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ORIGINAL ARTICLE

A Critical Analysis of Complete Denture Impression Procedures: Contribution of Early Prosthodontists in India—Part I

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Dedication to Dr. Udani *Professor Udani founder President of Indian Prosthodontic Society was a distinguished teacher, academician and researcher with highest level of perfection and uncompromising integrity. His communication skills, analytical mind, research acumen, ability to comprehend complex mechanisms, are admirable and unmatched. His dominating influence, didactic expressions with humor, the correct use of language, unforgettable discussions during seminars and thesis preparation as well as in various topics, some even besides Prosthdontics is remarkable. He trained the first generation of postgraduates in our country with these ideals, which laid the foundation of Prosthodontics during its early formative years and elevated the standard of Prosthodontics in India.*

Professor T. M. Udani completed postgraduate degree MScD. in Prosthodontics from the University of Toronto. He was the first person to start M.D.S. course in Prosthetic Dentistry in India in 1959 at the Government Dental College, Bombay. His students were fortunate to have their academic training from this highly scholastic Professor endowed with a rational thinking mind and a commendable critic of the various philosophies in Prosthodontics. This treatise on complete denture impression procedure which dates back to half a Century is a tribute to his creditability as a teacher par excellence. Prof. E. G. R. Solomon who had the opportunity to acquire his writings, presents Prof. Udani's philosophy on complete denture impressions in Part I of this article which is dedicated to his memory for the enlightment of the present and future post graduate students.

Keywords Complete denture impression · Landmarks of edentulous jaws · Biological considerations in complete dentures · Mucostatics

Introduction

Since the beginning of twentieth century much has been written and rewritten about the impression techniques for complete dentures; but the subject has remained as vague and inconclusive. There are several reasons for this. The most important one is that nearly all publications on this subject have an empirical basis. Hardly any research work has been done to prove or disprove the advantages of the various impression techniques. Another reason for the prevailing confusion lies in not recognizing a number of variable factors which are associated with the impression procedure. The number of variable factors associated with the impression procedures are so many that a single standardized technique is not possible. These include a number of impression materials each having their own manipulative qualities; the patients with their individual anatomical variations, and the operator's ability and experience.

Success lies in applying the physical features of impression procedures in conjunction with the biological factors involved. It is not feasible to group all the impression techniques into one rigid compartment but a broad classification is possible. They may be classified as scientific or empiric depending on whether they are based on the knowledge of anatomy. Impression techniques may be divided into closed or open mouth impression depending on the condition of the mouth at that time. Again, they may be better classified as either pressure or non-pressure or selective pressure types of impression procedures depending upon the amount of pressure applied at the time of taking the impression.

Pressure Group

The main objective of this group of impression techniques has been to attain better retention of the denture. The advocates of this group have worked towards that end by incorporating a variety of mechanical measures in their procedures without much regard to the biological aspect. The Green's all compound technique which has been

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described by Lieberthal [1] is an example to it. A great amount of variation is possible in this technique.

1. Some have taken a preliminary impression in a metal tray and instead of making special tray they have preferred to remove the compound impression from the metal tray and use it both as a tray and an impression to be improved by muscle trimming. This may be considered a short cut but it is liable to yield poor end result.
   There are others who prefer to make a special tray in more stable and stronger material than compound for better results. Special trays were made out of sheet metal or cast in metal. The use of shellac or a compound baseplate tray is certainly objectionable especially when thermoplastic materials like compound are used under biting pressure. Stronger and more stable trays with PMA resin should be preferred.
   In the technique described above the special tray has been made without any spacer on the cast. This special tray without any spacer exerts a considerable amount of extra pressure on the tissues when a compound impression is taken. Allowance for the space is a better procedure.
2. In all closed-mouth impression procedures usually compound bite-rims are made, but in some procedures a centre bearing point has been used. There are still others who do not use biting pressure but take pressure impressions by an open mouth method. Sometimes the disadvantage of closed-mouth impressions is the difficulty in controlling the extent flow of the impression material especially around the tuberosity areas and lower lingual areas. The closed-mouth impressions press and displace the soft tissues more than the open-mouth techniques. Impressions obtained under pressure are thrown back by the elastic tissues when the pressure is relieved.
3. Relief in the hard areas is obtained in a number of ways. Some special trays are made with escape holes in areas overlying the hard tissues and close adaptation is provided in those areas covering very soft tissues. Certain other techniques advise scraping the impression. If it is of plaster, the impression itself is scraped on the hard areas whereas other materials such as compound or Zinc oxide-Eugenol paste require relief on the cast. Some methods employ both measures to achieve the result.
4. Muscle trimming is done in a variety of ways. Most people use low fusing compound stick for this purpose. This needs both care and experience to achieve reasonable efficiency. Some of the techniques advocate a number of exaggerated *unnatural movements of the mouth along with massaging of the cheeks and lips from outside during muscle trimming. Natural movements of the mouth made by the patient and aided by judicious use of peripheral molding from outside is all that is necessary*.
   Post-dam or palatal seal is obtained in a number of ways. The addition of soft wax like carding wax or low-fusing compound for this purpose is common. Scraping the cast is also liberally used. Some techniques employ both. Post-dam obtained in the mouth by the addition of wax or compound is superior to the arbitrary scraping of the cast.

