My objective in this presentation is to bring to your attention considerations that appear to me to be basic and fundamental in making impressions—impressions of mouth tissues for the purpose of constructing mucosa-attached artificial dentures.

Someone has said that “you can’t learn dentistry from books.” This is true, and it is likewise true that you cannot learn dentistry without books, without theories and hypotheses deduced from basic principles, for problems can be better solved in practice when they are first resolved in theory.

**RESOLUTION OF THE PROBLEM**

Let us now resolve the impression problem—trace its factors to their very roots. The impression problem would not be a problem if we were taking impressions of casts. The problem is due to the fact that the mouth is lined with displaceable tissue; displaceable tissue that varies in degree of displaceability, according to: (1) its thickness, (2) its rigidity, (3) the point, magnitude, and direction of the forces applied to it. In view of these facts, it is reasonable to say that the ideal impression must be in the mind of the dentist before it is in his hand. He must literally make the impression rather than take it. The kind of an impression he will make depends on many factors, factors which we shall presently consider.

**DEFINITION OF IMPRESSIONS**

An impression is a registration of mouth tissues made with an impression material. It is a record, a facsimile of mouth tissues taken by various positions of displacement. The impression form is the shape of the saddle which will harness mouth tissues for the purpose of counter-acting masticatory forces delivered at different levels of jaw separation. The mucosal displacement recorded in an impression will vary in degree and direction. Unless an impression is made with the mucosa in an unstrained rest position, it is well impossible to duplicate. It is hardly likely that two impressions taken of an edentulous mouth are ever identical. For in seating the impression tray containing the impression material, the amount of force, the direction of the force, and the point of application of the force will vary with each attempt. Until an impression material is developed that may be sprayed with light and uniform pressure upon the mucosa, registrations in a rest position will represent an ideal rather than a reality.

The present practical means at our command merely approach this ideal without ever attaining it, and considering the variables incident to denture construction, it is fortunate that this is so. For, unless mucosal rest impressions are combined with certain stabilizing factors, they may be inadequate to effect sufficient retention during function. Then again the construction of dentures from tissue-at-rest impressions limits the choice of denture base materials to those requiring a more exacting technique, usually metal castings of the impression area. The impression surface must be so meticulously reproduced in the finished denture that many denture base materials due to their curing shrinkage and the use of separating media cannot be employed.

**THE IMPRESSION AREA**

For purposes of our present analysis let us somewhat arbitrarily divide the impression area into two parts: (1) the vault-ridge areas, (2) the flange-heel areas. I cannot imagine a situation where it is undesirable to achieve unstrained rest tissue registration in ridge-vault areas. However, I have encountered many cases where rest registration of flange-heel areas would not suffice to retain the denture during mastication. It is important that this differentiation be clear in one’s mind. Rest registrations are apt to result in insufficient saddle and flange areas resembling old-time plaster impression dentures where lowers especially were flangeless. And, ever since Dr. Wilfred Fish’s pronouncement of the importance of flange inclines in stability, one is loath to permit this stabilizing force to go unemployed.

**THE THEORY OF REST IMPRESSIONS**

The facts cited in support of the theory of rest impressions are irrefutable. However, the interpretation of these facts and their unqualified application in practice may be questioned. The facts are these: (1) The laws
of hydrostatics tell us that water is incompressible, i.e., you cannot take a given amount of water and through pressure reduce its volume. (2) The mucoperiosteum is a semi-solid with over 80 per cent of water in its composition, and if the known facts of hydrostatics are utilized, the mucosa is incompressible by any force that the muscles of mastication are able to deliver. (3) While the mucoperiosteum cannot be compressed, it may, however, be displaced in the absence of confining walls. (4) Any substance, no matter how fluid, when enclosed in a rigid container, takes on the same rigidity as that container. Thus, soft tissue, provided it is completely contained, would under these circumstances become as rigid as bone. (5) Tissue is elastic and will not remain passive in a displaced position. It will try to recover its unstrained rest form.

MOVEMENTS OF THE MUCOSA

It is possible with rest impressions to harness the mucoperiosteum to such an extent that within the area covered by the impression it cannot be appreciably moved by a vertical force applied within the ridge crest; but this is not true when the vertical force is applied outside the limits of the base area. The mucosa, likewise, is displaced when the force applied is horizontal or possesses a component that is horizontal, this, regardless of where it is applied, within or without the base area. Under these circumstances, the mucosa may not move within the impression, but one would have no difficulty in having it move with the impression. As I cautioned, we must be careful about the interpretation of so-called mucostatic facts, for all one has to do to verify my contention is to grasp a rest impression in the premolar region with index finger and thumb and press sidewise or forward and backward. One would have no difficulty in detecting movement. Let me repeat for emphasis. When the tissues are completely contacted (whether at rest or in positions of displacement is immaterial), they are impotent to move within the impression; no room for movement will be available.

