical growth, as mentioned above."

But in the right assumption that there is an under-development in the sphere of the buccal teeth, only causal treatment remains for the practice,

viz., to give the buccal teeth opportunity for stronger development. This method of procedure, however, is put to action by but only a few authors, (Winkler[11]*; McCoy[60] (p. 330); Strang[58], (p. 622); etc. Yet we find also authors who, in spite of the correct theoretical knowledge, practice shortening of the front teeth nothwithstanding they must have ascertained and experienced the great frequency and the universality of the relapse. And the partial or complete relapse of just this group of teeth must be taken more seriously than the relapse of many other corrected tooth-positions, as it means not only a local appearance, but also endangers the whole denture. We find this fact very well observed and described by Simon[59], (p. 278: "Especially dangerous is . . . even a quite small relapse of the deep bite, for necessarily the already happily removed sagittal deviation is again provoked; the already corrected mesio-distal occlusion changes into a distal bite; the lower jaw shifts backwards and with it the buccolingual relation of the teeth is disturbed; it involves upper contraction—and slowly but surely the old anomaly again comes into being.



(Fig. 102 (Kantorowicz Fig. 707)
Offener BiB, charakterisiert durch bogenförmige Zahnhalslinie.

Many authors take already a sceptical attitude as to the permanent result of a nivellisation of the compensating curve by shortening the front teeth, (Grieve, de Vries**). Nay, some do not at all believe in the possibility of success, (Izard[69]***).

*p. 244: "In most cases of deep bite lengthening of the buccal teeth is more necessary than shortening of the front teeth."
**Int. Journ. Orthod. 1933, p. 151: "Possibilities and limitations of treatment" with subsequent discussion.
***p. 502: "Pour le traitfent de l'infragnathie maxillaire . . . de l'un ou de l'autre des deux maxillaires . . . les moyens mechaniques sont les plus souvent impuissants."

In the assumption that a strongly developed compensating curve deals with a lengthening of the front teeth, "the ascertainment of which is based upon the model analysis, the front teeth have to be shortened." (Korkhaus[33], p. 192). This is brought about by the active effect of the labial arch or by springs from the lingual or labial arch, or by any form of a biting-plate or -splint.

In order to nivellisate the compensating curve, some individual authors advocate a lengthening of the premolars by an active spring-effect from the labial or lingual arch, (loop-spring!). Like the active shortening of the front teeth, this measure, too, represents an absolutely inadmissible procedure. As already mentioned, most severe stasis in the young pulp is caused by the shortening, for the vertical pressure endangers the *Hertwig* epithelial sheath, if the root development has not yet been finished, viz., the calcification has not correspondingly progressed.

On the other hand, the lengthening of the premolars endangers their pulps to the same degree. I claim this assumption as justified, for it is based on unfortunate experiences in lengthening highly placed canines, (see deductions in the chapter, "Alignment of High Standing Canines." On the other hand, I am in full accordance with Winkler[11], (p. 244): "the rebuilding of the jaw cannot keep pace with this rapid lengthening, carried out very often in but a few days, so that the result is only a mock result."

The process of procedure in the use of the bite-plate, and similar methods, recommended by individual authors, in order to shorten the front teeth, by which the strongest possible forces, (biting forces), are put to work, conforms, as Watkins[38] describes, (p. 856), to the following: "The children must be instructed to eat with the front teeth, (which bite on the vulcanite plate in the upper jaw, because the molars do not quite touch. This allows the molars to erupt a little more and thus helps in opening the bite."

Apart from this entire unbiologic process, the front teeth are shortened, by this most active procedure, sooner than a lengthening of the molars, which are excluded from occlusion, can occur by growth. Therefore such a treatment also misses its purpose. The bite has not been raised and consequently the result is not satisfying from the cosmetic point of view.

Opposition, from the clinical point of view, to this way of (nivellisation), correcting the compensation curve was made in the International Journal of Orthodontia, 1934, p. 463.

A nivellisation of the compensating curve, with guaranteed permanent results, can only be obtained by the natural growth of the buccal teeth as a result of their long, lasting elimination from occlusal contact and never, as