The claims made by the advocates of this group of impression techniques are that when muscle trimming is done the border tissues are recorded in their functional positions and not in their rest positions, and so the dentures cannot be dislodged during any functional movements of the jaws. Moreover a positive peripheral seal is obtained by this procedure.

Ill Effects of Excessive Pressure

These claims are true, but experience has proved that the excess amount of pressure applied to the tissues during all these mechanical means of achieving better retention is not only too great but is applied to the denture bearing areas and the peripheral tissues; which are not well suited to receive the maximum biting load. This interferes with the normal blood supply of those tissues resulting in their breakdown. As soon as this change takes place both the peripheral seal and the excellent retention are lost. The retention achieved by these means is transient and harmful to the health of the tissues. Excessive pressure in any form especially by arbitrary means of scraping or grooving the cast must be discouraged. Certain impression techniques have made use of these means of attaining retention and have made such fantastic claims for their techniques that students must be advised against such procedures no matter who recommends them.

Non Pressure Group

This group has regarded adhesion by contact as a safer means of achieving retention rather than by atmospheric pressure obtained by heavy muscle trimming and post-dam. The techniques of this group are based on the principle of safeguarding the health of the denture supporting tissues by obtaining accurate tissue adaptation for adhesion. A typical impression method representing this group is as follows:

1. A compound impression is taken in a suitable tray and a cast is obtained from it. On this cast a baseplate is adapted and trimmed according to the denture outline which has been previously marked. This first baseplate

works as a spacer. The spacer is tried in the mouth for fit and peripheral extension. Over this spacer another baseplate is adapted; it is trimmed and formed into a special tray.

2. A soft ribbon of carding wax is applied at the posterior margin of the upper tray and it is placed in the mouth with slight pressure. The patient is asked to give swallowing movements. A postdam is thus obtained.
3. A small amount of impression plaster is mixed into a smooth creamy consistency and is placed evenly in the tray. The tray is introduced in the mouth and is slowly raised to position and is held with as little pressure as possible. The lip and cheeks are quickly held out of the way while the tray is raised to position. No muscle trimming is advocated, but the soft plaster is expected to mould itself to the relaxed vestibular tissues. The impression is held till the plaster is hardened and is then removed.

Though the procedure is quit simple, a number of variations in the technical steps are possible.

a. Some do not use a spacer for the special tray. Such techniques do exert more pressure than those which do use a spacer. The special trays must be made very carefully otherwise the objective of no pressure would be defeated by over extended peripheries, of any other flaws in its details. Various methods of relief of pressure are used; e.g. a spacer, escape holes, etc. it is difficult to support thin plaster on thin margins of the special tray, so wide and rounded margins should be made.
b. Some techniques use compound instead of wax for obtaining post-dam. Certain other techniques make the post-dam over the final impression. This latter method is not a good procedure because post-dam should be made before the final impression is made. Some techniques do not advocate any post-dam. Post-dam certainly improves retention without injuring the tissues by its pressure provided it is correctly and accurately made.
c. Usually impression plaster is used because it is quick and gives very fine details without tissue displacement. Zinc oxide-eugenol paste and alginate material have been used for similar results. Unless care is taken in the consistency and amount of all these materials, considerable pressure may be exerted by them. The wide latitude in the consistency of these materials should be used to advantage to relieve pressure while taking the impression.

The merit of this group of impression techniques is its high regard for tissue health and preservation. Its disadvantage is that though they attain better adhesion through finer tissue contact, the force is often not sufficient to retain the denture with comfort. Dentures made from a pressure type of impression have much better retention though it is transient. Due to this disadvantage the non-pressure group of impression techniques have not been very popular. They are well-suited to those cases where the residual ridges are sharp, thin, flat, or unhealthy and which cannot take up the normal load.

There is one school of thought belonging to this group that has challenged the basis of the rest of the techniques so much so, that it needs separate consideration. This school is known as the Mucostatic School.

