Free-end pontics used on fixed partial dentures

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The use of a free-end pontic on a fixed partial denture for replacing a missing tooth has become an acceptable clinical procedure.

ANTERIOR FREE-END PONTICS

The most typical free-end pontic on fixed partial dentures is a single pontic attached to a single abutment casting. For example, a missing upper lateral incisor is restored, with the cuspid as the abutment tooth, by soldering the lateral incisor pontic to the cuspid with no direct attachment on its mesial surface (Fig. 1). Restorations of this type have served well for many years without any clinical or roentgenographic signs of pathosis. The supporting tissues seem to be able to tolerate the pressures applied against them. The restoration's success may be explained (1) by the length, strength,, and oval form of the cuspid root; (2) by the labiolingual thinness of the pontic; (3) by the fact that the lateral incisor pontic rests it free surface against the central incisor and thereby receives some support; or (4) by the fact that incision occurs less frequently than the grinding of food in functional mastication. Perhaps it is a combination of these factors.

Where an upper central incisor supports an adjoining central incisor pontic, the long-term results are not so successful. When a lateral incisor supports an adjoining central incisor pontic, the results are least successful. The lever arm is shortest and most favorable where a lateral incisor pontic is supported by a cuspid or by a central incisor. Where a central incisor pontic is supported by a central or lateral incisor, the lever arm is longest and least favorable (Fig. 1).

FREE-END BICUSPID PONTICS

While these forms of two-unit cantilever bridges are quite common, a similar form of cantilever replacement has been used, but not as frequently and not with

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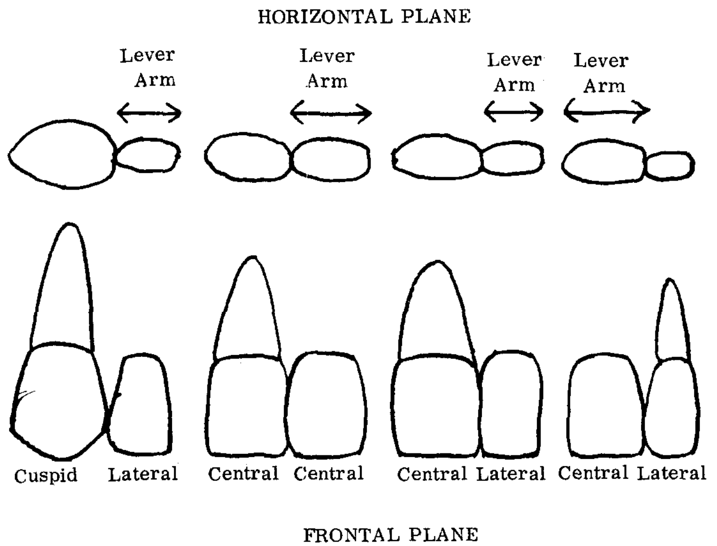

Fig. 1. Anterior single tooth free-end pontics. The strongest restoration is the one with a cuspid supporting a lateral incisor free-end pontic. The weakest one is a lateral incisor supporting a free-end central incisor pontic.

the same success. This form is demonstrated when a missing first or second bicuspid is replaced by the retained natural bicuspid, and the missing bicuspid free-end pontic is soldered directly to it but without an attachment on one end to the adjacent tooth. With this type of replacement and with the entire occlusal surface of the bicuspid pontic restored, the longevity of the fixed partial denture in function has not been as great, and the supporting structures have not stood up as well as with anterior free-end pontic fixed partial dentures.

The reasons for these differences are (1) the bicuspid roots are not as strong nor as long as the cuspid roots used as abutments; (2) the type of chewing which this form of replacement is subject to, i.e. functional grinding and empty grinding or bruxing, is more traumatic and occurs over a greater duration of time than incising; (3) the larger area of masticating surface is capable of exerting a greater force on the abutment tooth than do the incisal edges; and (4) the center of gravity (leverage) falls outside of the root of the abutment tooth, even when a vertical force is exerted. The attached free-end pontic converts this vertical force into an unfavorable lateral force. This change is not as great when the same vertical force is delivered to the lateral incisor free-end pontic. The narrow, blade-like, labiolingual surface of the incisor is able to divide and dissipate the vertical force before it can cause damage.

In the bicuspid and molar regions, there is another form of cantilever which is found often enough to warrant consideration. Where a molar or a bicuspid has been removed and not replaced, the space it occupied usually closes by means of a natural movement of the positions and inclinations of the remaining teeth. Frequently, some form of abutment casting is placed on the adjacent molar to extend to and to fill in the small space which remains after the natural drifting of teeth has occurred.

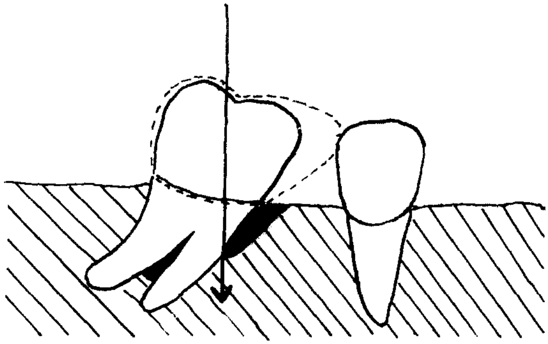

Fig. 2. A missing bicuspid is restored by extending the crown on the molar to contact the distal surface of the first bicuspid. The vertical force falls outside the center of the molar and becomes a tipping force. A periodontal pocket forms on the mesial side of the molar. The bifurcation of the molar root often becomes involved in this situation.

Regardless of how small the space is, replacements of this type may be regarded as small cantilever partial dentures with one free-end pontic. Inasmuch as the vertical forces applied to these restorations usually fall outside the roots of the teeth, especially in the case of bicuspids, and often in molars, this type of restoration frequently fails. The vertical forces create unfavorable pressures, and a periodontal pocket forms on the side of the abutment tooth (Fig. 2).

BROKEN-STRESS FIXED PARTIAL DENTURES

Broken-stress fixed partial dentures may be regarded as a form of cantilever having only one soldered or fixed end. The opposite end of the pontic(s) has a lug resting in a lug seat in the abutment tooth. Broken-stress fixed partial dentures have been used to replace a single bicuspid where the adjoining teeth are strong and healthy and the space is not large. This type of restoration has been successful, especially in young patients. However, when this same type of broken-stress denture has been used in older patients whose mouths have weakened supporting structures, there have been many failures. The cause of failure has been the unphysiologic movement of the unattached lug in its rest which causes a pumping action in the abutment tooth on the fixed end. This movement is not as severe as that where there is only a terminal pontic without a supporting lug and rest limiting the movement. There is sufficient continuing motion to eventually cause the loss of the fixed-end abutment tooth if no relief is provided.