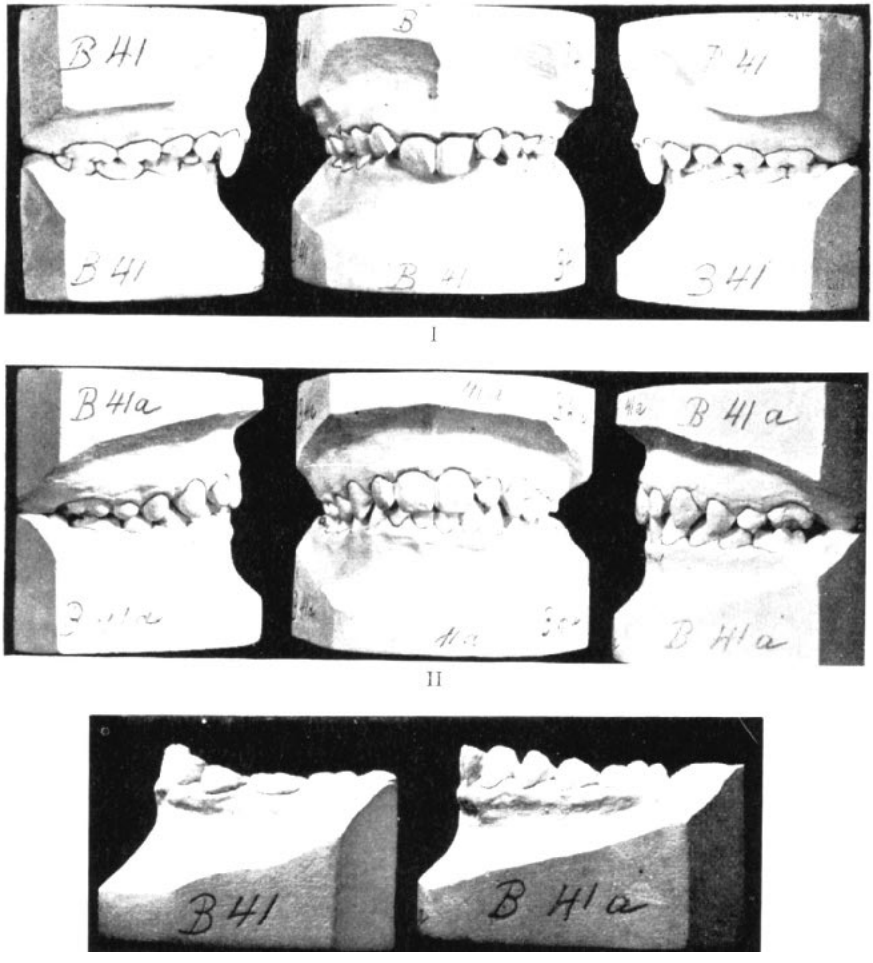
said already, by shortening of the front teeth. For this purpose an upper vulcanite plate is worn, on which the lower front teeth rest, (impinge). During the meals the plate is always removed and the attention of the patient, (and his family), is called to the fact that the plate *acts only as a reminder* for him to leave out of contact the buccal teeth, in order to render possible their growth and that the lower front teeth will surely elongate again by the same degree as they were depressed by active force. In case the patient is grinding his teeth during the night, so that a real depression of the front teeth may be expected, this grinding must first be eliminated also by a suitable position of the head during sleep before using the plate. Only three typical cases may be shown, (Class II, Div. 2 and two cases of Class II, Div. 1), all with strongly developed compensation-curve and deep overbite, in which lasting good functional, as well as cosmetic success, has been achieved by actually raising the bite, the occlusal contact of the buccal teeth having been eliminated for a long time, (one and one-half to two years), by wearing the plate.

In Fig. 103 we see the models of one case, (Class II, Div. 2), before and after treatment. In Fig. 104 are the photographs, which show the cosmetically favorable lifting of the profile. The state of the teeth three years after the removal of the appliances was unchanged. Fig. 103, II, proves that the lower front teeth were not depressed during active treatment, for by the lifting again in that time the deep bite would have been irrefutably re-established. The intended making of further control models could not be performed, for the patient has died meanwhile.

The lower molars in Fig. 103, III, give the impression that they do not belong to the same case but before starting to nivellisate the compensating curve, (Fig. 103, III, left), the third (distal) cusp had not yet cut through the gum and is therefore invisible. In Fig. 103, III, right, we see the compensating curve balanced by growth of the buccal teeth.

The second case which, on the occasion of the discussion of the question of root-resorption[10] had been published already, is shown in Fig. 105. In Fig. 105, I, we see the original models. The denture is very much neglected and the molars, especially the lower ones, are entirely destroyed by caries. The original deep overbite was, thereby, intensified and a further eruption of the premolars, already erupted a third of their height, was impossible. After treatment of the root canals and building up of the lower molars, a plate was inserted which, for a year and a half, was worn without further control, the patient having been abroad. The success of this procedure, (the nivellisation of the compensating curve), is to be seen in Fig. 105, V.

The second molars also had the chance for development. Owing to the strong development of height in the upper and lower buccal sections, and partly by the disappearance of the alveolar process in the sphere of the



I

II

III

Figure 103

A Class II, Division 2 case. I, before treatment; II, three years after the removal of all appliances; III, compensating curve nivellisated by self growth of the buccal teeth.

lower front teeth, the stage of open bite had developed, which is shown in Fig. 105, II. Now the real treatment started, and after a year and a half had relatively good success, Fig. 105, III. On the left side, never quite

normal mesio-distal relations were obtained but two years after the removal of the retention there was nearly a full relapse on the left, (compare the second molars in III and IV), and a slight relapse in the upper front, Fig. 105, IV. On account of decay on the distal approximal surface of the right upper second premolar, and also by the eruption of the wisdom tooth, the molars on this side were driven somewhat forward.