Page [2] first brought out the fact that all soft tissues are chiefly fluid and so behave in a confined state according to Pascals' Law. This law states that any pressure applied to a confined fluid is transmitted undiminished in all directions. Page contended that the soft tissues are confined under a denture so that when pressure was applied to the denture it was transmitted undiminished in all directions. In other words, the soft tissues under the denture assume the same rigidity as that of the underlying bone; i.e. non-compressible. He further said that due to this fact there was no need to cover as large an area as possible with the impression. Nor was there any need of extending the flanges of the denture as far as possible. All that was required was to get an impression of the tissues in their relaxed form. He advocated that the denture flanges should be kept short and thin, enough to prevent lateral skidding of the denture. He considered that the only active force in denture retention was interfacial surface tension. Adhesion, cohesion, and atmospheric pressure had nothing to do with denture retention.

Page's application of Pascal's Law to the field of denture impressions is only partly correct because the tissues involved are not wholly incompressible. His contention that soft tissues assume the rigidity of bone is questionable and therefore his further arguments regarding the area and extent of the denture base cannot be sustained. His claim that retention is a function of interfacial surface tension alone is also doubtful because this tensile force is itself dependent upon adhesion and cohesion. Atmospheric pressure is used for retention in the pressure techniques.

Selective Pressure Group

The pathogenic qualities of the pressure group impression techniques and the difficulty in acquiring adequate retention with the non-pressure group suggested to many men to test the value of combining the merits of both groups by taking impressions in two materials. This probably is the largest group, consisting of a variety of techniques, which have in common the objective of achieving the necessary retention through proper adaptation of the peripheries

having at the same time due regard for the health of the tissues. In other words, the idea of tissue preservation is combined with the mechanical factor of achieving retention through minimum pressure. This minimum pressure is designated as being one within the physiologic limits of tissue tolerance.

An earlier technique representing this group consists of the following steps:

1. A well-fitting tray with a uniform clearance of about 5 mm is selected and a compound impression is obtained with a little muscle-trimming done on its periphery.
2. This compound impression is separated from the metal tray and its peripheral borders are trimmed about 1–2 mm in the areas of muscle attachments. The impression is now tried so that there is enough clearance for the soft tissues to move. The base portion of the impression is scraped evenly to a depth of about 2 mm except in the post-dam region where no scraping is done.
3. The impression is now ready to receive a lining. A sufficient amount of a creamy mix of plaster is spread over this impression and it is placed in the mouth with light pressure. The cheek and lips are lightly patted from outside while the plaster is still soft. This procedure gives a sufficient valve-like seal without exaggerated pressure on the soft tissues.

This is one of the earlier methods. It has been altered and improved in nearly every detail. This method has a large choice of materials, their manipulation and technical details of achieving selective pressure; with the result that a large number of methods have been developed. Many of these are acceptable.

Most of the techniques prefer taking a preliminary impression and using a special tray rather than using the initial compound impression for further improvement. The preliminary impressions are usually taken in compound but materials like alginate and activated resins are also used. The choice of the impression material for the preliminary impression is not so important as the selection of the tray. Special trays are made of different materials. The best ones are those made of cold curing resins which are quick to make and are reliable. The muscle-trimming is generally done by any low fusing compound. *Certain methods advocate the use of three small compound stops in the base area of the special tray before doing the muscle trimming*. This is a good procedure as it prevents the periphery of the tray from impinging on the tissues and it standardizes the relation of the tray to the limiting tissues for every insertion of the tray while muscle-trimming. Post-dam is obtained by several methods. These methods have been discussed previously.

Impression plaster, zinc oxide eugenol paste and elastomers are used as lining materials. The desired qualities of these lining impression materials are; their free flow, smooth consistency, ability of recording fine details, and stability of form and dimension when set. All the three materials have these required merits and so if used with care each would yield equally good results. Relief of pressure is obtained in a variety of ways. The amount of material, consistency of material, use of space or escape holes and the manual pressure with which the impression is made are all possible variables which have been used to advantage by different techniques.

The merit of this group is their aim of achieving the required retention within the physiologic limits of tissue tolerance. These techniques comply with biological as well as physical factors of impression procedure. The disadvantage of this group of impression techniques is the slight and unavoidable amount of tissue loss which follows slowly. This group of techniques is well-suited to cases with healthy well formed residual ridges.

The following are some of the facts which may be observed from the foregoing analysis.