Where two posterior adjoining missing teeth, such as a bicuspid and molar, are restored with this type of fixed partial denture, deterioration takes place more rapidly and is more severe (Fig. 3).

REMOVABLE PARTIAL DENTURES WITH FREE-END DENTURE BASES

While it is not the purpose of this study to consider removable partial dentures, it becomes apparent that those with free-end bases can be considered because of their similarity to the free-end pontics attached to fixed partial dentures.

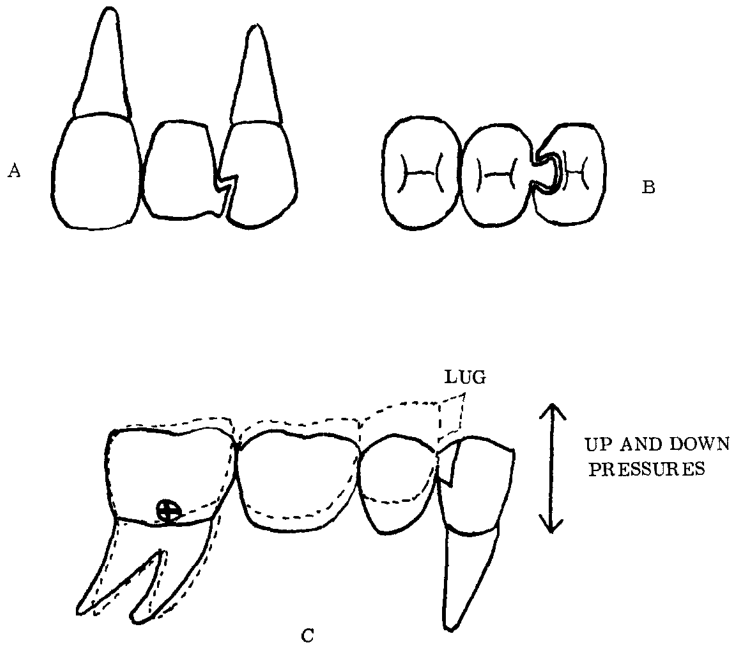

Fig. 3. Broken stress fixed partial dentures: *A,* Buccal view of a tapered lug and lug rest; *B,* same as *A* except that it is an occlusal view; *C,* a four-unit broken stress fixed partial denture in which the second bicuspid and first molar are replaced by a soldered attachment to the second molar with a tapered lug and rest as the anterior support. The molar abutment is subject to unfavorable upward and downward pressures around the axis of rotation (⊕).

The vertical and lateral pressures on these removable partial denture restorations have caused them to be of great concern, because of the deleterious effect of their uncontrolled movement upon the terminal abutment teeth. In order to protect these teeth, splinting of multiple abutments and all kinds of broken stress attachments have been used. Also, various methods of impression making have been advocated to better stabilize the removable partial denture and to relate it more correctly to the fixed parts of the dental arch so that the minimum of unfavorable leverages will be created.

In the replacement of the upper molars by means of a removable partial denture where there are no posterior abutments, the use of double abutments is almost a standard procedure. Even when double abutments are used, and when a special "mucostatic" impression and a double impression technique are resorted to, the longevity of the abutments is not favorable when compared to fixed partial dentures. A fixed partial denture possesses passivity to a degree which is impossible to obtain with removable partial dentures.

REMOVABLE PARTIAL DENTURES WITH FREE-END BASES VS. FREE-END PONTICS ATTACHED TO FIXED PARTIAL DENTURES

Many patients whose mouths are being rehabilitated prefer to avoid removable prostheses if possible. This is particularly true when it is necessary to replace the molar teeth. In many of these patients, the remaining natural teeth have weakened periodontal structures, and it is advisable to reduce the functional load by restoring only one missing molar on each side instead of two. These posterior teeth have been replaced by removable partial dentures. Sometimes the dentures have been attached to single abutment teeth on each side, but, more often, they are attached to a minimum of two abutment teeth on either side. These restorations have replaced at least two missing molars on either side for adequate function, and they have protected the temporomandibular joints by supplying interocclusal contacting surfaces at the region where the greatest pressure is exerted. If these posterior molars were not restored, the occlusal pressures could cause symptoms of temporomandibular joint disturbances. These pressures may affect the masticatory muscles and result in muscle spasm.

Thus we meet with a paradox. On the one hand, many patients seriously object to having to wear removable partial dentures. On the other hand, the elimination of the partial dentures may set up noxious influences, including temporomandibular joint symptoms. The former discussion shows that both fixed partial dentures with free-end pontics and removable partial dentures with free-end bases act as cantilevers and exert unfavorable pressures upon the abutment teeth. Also, the removable partial denture exerts unfavorable forces upon the supporting bone of the ridge and soft tissues.

PROBLEMS ASSOCIATED WITH FREE-END PONTICS

Because of the requests for fixed partial prostheses by patients and because of the extensive restorative procedures used in complete oral rehabilitation, many dentists have been using fixed partial dentures with free-end pontics. We have used this type of restoration for several years with more than moderate success. However, during this period, the number of failures observed has been too high to be considered the result of accident; therefore, it became necessary to probe deeper into the problem. Too many roots and crowns fractured on the abutment tooth adjoining the free-end pontic. Also, some of the gold crowns that covered these terminal abutment teeth loosened without the crowns covering the remaining portion of the splint loosening. This was not always detected until caries had caused acute dental pain which involved the pulp and destroyed the crown of the tooth next to the cantilevered pontic. In some instances, the crown in the tooth adjoining the free-end pontic became loose and, finally, the second tooth from the free-end pontic fractured at its cervical end because of the pumping action of the cantilever, which now could be regarded as a two-tooth free-end pontic.

MASTICATORY FORCES AND THEIR ACTION UPON PROSTHETIC APPLIANCES

The root of the natural tooth is imbedded in the alveolar bone. Suspensory fibers from the periodontal ligament completely surround the root, and are attached to the root and to the bone.