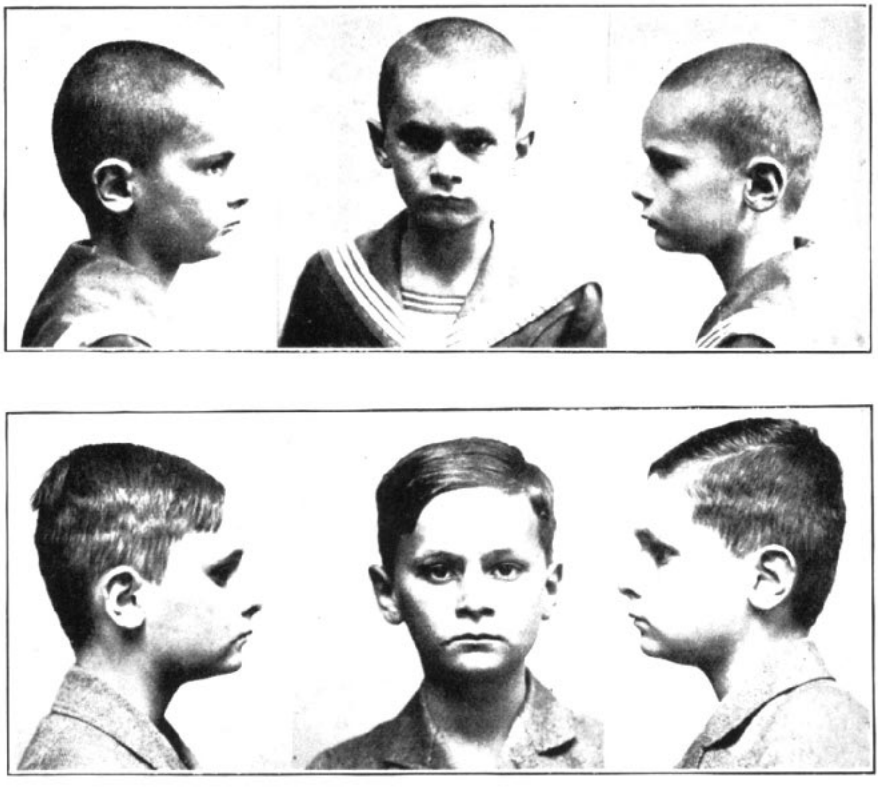


Figure 104
Photographs of patient whose models are seen in Fig. 103.

That actual growing in the buccal parts and that no great shortening of the front teeth had resulted, (Fig. 105, V), is evident by the fact that the molars and premolars have fully developed to their normal height, (compare I and II, Fig. 105). It is also apparent that the lower front teeth have lengthened again only in a small degree, pushing, thereby, the upper front teeth forward to a corresponding degree. The self-grown buccal teeth were

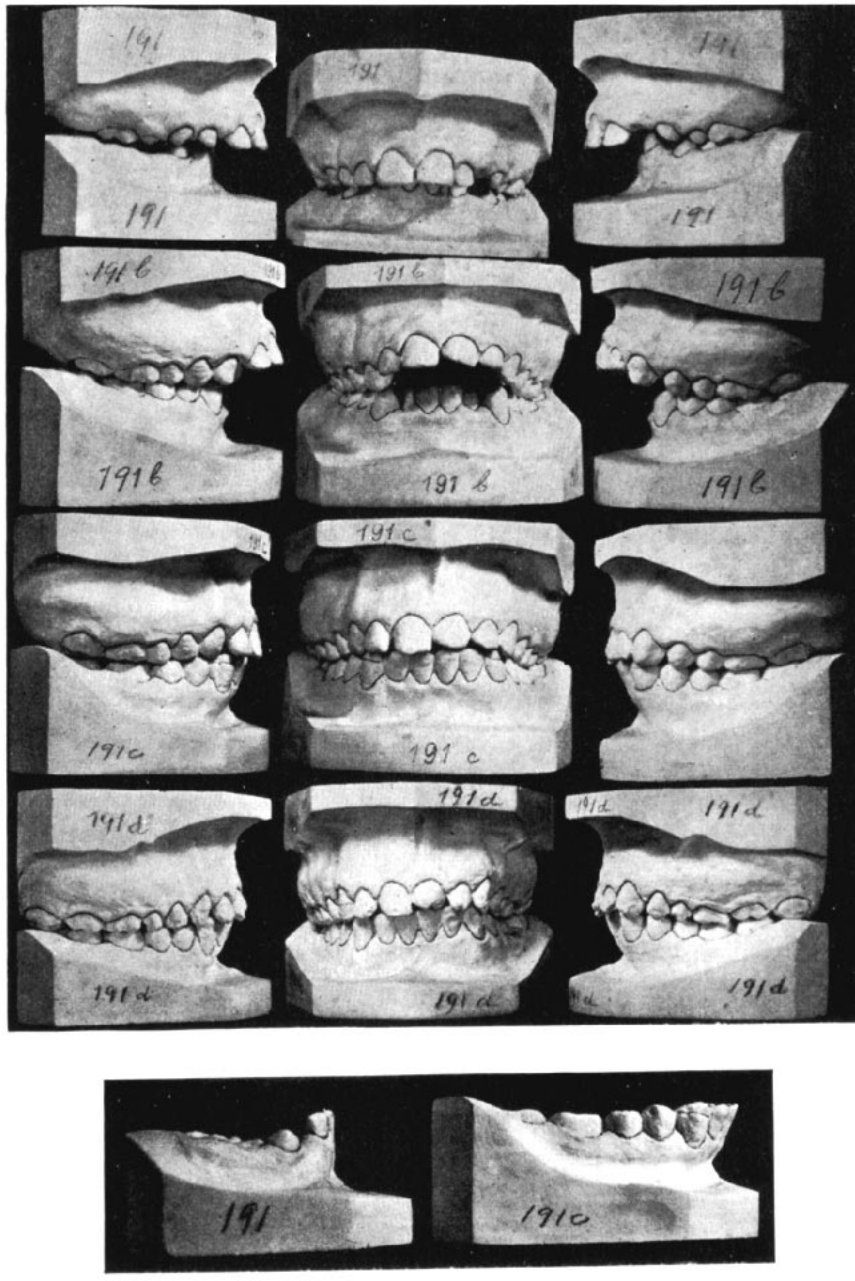
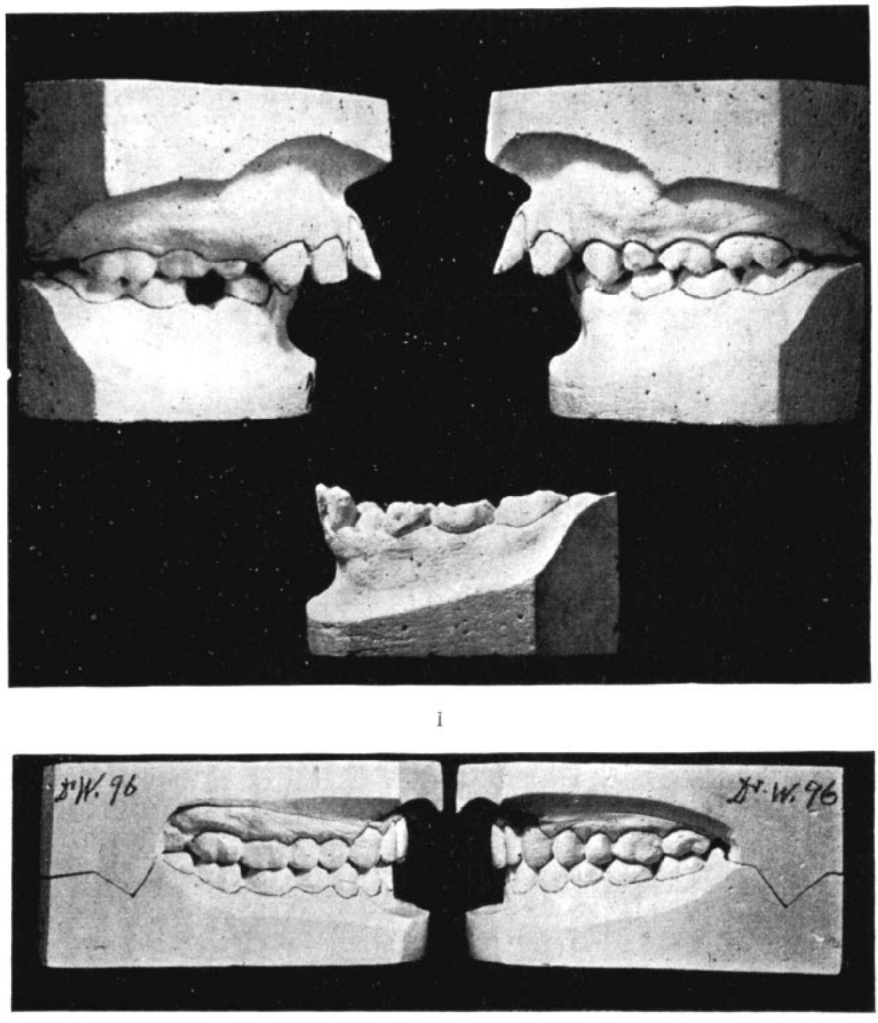