1. Pressure group of techniques is of transient value in obtaining retention and are injurious to the health of the tissues. They should be discouraged.
2. Non-pressure group of techniques are based on safeguarding the tissues health but they lack in obtaining sufficient retention. They are good techniques for cases with thin flat ridges.
3. Selective pressure group of techniques are based on the principle of regarding both the biological as well as the physical factors concerning impression procedure. These techniques are good for cases with well-formed healthy ridges.
4. The unfortunate fact remains that nearly all that has been written about impression procedures has come from empirical knowledge. There is hardly any research, either at the laboratory level or at the clinical level that has been done to clarify many of the accepted statements.
5. The number of variable factors associated with impression procedures are so many that a single standardized technique is not possible. There are many good techniques which are acceptable.
6. In impression procedures the success lies in recognizing the physical factors of retention and stability in relation to the biological factors of the same, rather than in the step by step procedure of any given technique. So any impression technique to be successful can only be designed and developed on the knowledge of biological and physical factors affecting such a procedure.

ANATOMICAL CONSIDERATIONS OF COMPLETE DENTURE IMPRESSION PROCEDURES

Description of the gross anatomy of the tissues encountered in impression techniques is found satisfactory in all standard textbooks of anatomy. Those features which are of special value are mentioned.

Applied anatomy in relation to complete denture impression procedure

In discussing the application of anatomy to impression techniques it is convenient to consider it under the following two main divisions:

I. *Base area of the denture limiting tissues*
II. *Peripheral areas or denture lining tissues*

The Base Area

It is further divided into the residual ridges and the vault of the hard and soft palate

(a) *The residual ridges*

Both the upper and lower residual ridges resorb to a certain extent after the loss of teeth and acquire different shapes. They are sometimes arbitrarily classified as parabolic, broad, square, narrow and few other less common shapes. These divisions are not important although certain shapes help the retention and stability of dentures more than others. *Knowledge of the nature and distribution of the soft tissues covering the residual ridges is of great value in successful planning of the impression procedure*. Normal healthy ridges present varying amounts of soft tissues distributed in different regions, and it varies from individual to individual.

The crests of both the upper and lower residual ridges with the exception of the area of the lower molar slope and the tuberosities of the maxillae are covered with thick fibrous connective tissue. The palatal surfaces of the maxillary tuberosities are covered with soft tissues.

Well attached thick tissues are better able to carry the stresses of dentures than those which are thin and loosely attached. For this reason the crest of the maxillary ridge should be regarded as the primary stress bearing area of the upper denture base and the impression techniques should take this into account. Some impression techniques put maximum pressure on the centre of the palate and on the soft limiting tissues which are not well suited to receive the masticatory load. These are the closed-mouth techniques.

On the mandibular ridge the crest is usually not broad and well formed and the structure of the bone may be more cancellous containing large nutrient canals. Furthermore, the lower denture base is the weaker of the two and therefore the sides of the crest of the ridge and the buccal shelf area situated on both side should be regarded as a primary stress bearing area. The buccal shelf is especially well suited as it is made up of hard compact bone and is more horizontally situated. *Impression techniques which do not cover this area but keep the flanges short are not utilizing one of the important stress bearing areas*.

The Retromolar Region

The lower molar slope or the retromolar pad is a soft area covering several important structures. Underneath this region are the attachments of the pterygomandibular raphe to which the buccinator muscle is attached. Below the buccinator muscle lies the tendon of the temporal muscle. A pad of mucous glands lies superficial to these structures which in turn is covered by the mucous membrane. Due to the soft character of this pad and the presence of active muscles, care should be taken in making the impression of this region. Some techniques advise pressure on this tissue with a view to obtain a post-dam, but it is not a sound procedure because of the nature of these tissues. The mental foramen in the lower jaw is covered by fibrous tissue and in normal cases where the resorption has not progressed very far, it does not require relief.

(b) *The vault of the hard and soft palate*

In the hard palate the anterior rugae zone and the area of the median suture are covered with aponeurotic connective tissue. The remaining area of the hard plate, that is the area bounded by median suture and the crests of the alveolar ridge on either side in the molar region, is covered by tissues having varying degrees of softness. *This distribution of hard tissues in the centre and softer tissues in the sides calls for equalization of pressure to make the denture stable when inserted*. This is achieved by providing relief in the hard areas. There are a number of ways to provide this relief. It is not important how the relief is provided, but it is important that it is made. *The area of the relief will depend on the area of hard tissues and the depth of the relief will depend on the relative displacibility of the soft tissues in comparison with the hard ones*.

This factor of relative displacibility varies from person to person and so it should be judged carefully in individual cases. In some techniques large and deep relief is given in every case. Such procedures are harmful as they decrease the retentive forces and increase the load on the contacting area. The nerves and vessels passing through the greater and lesser palatine foramina are well protected by running

in a groove in the bone and by thick adipose tissue and generally do not require a relief. The incisive foramen lies nearer the crest of the anterior ridge in many cases and so this area needs relief to avoid pressure on the long sphenopalatine nerve and vessels passing through it.