CONTACTING DENTURE SURFACE

This fact accounts for the lack of mucosal irritation in the presence of the rough contacting surface found with mucostatic dentures. It is fallacious to argue, as some do, that minute tissue registration in an impression will result in multiple miniature, wedges that irritate the mucosa unbeknown to the patient because it is below the threshold of pain response. A wedge cannot operate except in space, for a wedge is an incline plane moving under an object. When the tissues are completely contacted, wedging action cannot take place. There is no room available for movement. It appears evident that minute registration of soft tissues in a state of rest is not objectionable on the ground that it results in a rough surface. It is also wise to bear in mind that a relatively rough surface increases the surface area in contact with the mucosa; and this increases the forces of interfacial surface tension, which is directly proportional to the area involved. In arguing this point, the shoe analogy is sometimes cited; that is, what would happen to the sole of one’s foot if the contacting shoe surface was a minute reproduction of tissue form? The analogy, however, is ill chosen, for conditions are not similar. The foot rests in the shoe, whereas a well-constructed denture is attached to the mucosa.

THEORY AND PRACTICE

Someone has said: “When theory and practice differ, use your horse sense.” This is good counsel in our impression problem. In theory, rest impressions are plausible, but in practice, they may not suffice for retention and function. However, they are ideal during periods of rest which embrace the greater part of the day and night. But under the hazards of a resistive bolus (where one-sided horizontal forces prevail) such impressions may be dislodged or rather dentures made from such impressions may be dislodged. Yet, this must be said in favor of rest, impressions: Given a satisfactory end result, dentures made from rest impressions will remain serviceable for a longer period of time than dentures built from impressions taken during displacement. For displacement will subject osseous tissue to a continuous stress. Displaced mucosa has a steady urge to return to rest position. Then, again, displacement results in tensile and shear forces to osseous tissue. Just as intermittent stress, rather than continuous stress, is more physiologic to bone, likewise, bone is more counteractive to compressive loads than to tensile and shear stresses.

RETENTION AND STABILITY

It is well in our thinking to be clear about the terms retention and stability. Generally speaking, stability is that state wherein forces that tend to cause motion are successfully resisted without a loss of equilibrium. A stable denture is one that successfully resists the magnitude and direction of functional forces that tend to alter the positional relationship of the denture to its osseous support. Probably it should be stated that a stable denture is one relatively stable, for absolute stability under edentulous circumstances is out of the question. In this definition of a stable denture, it is important to note that the term osseous support and not mucosa was used. For, during function, a denture may lose stability and yet maintain its positional relationship to the mucosa. Under these circumstances this denture still possesses retention. Thus, retention may be defined as that state of a denture wherein functional forces are unable to destroy the attachment existing between the denture and the mucoperiosteum. It is thus apparent that a denture
may be unstable and yet possess sufficient retention to resist dislodgement. As long as the denture does not lose its grip upon the mucosa under functional loads, it may be said to possess an adequate degree of retention. Stability is something else. If a denture does not move noticeably in function, it is said to be stabilized. Movement means displacement of the mucoperiosteum in function.

RELATION OF DENTURE TO MUCOSA

It is probably a misstatement to say that a denture merely rests on the mucosa, for the statement suggests that its relationship to its base is that of a chair to the floor or a dinner plate to a table. This is not the case. A present-day denture does not merely rest upon its mucosal base; it is attached to it, as veritably as the mucosa is attached to the underlying bone. The difference is that in one case the attachment is fixed and in the other it is not fixed. That is, a denture can be detached, although I heard not too long ago of a lower denture that stuck so tight to the lower jaw that the patient was unable to remove it and the dentist had to give two mandibular injections in order to loosen it. That, of course, is an unusual case. Ordinarily, the lower denture surely can be detached and often is when we don’t want it to be. When an object is attached to a base, the base may be employed to support or suspend the object. The dead weight of the lower denture is supported by the lower base. The dead weight of the upper is held in suspension by the upper base. When the force is directed toward the base, the base is used to support the object. When the force is directed away from the base, the base is used to suspend the object. A base, to support an object, must be hard and unyielding, possessing compressive strength. A base, from which to suspend an object must be tough, possessing tensile strength.