Two types of forces are present in normal masticatory function. These are vertical and horizontal forces or a combination of both. The vertical forces serve to stretch almost all of the periodontal suspensory fibers except those at the very apex of the tooth. If the vertical force is intermittent, it serves as a physiologic stimulus to the periodontium. The tooth becomes tighter unless the verical force is excessive or sustained for a long period of time (Fig. 4). A horizontal or lateral force stretches only a relatively small part of the periodontal suspensory fibers, and it tends to crush other fibers on the opposite side of the root. Lateral forces are not physiologic and not well tolerated (Fig. 5). With large crowns and short roots, even vertical forces can be excessive (Fig. 6).

Single-rooted teeth, when acted upon by lateral forces of mastication, tend to tip with the axis of rotation somewhere in the region of the apical third of the root (Fig. 7).[1] Multirooted teeth, such as a lower first molar, when subjected to a

Fig. 4

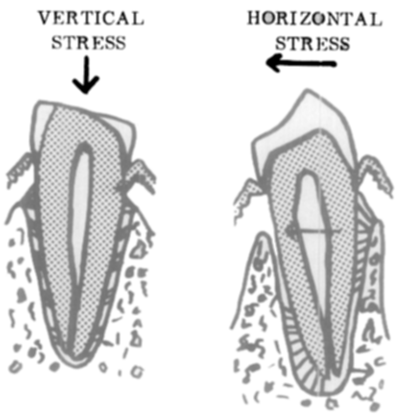

Fig. 5

Figs. 4 and 5. Under vertical stress all oblique suspensory fibers are subjected to equal strain. If such a force is intermittent, it serves as a physiologic stimulus to the involved tooth. Horizontal stress tends to cause a rotation of the tooth in the socket and places stretching forces on *some* of the fibers of the periodontal ligament. (Redrawn from Boyle: Kronfield's Histopathology of the Teeth, ed. 4, Philadelphia, 1955, Lea & Febiger.)

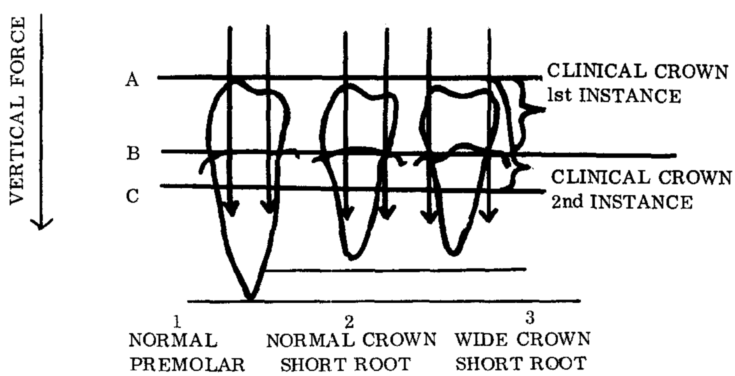

Fig. 6. The unfavorable distribution of functional forces associated with variation in crown/root relationship is accentuated when there is reduced periodontal support. With wide clinical crowns and short roots, even vertical forces fall outside the center of the roots. (Redrawn from Cohn, L. A. *in* Glickman, I.: Clinical Periodontology, ed. 2, Philadelphia, 1958, W. B. Saunders Company.)

Fig. 7

Fig. 8

Fig. 7. Single-rooted teeth are subject to lateral forces that tend to tip with the axis or rotation somewhere in the region of the apical third of the root. (From Gottlieb and Orban: Die Veränderungen der Gewebe bei übermässiger Beanspruchung der Zähne, Leipzig, 1931, Georg Thieme.)

Fig. 8. A multi-rooted tooth when subjected to a mesiodistal force tends to rotate on a buccolingual axis which is located in the alveolar bone between its two roots. (From Gottlieb and Orban: Die Veränderungen der Gewebe bei übermässiger Beanspruchung der Zähne, Leipzig, 1931, Georg Thieme.)

mesiodistal force, tend to rotate upon a buccolingual axis which is located in the alveolar bone between its two roots. In this instance, if the force comes from a distal direction, the mesial root would tend to be depressed into the socket whereas the distal root would tend to be elevated (Fig. 8). Thus, in a comparison between a single-rooted and multirooted tooth, each subjected to the same mesiodistal force, the tipping action of the multirooted tooth would be much less. The multirooted tooth can be regarded as a small splint in which two single-rooted teeth have been united. The three-unit fixed partial denture is a small splint in which the axis of rotation against mesial or distal pressure is situated in the alveolar bone between the two roots, and at a right angle to the pressure instead of in the apical third of the individual tooth. Movement is more bodily than tilting or tipping. More periodontal fibers resist the pressure, and there is less overloading.

When buccolingual or linguolabial pressures are exerted, the axis of rotation is in a mesiodistal direction or at right angles to the direction of the force. This causes unfavorable tilting and tipping. Therefore, a unilateral posterior fixed partial denture or a three or four-unit anterior partial denture, although aided by having two or more abutment teeth resist the horizontal stresses, is not as well supported as it

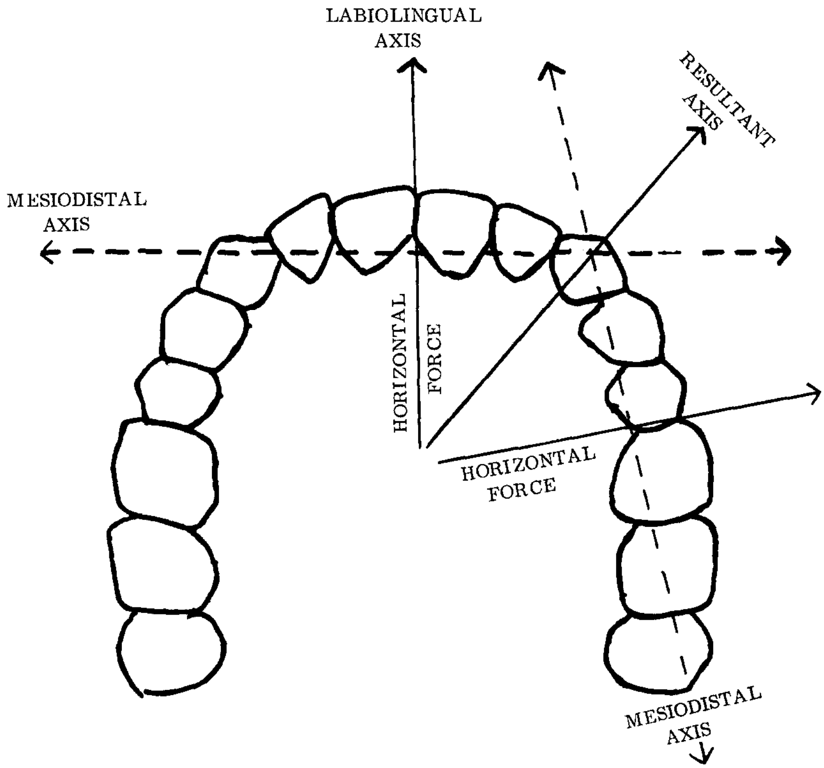

Fig. 9. Horizontal forces are more favorably counteracted by splinting anterior and posterior teeth together. (Redrawn from Schweitzer: Oral Rehabilitation Problem Cases, St. Louis, 1964, The C. V. Mosby Company.)

would be if additional support had been obtained from a different segment of the dental arch.