Posterior Palatal Seal Area

The soft palate, besides its musculature, is largely made up of loose connective tissue together with large amounts of adipose tissue and mucous glands. All these structures give it a soft elastic character. This allows a seal to be obtained between the posterior margin of the upper denture and the soft palate. This seal is called the post-dam. There is considerable amount of disagreement in the placement of this post-dam. Most techniques place the posterior limit of the upper denture and the post-dam at the vibrating line. The vibrating line is an imaginary one situated at the junction of the hard and soft palate and also between the movable and immovable soft palate. Some techniques do not extend the denture this far, but end at the posterior margin of the denture on the hard palate. This procedure fails to utilize any advantage of the post-dam at all and is inadequate. In certain other techniques the posterior margin of the upper denture is extended further on the soft palate beyond the vibrating line. This is also unsound as it interferes with the normal functions of the soft palate. Care should be exercised in choosing the amount of pressure for the purpose of post-dam. This will depend on the elasticity of the soft tissues and the antero-posterior contour of the soft palate.

Contour of Soft Palate

The antero-posterior contour of the soft palate may be differentiated into three classes of curvature. In one the soft palate is found to be a more or less straight extension of the hard palate horizontally. Secondly it may take a smooth downward curve a short distance posteriorly from the hard palate, and in the third instance it immediately drops downwards from the junction with the hard palate. *The amount of displacement possible for post-dam is progressively less from the first to the third case*.

Peripheral Areas of the Ridges

Includes the tissues which come in contact with the borders of the dentures except the posterior border of the maxillary denture.

(a) *Peripheral Tissues of the Maxillary Ridge*

In the upper labial vestibule, the lip is attached to the alveolar ridge by a fold of mucous membrane called the labial frenum. Generally this frenum which is along the middle line does not give any trouble with dentures but at times it is attached too high on the crest of the ridge where it causes interference. This frenum does not contain any muscle and so if necessary it may be relieved surgically. From here to the cuspid area the muco-labial fold takes a fairly high curve superiorly and it is smooth and void of any important muscle attachments. The impression should also extend fairly high in this region. Nearing the cuspid or the first bicuspid region there are one or more folds of mucous membrane extending from the ridge to the buccal mucosa. This is known as the buccal frenum. This frenum is rarely ever attached too high on the ridge. The levator anguli oris muscle lies beneath this frenum. An adequate clearance must be made both in height and width in the impression for the free movement of this muscle.

From the buccal frenum posteriorly underneath the mucous membrane of the cheek this region is limited by the zygomatic process of the maxillary bone which projects directly lateral to meet the zygomatic arch. The mucous membrane lining this part of the bone is thin and loose. The buccinator muscle runs here anteroposteriorly in the region of the buccal vestibule. The height of the vestibule as well as the bony surface of the zygomatic process limits both pressure and extension of the impression periphery.

Posterior to this is the region of maxillary tuberosity. The reflection of the mucous membrane here is usually high and allows an extension of the denture margin without interfering with the tissues. In all events the tuberosity must be completely included in the impression. The vestibule from here turns medially to be continued with the oral cavity proper. Behind the tuberosity is a variable fold of tissue which bridges a notch between the tuberosity on one side and the hamular process of the pterygoid plate on the other. This fold of tissue does not contain any muscle or tendon and so pressure can be applied on it for the purpose of post-dam.

(b) *Peripheral tissues of the Mandibular Ridge*

In the lower labial vestibule, the lip is attached to the alveolar ridge usually along the midline by a fold of mucous membrane called the lower labial frenum. Nearly all techniques extend the peripheral border of the impression enough to contact the soft tissues with proper clearance for this frenum. The border of the impression should not be short of movable tissues. In the cuspid region another fold of mucous membrane is seen, which is the lower buccal frenum. The depressor angular oris muscle lies underneath this frenum. This is a muscle of expression and its action varies together with other muscles of expression. An adequate clearance should be made in the impression for its free movements.

Further posteriorly is the region of the buccal vestibule. The space is wide here and is termed the buccal pouch. The base of this pouch is formed by the buccal shelf. The buccinator muscle under the mucous membrane of the cheek lies over this pouch and is attached in the area of the shelf. The external oblique line lies laterally to it and is palpable in the mouth. The impression must be extended on this area of the buccal shelf as this is the primary stress bearing area. A little posterior to the buccal pouch lies a part of the masseter muscle. Sometimes this muscle is too close to the buccal pouch and it then limits the disto-buccal corner of the impression periphery. Some techniques advocate that the impression periphery be tightly fitted to the bone in this region but this is not possible as the buccinator muscle lies between the bone and the mucous membrane here.