STRATEGY OF USING SOFT TISSUE

Our strategy should be to use mouth tissues to support the denture rather than to hold the denture by suspension. Only in the event that this is not possible should the denture be suspended from mouth tissues. If the plan is one of suspension, then the soft border tissues are useful. A denture may be supported, suspended, or sustained by the mucosal base in one of three ways: (1) A denture is supported when the force is basewise and perpendicular, resulting in compressive loads. (2) A denture is suspended when the force is counterbasewise, resulting in tensile loads. (3) A denture is sustained when the force is basewise in one area and simultaneously counterbasewise in another area. This results in compressive, tensile, and shear stresses. To reiterate, it is more descriptive of the situation to say that a denture is attached to the mucosa than to say that the denture rests on the mucosa.

MEANS OF ATTACHMENT

What are the means of attaching a denture to the mucoperiosteum? The means are the forces of: (1) interfacial surface tension, (2) atmospheric pressure, (3) a combination of both. By means of the interposed salivary film, a denture is attached to the mucosa, as two pieces of moistened glass would be attached, through interfacial surface tension. By means of rarified air spaces between the denture and the mucosa, a denture is attached to the mucosa, as a suction cup is attached to a windshield of a car, through the force of atmospheric pressure. Carrying a large deep air chamber in the middle of the hard palate, a well-adapted denture is attached to the mucosa through both the forces of surface tension and atmospheric pressure.

In function, atmospheric pressure is superior to interfacial surface tension as a retentive force, for forces horizontal as well as parallel to the mean mucosal plane are resisted. Interfacial surface tension will resist only forces perpendicular to the axes of surface tension forces.

ATMOSPHERIC PRESSURE—SURFACE TENSION

And yet I would not recommend the use of atmospheric pressure to secure attachment. These are my reasons: (1) Attachment through atmospheric pressure is usually transient, for air chambers and reliefs tend to fill in with tissue or saliva. This is understandable when one considers the mucous glands that line the palate and the possibility of moisture seepage. The continued existence of rarified air spaces is precarious under these circumstances. (2) The resistance to detachment by horizontal forces that vacuum chambers and reliefs provide may not prove physiologic to alveolar bone. Forces parallel to the mean mucosal plane will always result in displacing the mucosa, even though the denture is not detached.

MUCOSA CONTACTED BUT NOT CONTAINED

It is well to keep in mind that mouth tissues including the mucosa may be contacted, but it can hardly be said that they can be contained. A denture cannot act as a container for mouth tissues in the same sense that a hypodermic syringe acts as a container for the anesthetic solution.

If a denture could contain soft tissue as a syringe contains the solution, then this would be the solution of the full denture problem. For then Pascal’s laws would apply—namely, (1) that any substance, no matter how fluid when enclosed in a rigid container, takes on the same rigidity as that container, and (2) that pressure applied to a confined liquid is transmitted undiminished to all parts and acts in all directions. If tissues could be contained as well as contacted, then all our program of...
preventive prosthetics, where we endeavor to salvage as much alveolar bone as possible, would be a waste of time. For, if a denture could serve as a true container of mouth tissues, then it would follow that soft tissue would be as good as bone in stabilizing a denture. And every practitioner knows from bitter experience that this is not so.

MUCOSTATIC SCHOOL

Let me again say that no one can quarrel with the facts cited by the mucostatic school of thought. It is the application and interpretation of these facts that we wish to question. In my opinion, Mr. Harry Page and those associated with him have rendered a valuable service to prosthetic dentistry in their provocative announcements. It is natural for anyone who has discovered an important truth to conclude that it is all the truth there is. The crux of Page’s announcement is this: Soft tissue should be registered in an impression in unstrained rest position—any other position will compel tissue to try to regain its rest position—this leads to dislodgement of the denture. He does not seem to comprehend that there are forces that can displace the mucosa without disturbing tissue contact with a denture. A denture may move with the mucosa without being detached from it.

Free movements of tissue are limited by two factors: (1) its thickness, (2) its rigidity. Thickness and rigidity are in a state of constant flux depending on fluid content and the stresses applied to tissue. The mucostatic school argues that soft tissue has permanent shape. This is a half-truth. It has a definite shape at any given time and when distorted will attempt to regain it. But this shape is not permanent—tomorrow it may have a different shape.