When the posterior and anterior segments are connected by means of one continuous rigid splint, the linguolabial forces, which tend to tip the incisors labially about a rotational axis running through the apical third of their roots in a mesiodistal direction, change the direction of the axis so that the resultant force is in neither a linguolabial or buccolingual direction. The resultant tipping force is somewhere between the anterior and posterior segments of the arch, and the tooth movement is more bodily than tipping (Fig. 9). The same analysis applies to the buccolingual forces on posterior splints. When anterior and posterior teeth are connected, the axis of rotation for the posterior teeth no longer runs anteroposteriorly, but it extends between the two individual axes. As a result, the posterior abutment teeth now move more bodily. A similar situation exists to a smaller degree because of the curvatures of the dental arch. When any two adjoining posterior teeth, such as a molar and bicuspid, are rigidly united, a greater foundational stability is provided, and their ability to resist lateral forces is increased because of this arch curvature (Fig. 10).

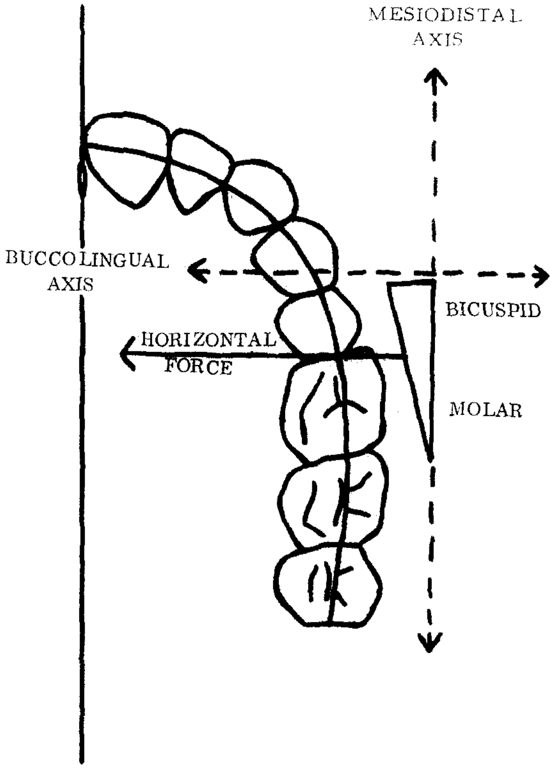

Fig. 10. The curvature of the upper arch aids in resisting horizontal masticatory pressures. (Redrawn from Schweitzer: Oral Rehabilitation Problem Cases, St. Louis, 1964. The C. V. Mosby Company.)

ANALYSIS OF MASTICATORY FORCES WITH EMPHASIS ON THE SAGITTAL PLANE

Most of the pressures which have been discussed are on the horizontal plane. Now let us return to one specific problem, namely the terminal free-end pontic in relation to fixed partial dentures, and see how these various pressures can be applied at the clinical level. We have decided to concentrate on the sagittal plane only. There remains for further investigation the horizontal plane shown in some of the diagrams of forces.

The problem is similar to that which must be considered in the construction of a diving board. The board must be strong and long on its fixed end and securely bolted down; otherwise the pressure created by the diver on the free end (cantilever) will be sufficient to loosen it from its moorings or to cause it to fracture where the free end joins the rigid part (Fig. 11).

Diving boards are similar to cantilever partial dentures (Fig. 12), but the pressures on cantilever restorations may be more easily comprehended by considering the seesaw (Fig. 13). A man standing close to the rotational axis of the seesaw can be balanced by a small child if the child is placed sufficiently far from the rotational

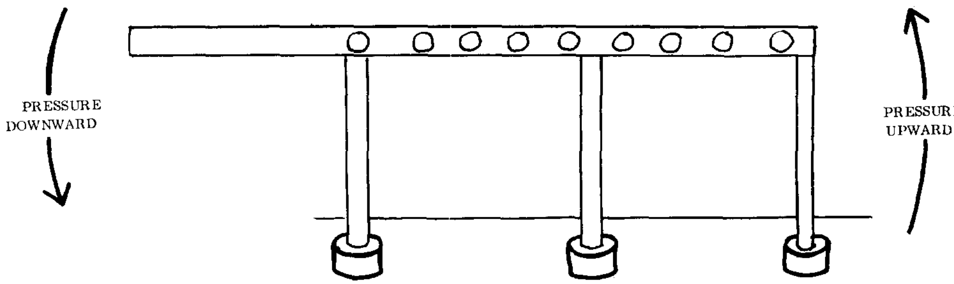

Fig. 11

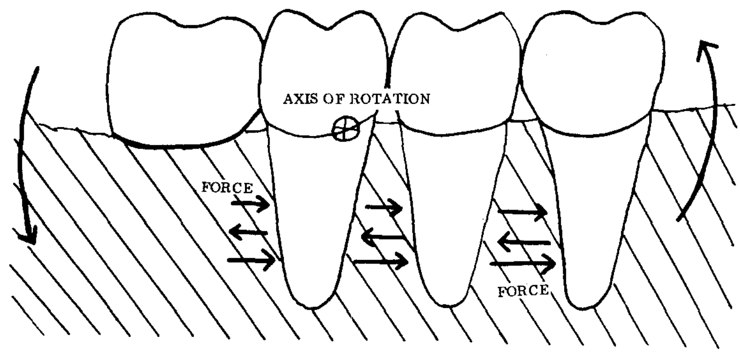

Fig. 12

Fig. 11. A free-end pontic attached to a fixed partial denture can be compared to a diving board. In this example, the three supports for the diving board can be compared with three natural teeth which support a free-end pontic.