Figure 105
A case in Class II, Division 1; I, before treatment; II, at the start of the actual treatment; III, after active treatment; IV, condition two years after removal of all appliances; relapse on the left, and somewhat in the upper front teeth; V, compensating curve mainly nivellisated by selfgrowth of the buccal teeth.

not pressed again into the jaw as far as can be judged by the length of their crowns, (compare II with IV). No photographs of this case are at our disposal and nothing can be said about the present stage for the patient has not presented himself anymore.

The third case, a typical one of Class II, Div. 1, is shown before treatment in Fig. 106, I. It deals with a boy of eight years. The compensation



II

Figure 106

A case in Class II, Division 1; I, before treatment; Ib, compensating curve; II, model twenty-eight years after treatment.

curve is strongly developed. Models immediately after treatment do not exist. It was one of the first cases which, in the years 1907-8 had been treated with the bite-plate, which device, like the headcap, later on for the following years, was no longer used, for reasons I cannot exactly account for at present. But numerous observations, in the course of the last decade, proved that the nivellisation of the compensation curve by shortening the front teeth and performed in the meantime without exception, was inopportune, as well as the various methods of distal-shifting of the teeth. I returned, therefore, after considerable deliberation and analysis of the observed failures to the former methods, and these methods, with little alterations and eliminating certain inexpediencies, serve now as most valuable therapeutical helps.

The cosmetic success at the end of treatment by actual growth of the buccal teeth and alveolar processes, respectively, is to be seen in Fig. 107. This success never can be and has not been lost, for teeth developed by self-growth, as well as the alveolar processes, are never more pressed into the jaw by occlusal contact, or brought to vanishing. No relapse can occur in a compensation curve nivellisated, (balanced), in such a way, unless the front teeth, still a little shortened by the plate, become elongated again.

Twenty-eight years after finished treatment a study model of the present stage of the denture of the patient who lives abroad was made by an orthodontically well-versed dentist and placed at my disposal, (II, Fig. 106). With the exception of a little crowding of the lower front teeth, (as we sometimes find in normal and never orthodontically treated dentures too), and small technical pieces, the denture is, from the orthodontical point of view, in a faultless condition. The reproduction of a photograph of the patient, who is now thirty-six years old, has to be omitted.