The posterior limit of the impression is marked by a fold running vertically from the posterior margin of the lower molar slopes to the pterygoid hamulus. This is the pterygomandibular raphe. Some of the techniques do not include this region in their impression. A few fibres of the superior constrictor muscle come here below the pterygomandibular raphe and make up a part of the retromolar pad. These fibers mark the distal limit of the lingual flange. Many techniques advocate distal extension of the lingual flange over this tissue and further posteriorly. This positively interferes with the action of the muscles, especially the internal pterygoid which is situated distal in this area. Other techniques keep the lingual extension much shorter but this also is not a good procedure as the tongue feels the posterior edge of the denture and dislodges it.

The Mylohyoid Region

The mylohyoid muscle gets an attachment on the mylohyoid line and about a centimeter distal to it. The posterior fibres of this muscle run directly downwards to be inserted in the body of the hyoid bone, whereas the anterior fibres from both sides run almost horizontally and meet in a central raphe. There is great controversy regarding the vertical extension of the lingual flange. Certain techniques keep the flange only up to the mylohyoid line. This is inadequate as the denture margin should always lie on movable tissues. Some other techniques extend slightly over the mylohyoid line but again short of movable tissues. It is difficult to extend the lingual flange much below the mylohyoid line and still keep it in close contact with the tissues. In many cases the bone creates an undercut and the tissues over the mylohyoid line do not tolerate pressure. The lingual flange should extend in the space between the ridge and the tongue well enough to contact the mucous membrane covering the floor of the mouth to get the posterior lingual seal though it may have a space between itself and the ridge. When the tongue is moved to the opposite side or brought forward this space will disappear.

Further anteriorly the fibres of the mylohyoid muscle run across practically in a horizontal plane and the tissues covering the ridge here are thin and so loose that an extension of the periphery is not possible here. Some techniques, put a lingual extension in the form of a rest but this is not a sound practice. Anteriorly in the centre a fold of mucous membrane runs from the ventral surface of the tongue to the alveolar ridge. This is the lingual frenum. The tissues here are very soft and some techniques advocate a lingual seal by applying slight pressure and keeping the denture margin very thick. This sometimes helps but the bulk of the material and collection of deposits of calculus underneath it are the disadvantages of such a procedure.

ALTERED ANATOMY

The most obvious cause of the alteration in anatomical relationship is the resorption of the alveolar process [4]. The initial resorption immediately after the loss of teeth is physiologic in nature. There is a slow rate of continued resorption of the bone throughout the rest of the life of the individual. The exact nature of this delayed resorption is not satisfactorily understood, but it is known that there are certain factors which augment this resorption greatly. Long edentulous periods, diseases, and ill-fitting dentures are some of them.

It is important to recognize these causes of rapid alveolar resorption as they do two-fold harm.

(1) The obvious loss of alveolar bone which is so essential for successful treatment of complete denture patients.
(2) The bone loss alters the anatomical relations of the hard and soft tissues of the jaws.

Mandible

With advanced resorption, the anterior aspect of bone disappears in the region of the lower incisor teeth. This brings both the incisive fossae into a more horizontal plane and the attachments of the mentalis muscles into prominence which in turn limits the extension of the denture periphery in the labial vestibule. The chin looks prominent following this bone loss. The genial tubercles with the attachment of the genioglossus muscle come to lie in close proximity to the crest of the ridge, restricting the denture border lingually, the mental foramen lies nearer to the crest of the ridge. This creates a need for relief of pressure on the nerve and vessels passing through the foramen. Further, the mylohyoid ridge and muscle lie very close to the crest of the ridge.

Maxillae

In the maxilla the comparative changes are less marked, as they provide the larger of the two denture bases. Sometimes the anterior portion of the alveolar bone become reduced and depressed. The resorption in general makes the palate shallower. *Changes in this region following Combination Syndrome should also be considered*.

Bone

Bone forms the foundation for dentures; it is bone that contributes largely to good prognosis and success in our objectives, and so every bit of this tissue is important and must be preserved. Next to enamel bone is the hardest tissue in the human body and at the same time it is one of the most labile tissues. How labile can easily be seen in the action of a coil spring in orthodontic treatment. Unfortunately this quality of plasticity of bone under pressure which is an asset in orthodontic treatment is an unwelcome feature in complete denture prosthesis. *Whatever the impression techniques are used, preservation of bone should be our prime objective*.