Fig. 12. A free-end pontic is attached to a fixed partial denture supported by three natural teeth. Compare this with the diving board in Fig. 11.

axis. Applying this principle to free-end pontics in relation to fixed partial dentures, the longer the lever arm, the less force necessary to apply great pressure. Conversely, the shorter the lever arm, the greater the force necessary to exert the same pressure. Practically applied, the greater number of natural teeth used to support a free-end pontic and the fewer the number of free-end pontics, the greater the longevity and the health of the supporting teeth.

In the sagittal plane, if two posterior bicuspids are covered with gold crowns and if one free-end pontic is soldered to them, a vertical force applied to the free-end pontic would locate the axis of rotation in the most distal bicuspid. This tooth would be depressed, while the first bicuspid would be elevated. If there were two free-end pontics and if a vertical pressure were applied to the most posterior one, the natural tooth next to the pontic would be subject to greater rotation and depression, while the first natural bicuspid would be subject to greater forces tending to elevate it. A vertical force acting upon the free-end pontic attached to a fixed partial denture causes the components to rotate; there must be an equal force in the opposite direction to balance this rotational tendency. In order that the fixed partial denture may be in equilibrium, the sum of the vertical forces and the hori-

Fig. 13

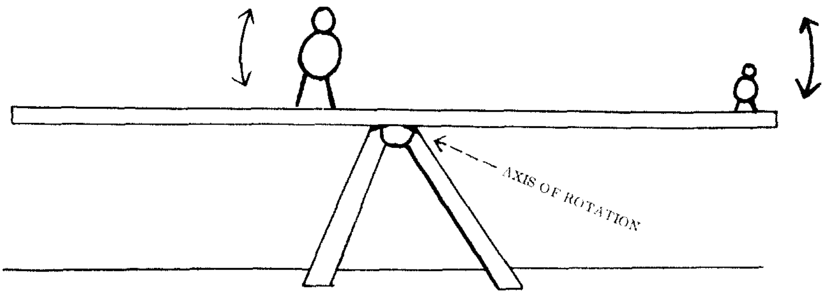

Fig. 14

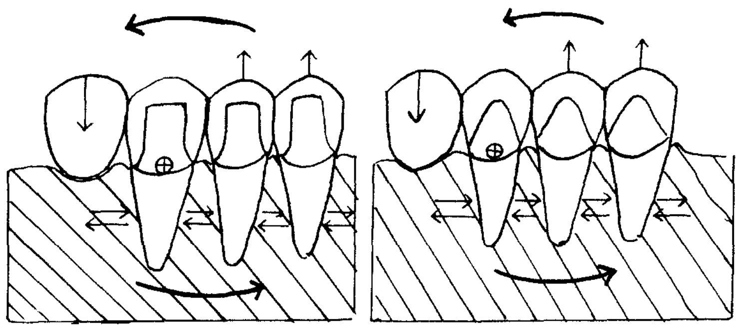

Fig. 13. The seesaw illustrates lever arms and vertical pressures.

Fig. 14. The abutment teeth should be prepared with nearly parallel walls to avoid dislodging forces. The full crown is the casting of choice. (⊕ = axis of rotation.)

zontal forces by themselves must equal zero. The greater the anteroposterior length of the free-end pontics, the longer the lever arm; with a longer lever arm, more natural teeth are needed to counteract the masticatory pressures. The broader the morsal surface of the free-end pontic is buccolingually, the greater the pressures that may be applied. The shorter the natural tooth crowns in a vertical direction, the less they are able to resist dislodging forces; hence, the preparation of choice, whether the teeth have medium or short clinical crowns, is the full coverage casting, and even then the preparation should have parallel walls instead of tapered ones (Fig. 14).

MASTICATORY FORCES WHICH TEND TO LOOSEN ABUTMENT TEETH AND THEIR CASTINGS

Vertical pressures may be reduced by making the free-end pontic short in an anteroposterior direction and narrow in the buccolingual diameter. The restoration may be strengthened by splinting more natural teeth together and by splinting "around the arch." The lifting forces that tend to loosen the abutment teeth and their castings explain why this type of failure occurs and why, with the axis of rotation in the terminal abutment tooth, the occlusal pressures are often sufficient to fracture the crowns.

Inasmuch as the axis of rotation in the sagittal plane for this type of restoration

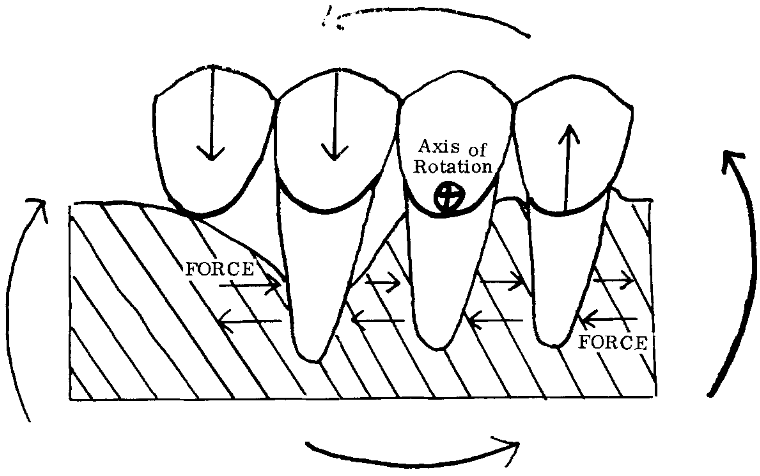

Fig. 15

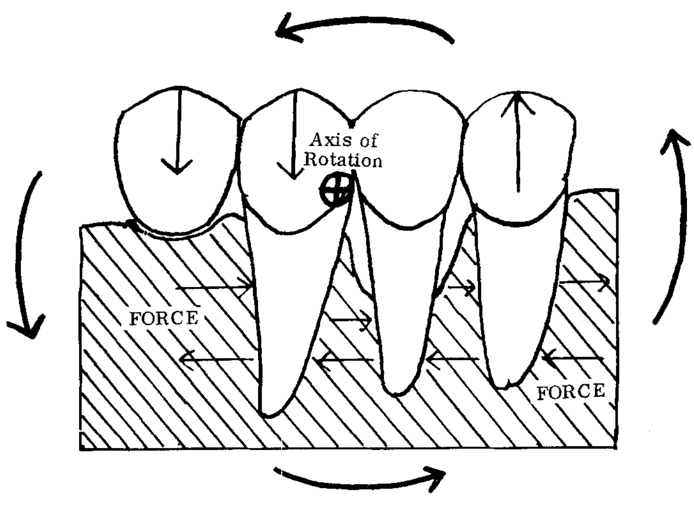

Fig. 16

Fig. 15. Where a terminal abutment tooth has lost its bony support in the free-end pontic restoration, it can be regarded as an additional free-end pontic. This causes increased leverage and requires additional support.