A fourth case in which the nivellisation of the compensating curve was performed in the same way and had the same good result, has been already shown in the "Crisis in Orthodontia", (I. Journ. Orthod., 1934, p. 464).

Shortening of Buccal Teeth Lengthened Through Lack of Occlusion

In the treatment of these changes of the dentures we have to deal with secondarily conditioned appearances which actually have formed by lengthening of single teeth or tooth-groups as a consequence of lack of occlusion. This state of the denture is, sensu strictiori, not to be regarded as an anomaly and therefore the points stressed on the nivellisation of the innately strongly developed compensating curve in young patients, must not be particularly

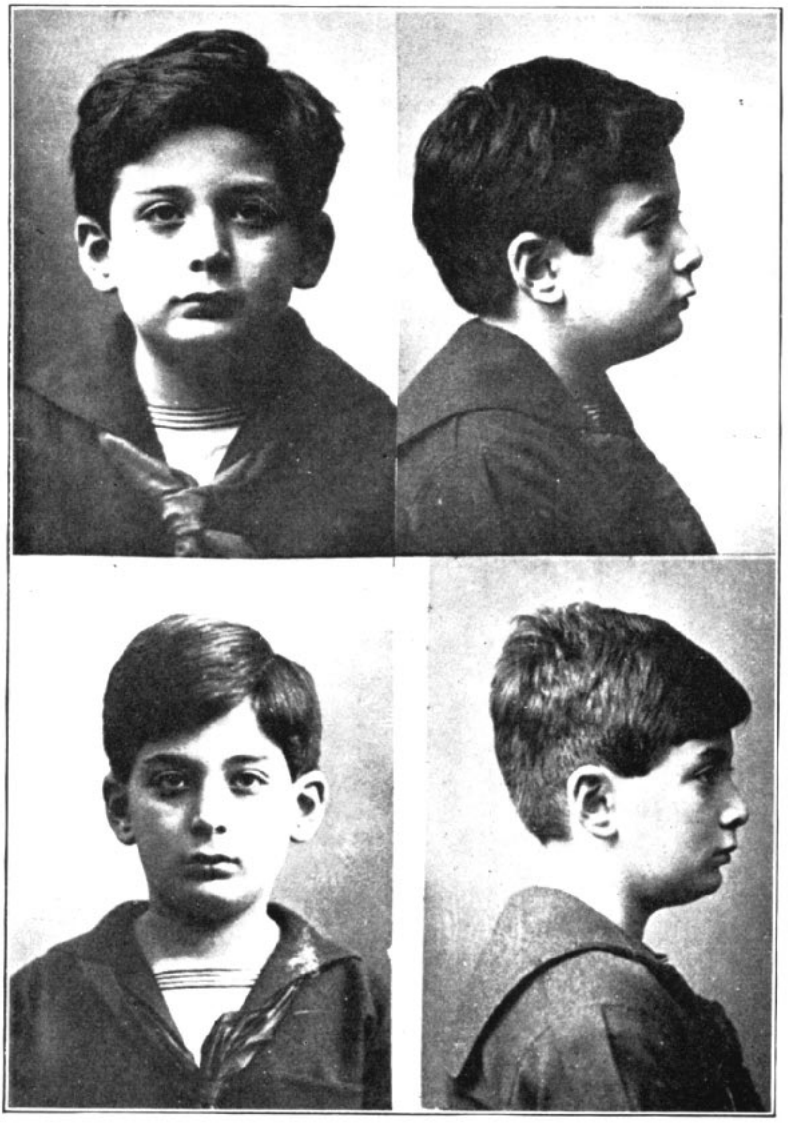


Figure 107
Photographs of Fig. 106 before and just after the finished treatment.

considered. Owing to this fact, the necessary active shortening which must be performed above all in cases with strongly lengthened upper buccal teeth, does not make extraordinary difficulties, and, what is more important, does not mean danger to the pulp, owing to the peculiar local anatomic conditions brought about by this lengthening and secondly, because the attained result can only be maintained by a permanent retainer.

Owing to the lack of occlusion for a long time, the bone has suffered changes, as the investigations of Kellner[70] and Kronfeld[18] show us, thus creating most favorable conditions for our procedure of shortening. As we see in Fig. 108, (Kellner Fig. 3), on the left, (the functionless molar), the

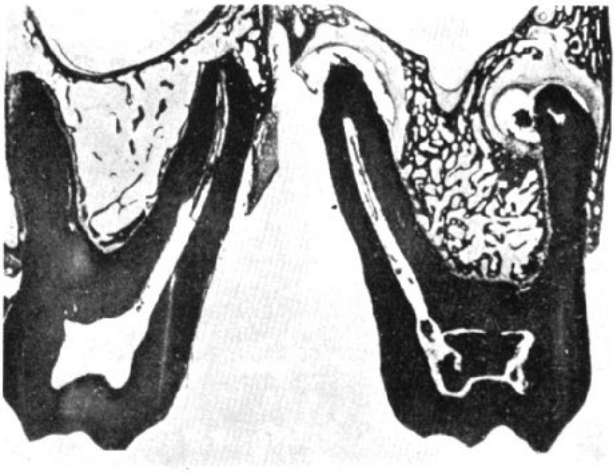


Fig. 108 (Kellner Fig. 3)
The upper first molars in frontal section; "a," non-functioning, "b," functioning side.

spongiosa, in comparison with Fig. 108 on the right, (the functioning molar), is considerably rarified—even reduced to some single bone-specules. This condition is found not only in the intraradicular septum but also in the area surrounding the apices, which are embedded in a broad-meshed spongiosa. "It is proponderantly a retroalveolar spongiosa, the stage of which is conditioned by the function", (Kellner[70], p. 283).