PHYSICAL CONSIDERATION OF COMPLETE DENTURE IMPRESSION PROCEDURES

Factors Influencing the Properties of Impression Materials

Scientific progress in the knowledge of dental materials [3] has changed many concepts, theories, and methods of the past and has contributed much in improving both the clinical as well as laboratory procedures.

The following factors are of special interest in impression procedures:

1. Bulk
2. Behaviour under pressure
3. Temperature
4. Mixing ratio of the components
5. Mixing or spatulation
6. Modifiers
7. Humidity
8. Dimensional changes
9. Syneresis and imbibition
10. Setting behaviour
11. Manufacturing process
12. Instruments

Bulk

Large quantities of impression material placed in the mouth can distort soft tissues apart from the other good qualities of the material. Control of the impression material becomes difficult and gagging is a common result.

Behaviour Under Pressure

Impressions are taken with the materials in a semifluid or a plastic state. When these materials are brought under pressure they behave according to certain rules. A plastic mass under pressure exerts greatest pressure in an area farthest from its place of escape. So in a maxillary impression, there is maximum pressure in the centre of the palate; and minimum pressure around its free periphery. This difference in pressure varies with both the confinement and viscosity of the material. These facts can be utilized effectively in impression procedures. Escape holes can be made of different sizes in the tray where relief of pressure is required and the tray can be made to approximate the soft tissues where additional pressure is needed. Conversely, neglect of these facts can deceive the operator.

Temperature

Temperature affects the working properties of most impression materials. The setting time of plaster of Paris decreases with a rise in temperature from 10 to 30°C;

There is little change between 30–50°C and over 50°C the setting time increases [3]. Within limits the setting time of alginate materials decreases with an increase in temperature. Some of the zinc oxide and eugenol paste impression materials are also affected by temperature differences. Apart from affecting the setting time, temperature affects other properties of the materials unfavourably. Temperature is therefore an unreliable factor for the control of setting time.

Mixing Ratio of Components

Plaster of Paris and water, alginate and water, or control solution, and zinc oxide and eugenol in paste form all have a definite proportion for balanced working properties. Within limits an increase of the amount of water in the first two cases and of the eugenol in the third case increase the setting time of the mix and decreases the strength of the hardened material. The reverse is also true. Water added during the mixing of zinc oxide eugenol paste can hasten its setting time.

Mixing or Spatulation

Both rate and time of spatulation of the mix affects the properties of impression materials. Within limits and increase in the rate and the time of spatulation of plaster of paris decreases its setting time and increases the strength. Too prolonged spatulation does the reverse. In zinc oxide and eugenol paste material, the longer the mixing time, within limits, the shorter is the setting time. Either insufficient or over mixing of alginate makes it weaker.

Modifiers

Certain substances when added to the mix of impression materials either decrease or increase their setting time. These substances can be used with advantage provided care and accuracy is observed because they have a critical value of concentration. For example, sodium sulphate at 3.4% concentration acts best as an accelerator for plaster. Either with stronger or weaker concentration, the accelerating effect is not as good and with 12% concentration it acts as a retarder. Sodium sulphate, potassium sulphate, and alums are accelerators while ferric sulphate, acetates, citrates and borax are retarders for plaster of paris. The most reliable accelerator for plaster is potassium sulphate and the retarder is borax. Many accelerators and retarders markedly reduce the setting expansion of plaster. These should be used to advantage.

Humidity

Humidity of the atmosphere or presence of a drop of water in a zinc oxide and eugenol mix will accelerate its setting time too much.

Dimensional Changes

Nearly all the impression materials show either contraction or expansion to a small degree. Accurate control of these dimensional changes gives the best results. Impression plasters exhibit some expansion even though it is controlled by the addition of accelerators and retarders. The greater the amount of water mixed with a given amount of plaster, the greater will be the setting expansion.

Zinc oxide eugenol pastes exhibit a minute amount of contraction. Impression compounds contract considerably.

Syneresis and Imbibition

Both reversible and irreversible hydrocolloids when set exhibit these phenomena. When hydrocolloid impressions are stored in a dry atmosphere they loose a part of their water content and shrink. On the other hand if they are kept in a more humid atmosphere they absorb water and swell up. The former process is known as syneresis and the latter imbibition. Both the changes affect dimensional stability and they must be avoided.