Fig. 16. The forces exerted by the free-end pontic are more favorably resisted if the terminal abutment teeth, namely, the furthest anterior and furthest posterior ones, have adequate support.

is in or near the terminal abutment tooth, this tooth should have good bony structural support from the periodontium. Where this support is lacking, the terminal abutment tooth may be regarded as an additional free-end pontic, and the axis of rotation would be in the tooth next to it. The longevity of the tooth is questionable (Figs. 15, 16 and 17). On the other hand. The extraction of the tooth is debatable, because these abutment teeth with questionable prognoses are sometimes retained for a considerable length of time. Radiographically, their lamina dura is obliterated

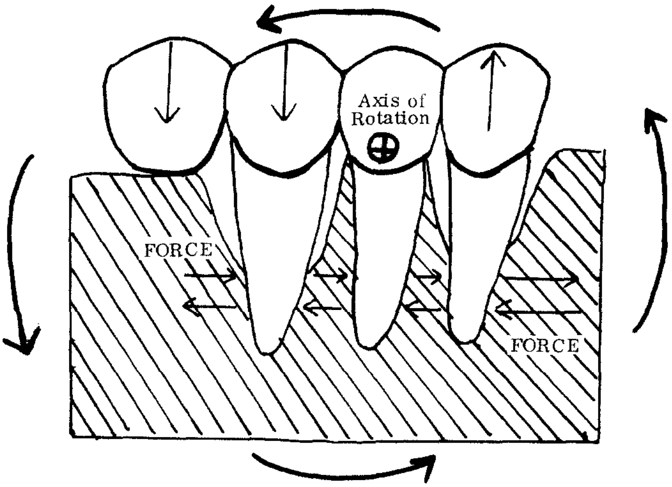

Fig. 17. The forces exerted by the free-end pontic are less favorably resisted if the terminal abutment teeth on either end have insufficient alveolar support. The dislodging forces are then able to act in a minor way as additional free-end pontics with the axis of rotation shifted to the middle abutment tooth.

and their periodontal ligaments are thickened, but that seems to be the extent of their pathologic involvement. It seems best, where large splints are involved, to provide some safety devices so that, if the questionable tooth must be removed, the entire splint need not be sacrificed.

In order to decrease the load from free-end pontics, the pontics have been made with facings but without complete occlusal surfaces. This does decrease the vertical and horizontal pressures on the pontics. Care should be taken to make certain that the interocclusal relationship is such that the opposing teeth will not "overerupt" because of lack of occlusal contact. The excessive eruption of teeth creates a condition which may prove to be equally as unsatisfactory as the excess occlusal force that one is trying to avoid.

MECHANICAL AND ANATOMIC FACTORS WHICH EFFECT FORCES TENDING TO UNSEAT FREE-END PONTIC RESTORATIONS

The rotational forces are better resisted when teeth with long roots are selected as abutments than when short-rooted abutment teeth are selected (Fig. 18). When there is dense, resistant alveolar supporting bone, the displacement is less than when weak and excessively porous (cancellous) alveolar supporting bone exists (Fig. 19).

When a three-unit cantilevered fixed partial denture has a second molar free-end pontic supported by a first molar and a second bicuspid, the axis of rotation is in the molar. The distal root of the molar will tend to be depressed, while the mesial root will be elevated. The greatest pressure causing vertical displacement would take place in the tooth farthest from the axis of rotation, which in this situation would be at the second bicuspid.

A free-end pontic attached to a fixed partial denture which is opposed by a removable partial denture with a free-end denture base is not subjected to the same

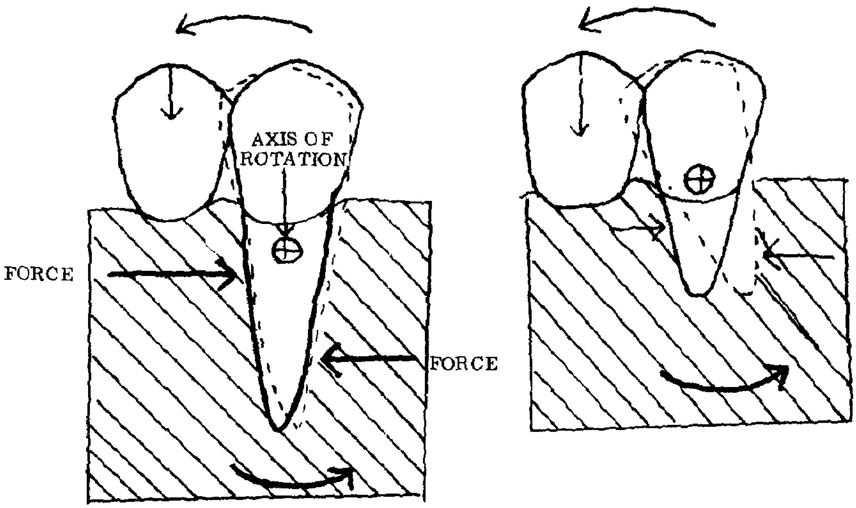

Fig. 18

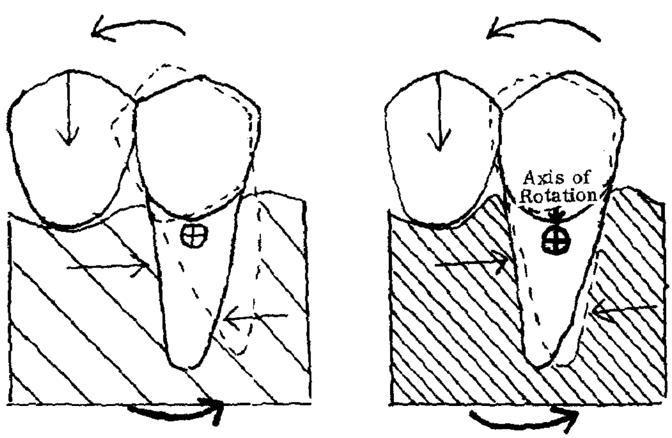

Fig. 19

Fig. 18. Long-rooted abutment teeth (left) permit less rotation and displacement than do short-rooted abutment teeth (right).