Kronfeld[18], (Figs. 285 and 286), reports on the same changes and says, in comparing the two pictures that represent a functionating and respectively a non-functionating upper wisdom tooth, p. 348, that about the functionat-

ing tooth is "well developed alveolar bone and supporting bone." About the non-functionating his report runs as follows: "Thin alveolar bone. The supporting bone has almost entirely disappeared and is replaced by fat marrow."

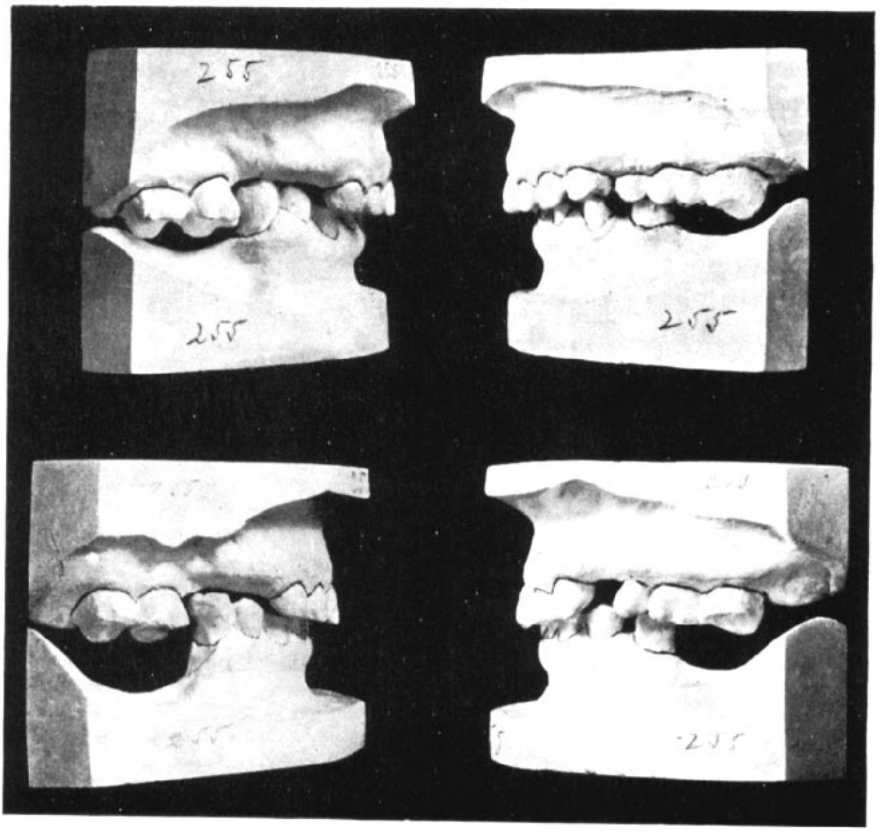


Figure 109
Depression of the upper molars, upper photographs, before treatment.

The assumption is justified that by these special anatomic local conditions the otherwise unavoidable severe stasis of the pulp, effected through active shortening will be diminished to a considerable degree. This can be taken as fairly probable and it is affirmed by clinical observation that molars and premolars shortened in this way and treated, hitherto, have never shown any clinical symptoms, either during the period of the shorten-