Mucostatics contends that all tissue acquires rigidity of form when completely contacted. This would be true if mucosa had no thickness which, of course, is inconceivable. As long as the mucosa has thickness, its rigidity of form is conditioned by other factors than complete contact with the denture base. It is conditioned by the point, magnitude, and direction of masticatory forces applied to it.

ALVEOLAR BONE

Mucostatics has little to say about bone—it concentrates upon soft tissue. It is interesting to me because my emphasis has been alveolar bone and its preservation. We have maintained that the primary prosthetic problem is the preservation of alveolar bone. Preserve alveolar bone, and the soft tissues will take care of themselves. Whether a denture is suspended from the mucosa or supported by it is important and not irrelevant as Page contends. This relevancy concerns itself with this fact—all bone and especially cancellated alveolar bone is more resistive to compressive loads than to tensile and shear loads.

After mucosal displacement, a strained equilibrium is established, and alveolar bone is subjected to tensile and shear stresses. In the human skeleton, Nature provides us with no instances where a mass of cancellated bone is used for any other purpose than that of resisting compressive forces. This thought is discussed at length in a published manuscript.

FORCES OF RETENTION

Retention begins with the impression. It depends primarily on the forces that produce attachment of the denture to the mucosa. These forces include adhesion, cohesion, and surface tension. Mucostatics dismisses adhesion and cohesion as factors in retention, the entire phenomenon being attributed to interfacial surface tension. An analysis of the problem would prove beyond doubt that if it were not for the forces of adhesion, the sticking together of unlike molecules, and cohesion, the sticking together of like molecules, the force of interfacial surface tension would not exist. For example, if you cannot wet a surface, which means that molecules of H2O will not adhere to the molecules composing the surface, then surface tension is out of the question. Attachment of a denture to the mucosa is possible because both tissue and denture base materials can become wet, which means that its molecules will adhere to H2O molecules. For example, two pieces of glass will not stick together if instead of moisture, mercury is placed between them. The reason is that the mercury molecule is not adhesive to glass. Likewise, if it were not for the force of cohesion, the interposed salivary film could manifest no adhesion. For, if like molecules did not stick together, then they could not exist in sufficient mass to stick to anything else.

My interpretation of retention is that, as a rule, it is not due to atmospheric pressure, even though a peripheral seal and roll may enhance it. Atmospheric pressure plays a roll in retention only when a vacuum chamber or a relief is present and the vacuum chamber or the relief is not filled with tissue or saliva. When the denture moves under masticatory loads, the function of border tissue and roll is to enable the border tissues to follow the movement and thus keep out saliva, as well as air. If adhesion fails, that is, if the denture is detached and dislodged, it is probably due to extreme torque and failure of the border tissues to maintain contact. In the presence of mucosal torque, a relief in the palatal area will help retention. Palatal relief prevents the vault from acting as a fulcrum and permits the denture to shift bodily, the movement being more translatory than rotary. Rotation puts more strain on retention than translation. As far as retaining a denture is concerned, it is more advantageous to permit the denture...
to shift bodily than to set up a lever action. When the denture shifts bodily, that is, shifts horizontally, the check on the working side comes to the rescue and helps to stop the movement. But if the denture moved vertically with the teeth apart, there would be nothing but retentive forces to rescue the denture, nothing to resist the movement. Under that circumstance, there would be a greater movement of the denture and consequently a greater need of the border tissues to follow the movement.

FACTORS IN STABILITY

Stability begins with the impression, by the avoidance of noticeable displacement in ridge-vault areas. The impression, however, is a minor factor in the problem of stabilizing a denture. The important problems are the following: (1) the inclination of the flanges, (2) the form, size, and arrangement of the posterior teeth, (3) the position of the posterior teeth in relationship to the foundational center, (4) the form of the polished palatal surface. In fact I deem these factors, which lead to a stabilized denture, so important that it is a rule with us never to take constructional impressions until these factors have been determined in advance. This information is established through diagnostic impressions and diagnostic denture models. During function, if the above-mentioned factors result in an essentially vertical seating force, then impression registration with the mouth tissues reasonably at rest is in order. We then endeavor in the constructional impressions to minimize tissue displacement in heel-flange areas as well as in ridge-vault areas. Post damming and high thick flanges with peripheral seal are avoided.