Fig. 19. Abutment teeth imbedded in dense alveolar supporting bone (right) permit less rotation and displacement of free-end pontics than do abutment teeth imbedded in weak, highly cancellous alveolar supporting bone (left).

degree of vertical and horizontal pressures as it would be if it were opposed by natural teeth. Therefore, greater longevity and better health may be predicted for it (Fig. 20). Actually, the presence of opposing teeth aids in neutralizing dislodging forces.

Nonvital teeth with broken-down crowns are poor risks when used as the terminal abutments for free-end pontics. These teeth are subject to various types and degrees of torque and, being brittle, fracture too often for the cause to be accidental. Broken-down teeth adjoining the terminal abutments should have their clinical crowns prop-

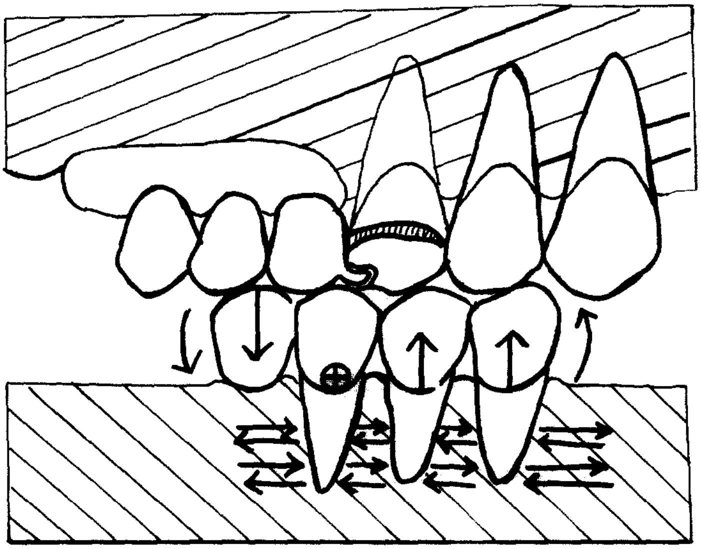

Fig. 20. A free-end pontic fixed partial denture has a more favorable chance for health and longevity when it is opposed by a removable partial denture with a free end base.

erly built up in order to fortify them; otherwise, their castings will loosen or they, themselves, will fracture (Fig. 21).

The greatest foundational strength is found where the anterior and posterior segments of the dental arch are joined rigidly together in the form of a splint connecting the anterior six incisors with the four bicuspids. This ten-unit splint is best able to support two free-end pontics, one on each side. This type of fixed partial denture has met with reasonable success for many patients. The inclusion of the first molar free-end pontic has helped to protect the temporomandibular joints from undue occlusal pressures (Fig. 22).

ABUTMENT CASTINGS

Complete fixation requires abutment castings that are able to resist torque which comes from both the vertical and horizontal masticatory pressures. These pressures cause compression and elongation of the castings. Two- or three-surface inlays are not able to withstand these pressures nearly as well as three-quarter or full crowns. These inlays fail because the metal is distorted. This distortion opens up the once well-sealed margins and permits caries to occur. The full crown is the strongest type of abutment casting, and it is less likely to be dislodged. If the tooth preparation has walls which approach parallelism, the dislodging forces are best resisted. A crown completely covering the tooth serves to hold it together, whereas an inlay may act as an internal wedge. The full crown engages a larger area of cement and has four vertical surfaces. Crowns resist dislodging forces better than any other form of retainer. The greatest dislodging forces are met in the abutment tooth farthest from the free-end pontic. If the forces which tend to rotate the prosthesis occur around the axis of rotation in the sagittal plane, which is in or close to the abutment tooth adjoining the free-end pontic, it is not difficult to understand that the forces tending

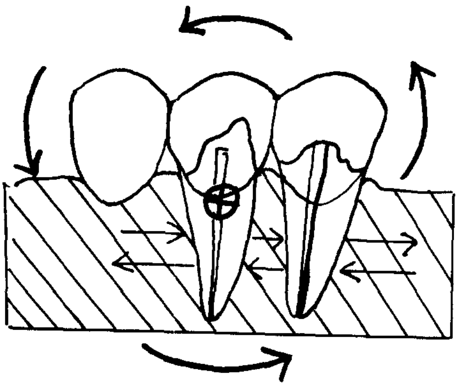

Fig. 21

HORIZONTAL PLANE

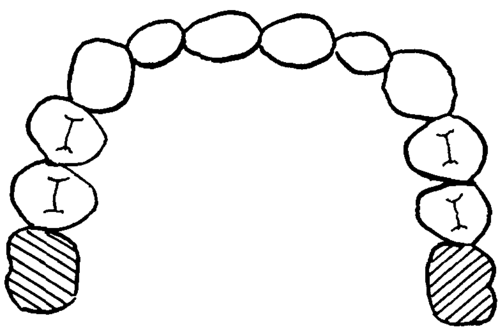

Fig. 22

Fig. 21. Nonvital teeth with broken-down clinical crowns should be restored by any method that will strengthen them to avoid fracturing. This is necessary in any type of fixed partial denture. It is especially true where free-end pontics are used.

Fig. 22. A splint involving ten natural teeth takes advantage of the combination of anterior and posterior segments of the dental arch. Two free-end molar pontics have been attached. This is the strongest form of a fixed partial denture with free-end pontics.

to lift the cast crown from the abutment farthest from the free-end pontic are greatest. At the clinical level, this means that the cement should be strongest where the forces of compression and distension are greatest and, also, that the metal should be strongest over these abutment teeth. The soldered joint between the free-end pontic and the proximal abutment casting should also be strong in order to withstand the compressive force in this region (Figs. 23 and 24).

It is to be assumed that a correct interocclusal relationship has been established. Without it, all dental prosthetic appliances would be subject to the trauma which results when there is a difference between the centric occlusion and the centric relation.