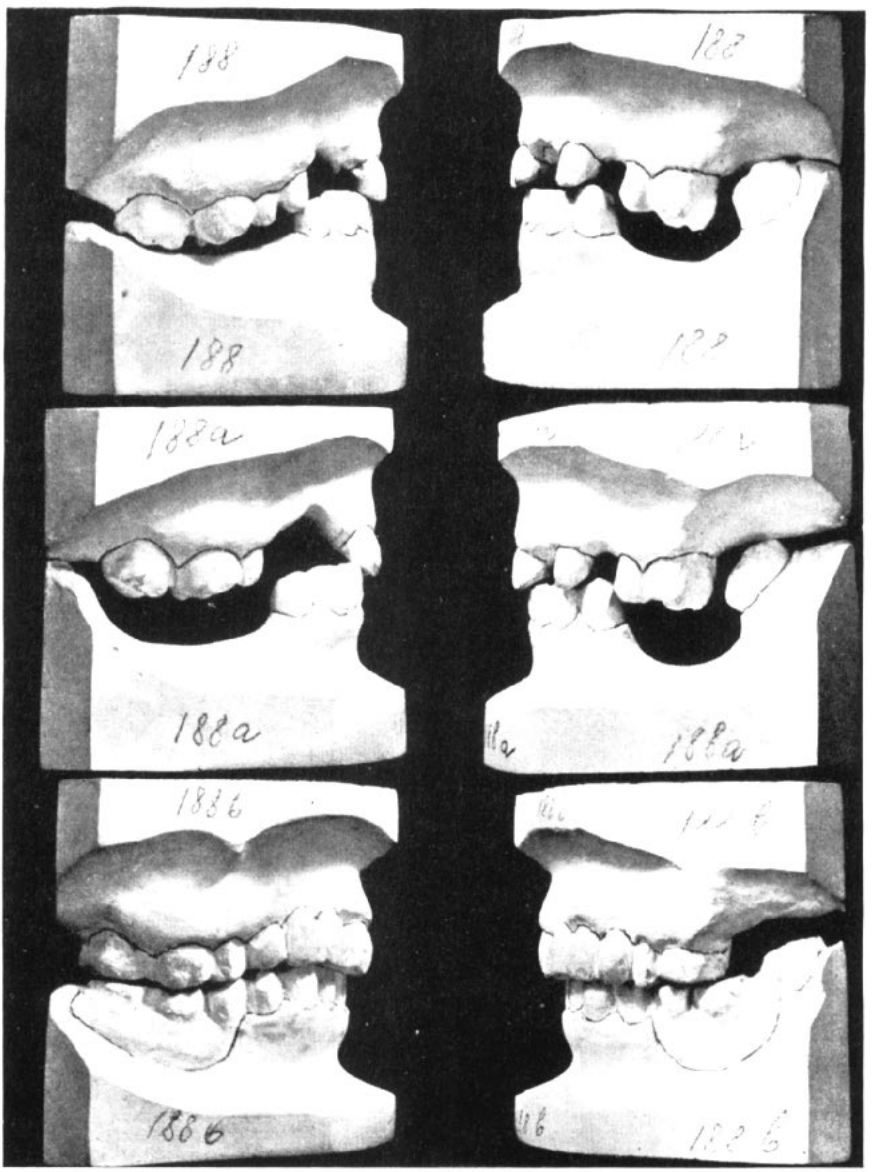


Figure 110

Depression of the upper buccal teeth; I, before; II, after depression; III, technical work in situ.

ing or many years after treatment. Such shortenings reach, sometimes, as shown in Fig. 110, the extent of over 1 cm.

The corrective pressure for this shortening was the biting force, in opposition to which, when applied as a corrective measure for the "physiologically" strongly developed compensating curve, a strong attitude was taken. The decision for this opposing attitude was based principally upon four moments:

1. It is the wrong treatment from an etiological standpoint.

2. There is danger for the pulp and apex, (Hertwig's epithelial sheath), in young individuals, through the vertical strain.

3. The frequency of relapse that occurs in shortened front teeth—almost without exception.

4. The infallible success in the nivellisation of the compensating curve by growth of the buccal teeth.

For teeth which have really lengthened as a result of lack of occlusion, the above-mentioned scruples are groundless, as these cases deal with older persons with certainly finished growth of the root and the already mentioned locally favorable conditions for the intended shortening, brought about by non-function, can also be taken into consideration. Furthermore, we treat causally, and no relapse can happen, as the prosthetic work, (a plate or bridge), is made after the completed shortening and represents a permanent retention.

The plate for shortening elongated teeth has proved an excellent means of treatment. With it, the correct mechanics of the denture as well as the lasting, efficacious function are gained and the remaining but overstrained teeth are guarded against inevitable loss. The procedure in making the plate for the shortening of lengthened upper buccal teeth, which already meet the alveolar bone of the lower jaw, consists in first constructing a metal plate with a quite thin tin cover, which opens the bite in the front for about 1-2 mm. Opening of the bite for sometimes 2 mm. cannot be avoided when making this first plate, but should generally not amount to more than 1 mm., so that it is not exaggerated in the front, and keeps the inconveniences for the patient in strictest possible limits. When shortening of the buccal teeth has taken place as a result of this treatment or if the anterior teeth which were depressed by the former overstrained occlusal contact have again lengthened to the extent that a blue paper can again be held between them, the time for again raising, (for increasing the height of), the plate is indicated. This is further done but always only to the extent of 1 mm. and managed in the articulator by putting a layer of tin on top of the first tin cover. The

finer grinding of the articulation is performed in the mouth. Generally this raising, by which a continued depression of the buccal teeth for about 1 mm. is attained, follows in periods of two to three months. After the attainment of the desired shortening, the permanent plate is made.