If we must, for one reason or another, compromise with the factors that lead to stability, then we know that mucosal-displacement during function is inevitable. We ought then to be concerned with retentive forces that will rescue the denture from dislodgement during use. Under these circumstances, the impression should register some degree of displacement, especially at the borders. This will result in: (1) higher and thicker flanges, (2) snugger borders including an effective post dam. This will eventuate in a peripheral seal which will better prevent dis-lodgement. However, it should be recognized that function under these circumstances is inimicable to alveolar bone preservation. Bone atrophy necessitating periodic refitting and rebasing of the denture is to be expected.

PREVENTIVE PROSTHETICS

A program of preventive prosthetics must commence with rest registrations of ridge-vault areas. Impressions containing such registrations must be combined with occlusal working units so shaped and placed that the resultant flange inclinations will help seat the dentures during function. In fact, it may be said that the prime requisite of artificial teeth is to help support the denture. For only when dentures are supported and seated in function will the teeth be able to prepare food physiologically.

IMPRESSIONS ONLY ONE PHASE OF PROBLEM

This approach to the subject of impressions makes obvious the inadequacy of dealing with the impression problem as though it were a separate entity. A rest impression merely assures an absence of tissue displacement during rest periods when neither teeth, tongue, lips, nor cheeks are forcefully contacting the dentures. This is important, for rest periods are prolonged periods. However, we should be clear in our prosthetic thinking. During function, rest registrations are impotent to prevent tissue displacement by horizontal forces. To reiterate for emphasis, it is not a question of the mucosa within the denture outline being displaced, but rather of the entire mucosal mass moving laterally and antero-posteriorly.

In the presence of inclines of both form and arrangement, there will be a horizontal component parallel to the base plane and thus capable of displacing the mucosa en masse. To prove this point, grasp any denture between thumb and index finger, press it back and forth and from side to side. You will experience no difficulty in moving the denture regardless of how the impressions were taken.

A MATHEMATICAL APPROACH

Rest registration of ridge areas is important in attaining stability, but to conclude as some do that this is all there is to the quest of stabilizing a denture is, to say the least, an oversimplification. In fact, horizontal stability is impossible in the presence of horizontal forces. This becomes clear as one considers the nature of the denture seat in the light of Synge’s mathematical analysis.3 Synge, a mathematician, working with Dr. Box of Toronto, has advanced a theory that explains tooth mobility better than any other theory yet conceived. As to Synge, the increase in displaceability of an incompressible membrane placed between two rigid bodies is directly proportional to the cube of the increase in thickness, or to the cube of the decrease in rigidity. His calculations were concerned with the periodontal membrane and tooth mobility. Yet there appears no reason why his conclusions are not equally applicable to account for mucosal displaceability in the presence of horizontal forces.
COMMENTS ON NATURAL AND ARTIFICIAL DENTURES

There is greater similarity than we commonly suppose between natural and artificial dentures. Both are attached to bone, one by means of the periodontal membrane, the other by means of the mucoperiosteum. The presence of roots with the natural denture, the absence of roots in the artificial denture is not their essential difference. The backbone of their difference is the difference between the periodontal membrane and the mucoperiosteum—their difference in thickness and rigidity. The crux of the entire problem lies in the fact that, the periodontal membrane can resist displacement much more readily than the mucoperiosteum. A conservative estimate is that the natural organ is 216 times as resistive to displacement as the artificial. If we arbitrarily assume the mean thickness of the edentulous mucosa to be five times that of the periodontal membrane and its rigidity to be one-half, it will follow that 1/216th part of the force required to displace a natural tooth will displace an artificial denture. That is, the stabilizing capacity of the mucoperiosteum in the presence of a horizontal stress component is only 1/216th part of the stabilizing capacity of the periodontal membrane. This figure is really an understatement. Even at that, the differential is enormous.

TISSUE REGISTRATION

A registration other than at rest should be for purposes of expediency only, for alveolar bone is best preserved with rest registrations. But, in the everyday practice of prosthetics, many cases will present themselves where rest registrations will not suffice to effect retention and comfort during chewing. It may be necessary to register in the impression a certain degree and direction of tissue displacement, this, in anticipation of dislodging forces during function.

Rest registrations in the impression must be combined with flange and tooth forms and placement that result in compressive loads. Otherwise the degree of mucosal displacement will be too great and denture dislodgement imminent.

CONCLUSION

In conclusion, let me say that the importance of the impression phase has been overemphasized. Steps essential for retention have been played up while the forces that lead to stability have not received the emphasis that they merit.

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