SUMMARY

This is a progress report of our endeavors to investigate a type of fixed partial denture in which one or more cantilevered pontics have been soldered to one or

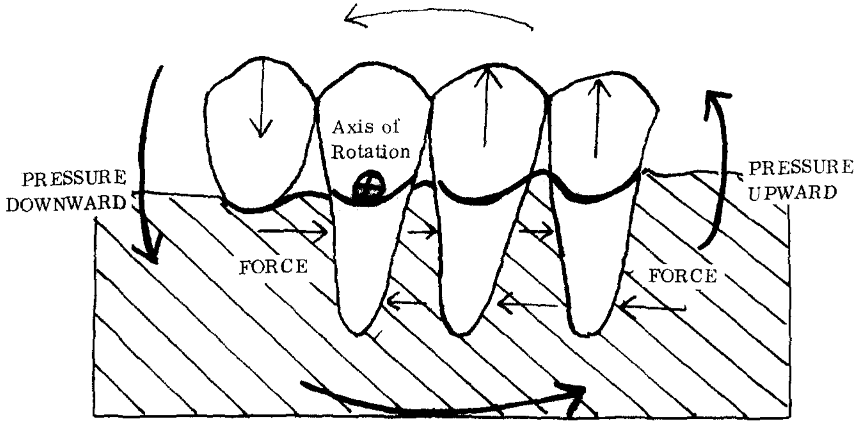

Fig. 23. Force exerted on the most posterior free-end pontic causes the greatest displacing pressure on the most anterior abutment casting. The cement must be strong to oppose the severe compressive and tensile pressures without disintegrating.

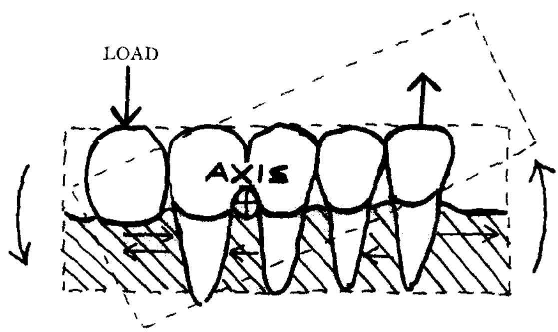

Fig. 24. The load directed downward on the free-end pontic causes the rectangle (dotted line) to rotate on an axis shown in the diagram. This demonstrates the compressive and tensile effects and the need for strong cements and strong soldered joints, as well as strong metal for the castings.

more natural teeth. These teeth have been joined together to form a splint by means of metal castings covering their crowns and soldered to each other.

By eliminating the necessity of inserting a removable partial denture with free-end bases, the type of fixed partial denture just described minimizes the damaging effects of attempting to stabilize a tissue-borne appliance by attaching the denture to rigid nonyielding natural teeth and a movable yielding base.

The beneficial effects of the fixed partial denture with the cantilevered free-end pontic, from the point of view of the periodontal tissues, mouth hygiene, and patient psychology have also been considered.

Explanations have been given for the fracture of natural tooth crowns and the loosening of abutment castings owing to the application of pressures on the cantilevered pontics and the dissipation of the forces which these pressures release.

Methods of protection against these unfavorable leverages by means of construction, design, and tooth preparation have been presented.

CONCLUSIONS

With the increased use of extensive fixed partial dentures, the use of large removable partial dentures is becoming less common. The protection of weakened periodontal structures by diminishing function and removing tooth units from the occlusal scheme seems to be logical. Free-end pontics are capable of meeting these requirements. The periodontal tissues favor the passivity and the diminished amount of torque found in fixed partial dentures.

Anterior single tooth pontics attached to only one abutment have been used more frequently than posterior single tooth free-end pontics of a similar nature. Upper cuspids supporting missing lateral incisors have proved to be most successful. One bicuspid supporting a missing bicuspid free-end pontic has proved to be the least successful of this type of restoration.

Vertical pressures which fall within the center of a tooth are more readily tolerated than those which fall outside the center of the tooth. Those forces which fall outside the tooth are converted into dangerous lateral forces.

Removable partial dentures with free-end bases can be compared to fixed partial dentures with one or two terminal free-end pontics.

Unless the abutment tooth to which a broken-stress fixed partial denture is attached is strong, the pumping action which takes place at the unsoldered end will cause a breakdown of its supporting bone. Leverages which are beyond the supporting capacity of the abutment teeth may be exerted by the broken-stress fixed partial denture; therefore, periodontally involved teeth used as abutments for fixed partial dentures should be rigidly connected on both ends. This is much more important where two adjacent missing teeth are being replaced.

Weak crowns of natural vital or nonvital teeth used as abutments with free-end pontics are subjected to excessive forces, and they should have the additional support of pins and posts to prevent their fracture.

Function in the region of the first molar may be significant to a healthy mechanism. When molar teeth are to be eliminated from the occlusal scheme, the effect upon the temporomandibular joints should be carefully considered.

Where free-end pontics have been used, the natural teeth supporting them have fractured and/or the abutment castings have loosened in enough patients to indicate that the occurrences were not accidental.

Intermittent vertical forces are well tolerated by teeth. Sustained horizontal pressures are unfavorable, and they cause periodontal pathosis.

A multirooted tooth may be regarded as a small splint with its axis of rotation situated in the alveolar bone between the roots.

Unilateral fixed partial dentures resist the masticatory pressures less favorably than do fixed partial dentures which receive support from two or more segments of the dental arch.

A terminal free-end pontic is best supported by two or more abutment teeth which adjoin it. A vertical force acting upon the free-end pontic in a fixed partial denture causes the components to rotate. There must be a force in the opposite direction to balance this rotational tendency. For the fixed partial denture to be in equilibrium, the sum of the vertical forces and the horizontal forces by themselves must equal zero.

The axis of rotation of a fixed partial denture with a free-end pontic is usually found in the tooth adjoining the free-end pontic. The terminal abutment tooth of a fixed partial denture with a free-end pontic should have adequate alveolar support, otherwise it will be subject to depression and rotation. In a fixed partial denture, when vertical pressure is exerted on the free-end pontic, the tendency to elevate is greatest in the abutment tooth farthest from the free-end pontic. The density of the supporting alveolar bone plays an important role in the support of fixed partial dentures with free-end pontics. Dense bone, even when its level has been reduced, can provide adequate support for a fixed partial denture.

When a fixed partial denture with a free-end pontic is opposed by the denture base of a removable partial denture or a complete denture, the pressures are considerably less than when it is opposed by natural teeth or a rigidly constructed fixed partial denture.

Free-end pontics in the form of facings without complete occlusal surfaces decrease the pressures on fixed partial dentures. However, the opposing tooth must be prevented from overerupting because of the lack of interocclusal contact.

Because of the compressive and tensile forces to which metals are subjected, the abutment castings should be strong and resistant to these forces. The soldered joints should be equally strong. For these same reasons, the cement should be resistant to the same pressures. While gold inlays may be used to support free-end pontics attached to fixed partial dentures, the full crown is the strongest abutment casting and is the least distorted by functional forces.

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