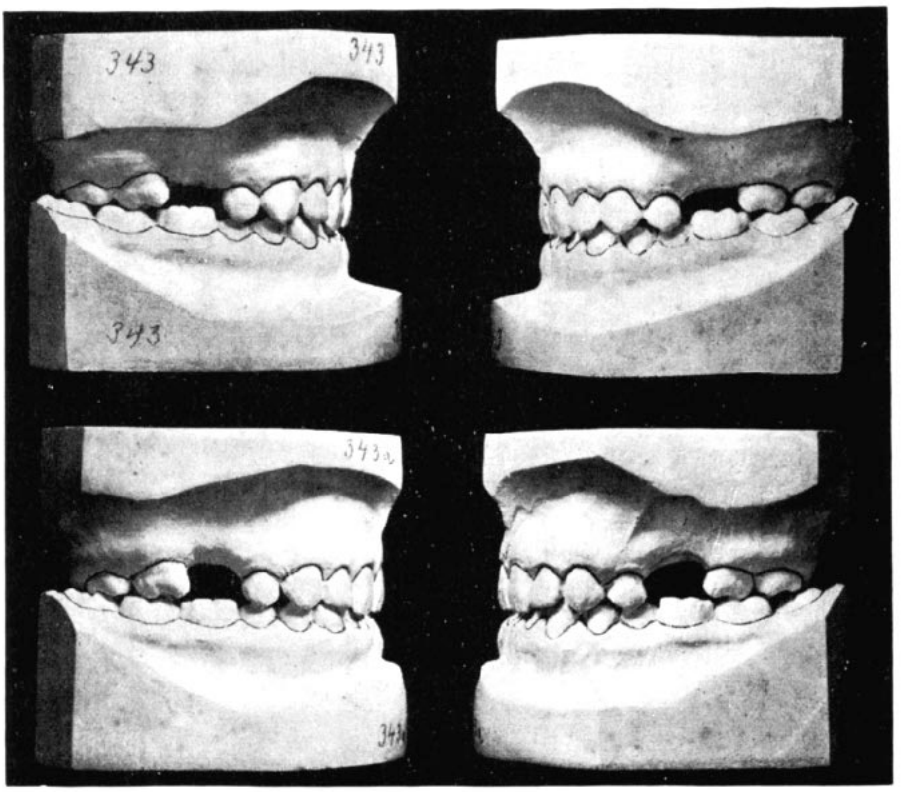


Figure 111

Depression of the lower first molars.

Only three cases may now be shown, the treatment of which dates back many years and in which, up to this day, twelve, thirteen and fourteen years later, respectively, no shortened tooth has been lost in the still fully valuable dentures.

Fig. 109, upper row, shows the models of a patient, fifty-two years old. Occlusion was present only on the left premolars and in the mesial

third of the upper first molar. The lower front teeth impinged on the palate roof. The upper first premolar on the left side was already so loosened that the removal of strain, through the lower plate, could not save it. The shortened teeth pressed into the jaw by overstrain, (second upper and lower premolar and first molar), have, owing to the relief of pressure through the plate, again regained their normal crown height, having grown out from the jaw. This can be followed in the illustrations. In Fig. 109, lower row, we see the case after the shortening of the upper molars and after the spontaneous lengthening of the former overstrained teeth, (upper and lower second premolar as well as the first molar on the left).

The distance gained for the making of the permanent plate is perhaps not only to be attributed to the shortening of the upper molars but probably, also, to some extent, to the disappearance of the alveolar bone in the lower jaw.

The treatment required about one and a half years. The plate was thickened five times in periods of two to four months. Today, after twelve years, the state of the denture is almost unchanged. Only the two lower premolars on the right side, which met the upper alveolar bone, and for the shortening of which the patient would not consent, were in the course of the years a little shortened, to prevent their impingement on the gum. The second lower premolar on the right is loose, partly because of progressive lengthening, partly because of the clamp of the plate and will fall a victim to the forceps.

The patient was satisfied with the occlusion on the four molars together with the relief obtained by taking the load off from the front teeth and would not consent to have treatment on the lower premolars.

Fig. 110, I, shows the models of a woman of forty, who called on me for the construction of a front-tooth bridge. I refused to do this, on the ground of experience, unless there was first a substitution made for the missing lower molars, which only could create safety for the bridgework. The patient decided to have the treatment, as she realized the necessity of making conditions within the entire denture mechanically correct.

The whole strain of the bite rested on four teeth. The upper right first premolar was already greatly loosened and had to be extracted. The treatment was analoguous to that which has already been described. It cannot be ascertained today how often the thickening of the lower plate was performed or the length of time required for the shortening. It is only certain that the permanent lower plate and the bridge in the front was made in 1919 after performing the shortening, (Fig. 100, II). A further tilting of the left lower molar has been prevented by a connection with the second

premolar on which the permanent plate rested. The technical work, in situ, is shown in Fig. 110, III.

In this case it cannot be determined whether the room obtained for the permanent plate has been procured only by shortening of the upper teeth or also partly through disappearance of the alveolar bone in the lower jaw, but concluding from the much smaller height of the upper alveolar pad, it seems that the space gained was principally the result of shortening the molars. Three years ago the patient appeared for the last time for observation. After thirteen years the conditions in the mouth were found good and hygienic.

In the third case, shown in Fig. 111, also before the making of the two upper buccal bridges as a substitute for 6-5|5-6, a shortening of the lower 6|6 was performed by an upper plate which permitted exclusively the biting on 6 6. The upper second and third molars have certainly lengthened, which can be ascertained by a comparison of the models before treatment, (upper row), with those after the completed treatment, (lower row).

As a result of lengthening of 6|6 by lack of occlusion there followed a wedging of 5|5 below the contact points. Therefore, in order to remove this obstacle for the shortening, the mesial surface of the 6|6 was ground off. Today, I would remove this hindrance in some months by wearing of a head-cap applied on 7|7.

In this case it gives the impression that the space obtained has been procured rather by a disappearance of the upper alveolar bone between 4|4 and 7|7, than by a shortening of 6|6. But, just the same, the room was gained and Fig. 111, (lower row), shows the condition shortly before making the inlay bridge which, up to this day, after four years, does not cause any complaints.

The shadows on the alveolar ridge of the upper jaw on the models after treatment, especially on the left, (lower row, Fig. 111), are not caused by "scraping".

It is the first case in which I performed a shortening of a lower lengthened molar. No further opportunity was offered for a similar treatment.

As to the condition of the bone in the retroalveolar space of lengthened teeth in the lower jaw, the works of Kellner and Kronfeld do not give information. It is possible that no such reduction of the spongiosa of the supporting bone, (which in the work of Kellner obviously exists in the intraradicular septum), follows as in the case of the upper jaw, and that also the structure of the bone of the mandible makes shortening of lengthened buccal teeth on this bone more difficult.

(*To be concluded*)