Setting Behaviour

All impression materials set or harden either by a chemical change or by a physical one. In both cases the behavior of setting has a bearing on the possible dimensional stability after the material has hardened. Plaster of Paris sets by a chemical change and it sets en masse. Alginate material also hardens by a chemical change but it does so in layers, due to temperature difference in the portion of alginate in contact with oral tissues and that in contact with the tray. The first layer to harden is the one in contact with the oral tissues and the last one to harden is the one in contact with the tray. Impression compound hardens by a physical change of temperature and so it also hardens in areas depending on the variation of temperature from one place to the other. Both in the case of alginate material and in compound which harden in layers, if the impression is disturbed even slightly while the material is hardening the structural relation from one layer to the others gets disturbed, and strains are introduced in the material. These strains are released later on, distorting the impression.

Manufacturing Process

Manufacturing processes as well as the amount of impurities present in a material affect the setting time of impression materials. Especially, the particle size of plaster of Paris and that of zinc oxide in paste influence their setting time. The finer the particles, the quicker is the set and vice versa.

It is seen here that the properties of the impression materials are not absolute but are relative to the method in which they are handle. For example, plaster and alginate is considered to be a free-flowing non-pressure type of material but it can be made to press the tissues or it may even distort them by a number of physical factors like bulk of the material, its confinement, and the consistency of the mix. *Therefore, a knowledge of the properties alone is not sufficient but a knowledge of the factors which enables one to control the properties is essential for successful results.*

Instruments

The only instrument which directly affects an impression is the tray in which the impression is taken. A variation in the size, shape or the dimensional stability of a tray can help or defeat the objectives of any impression technique. So far as the size and shape of the tray are concerned, no stock tray

can answer these requirements. A special tray is a necessity in every case, irrespective of the technique to be followed. Special trays are made of various materials. Rigidity of a special tray is very important as the stability of any impression can be no better than that of the tray on which it rests. Special trays should be carefully made to fulfill the requirements of each particular technique. Additional features like escape holes, relief of pressure areas, stops and spacer may be made in the tray as required.

Factors of Retention and Stability

The objectives of impression procedures are to record the denture bearing tissues in that condition which will best support and retain the dentures.

Retention as related to artificial dentures is the resistance offered to a force directed at right angles to the seating surface which tends to lift the denture from the supporting surface of the tissues. Stability refers to the maintenance of equilibrium and to the resistance to displacement when the masticatory forces act in general, towards the seating surfaces [4]. Occlusion plays a more important role in the stability of the denture, than the accuracy of surface adaptation. The impression surface though relatively less important, cannot be ignored.

Conditions of the impression surface that influence denture retention and stability:

Retention	Stability
1. Adhesion and cohesion	1. Area of the impression surface
2. Atmospheric pressure	2. Surface contact
3. Interfacial surface tension	

Retention

1. ADHESION AND COHESION
   Adhesion is the force of molecular attraction between the surfaces of two dissimilar materials in close contact. Cohesion is a similar force between the molecules of two surfaces in close contact of the same substances. The force of adhesion in artificial dentures is between the impression surface of the denture and a thin film of saliva, and also between the film of saliva and the tissues. Cohesion is the force between the molecules of the film of saliva. Both these forces vary with the closeness of contact and the area of the contacting surfaces. Therefore in an impression it is essential to achieve maximum area and closeness of contact with due regards to other factors.
2. ATMOSPHERIC PRESSURE
   Normally, atmospheric pressure plays no part in retention of dentures at rest. During function when the denture is lifted slightly, atmospheric pressure acts to seat them again. Smooth, rounded denture peripheries closely adapted to the soft resilient tissues at the height of the vestibule, and the sealing effect of the cheeks and lips on the polished margin of the denture are the main contributors in developing effective atmospheric pressure. It should be remembered that only impression methods which apply pressure within the physiologic limits should be utilized for obtaining this force. Any attempt to enhance it with the help of beading, heavy post-damming or the use of large air chambers will prove to be pathogenic and of transient value. These procedures should never be followed.
3. INTERFACIAL SURFACE TENSION
   This force is exerted by a thin film of saliva interposed between the impression surface of the denture and the tissues. The resistance due to surface tension is greatest when the application of force separating the two surfaces is at right angles to the fluid and it is none when the force is parallel to the film. The force of surface tension varies inversely with the thickness of the fluid film between the interposing surfaces. Here again the closer the contacting surfaces, the thinner will be the fluid film and the better will be the retention.

Stability

1. AREA OF THE IMPRESSION SURFACE
   The larger the area covered by the impression surface without interfering with the musculature the better will be the stability of the denture over the tissues.
2. SURFACE CONTACT
   Apart from the reasons of better retention, the closer the contact between the denture surface and the tissues, the better will be the stability. This calls for equalizing the pressure over the soft and hard tissues during impression procedure. This is achieved by areas of relief on the contacting surface of the denture. It should be realized that the areas of relief deplete the total contacting surface area so far as the distribution of load is concerned and therefore should not be used arbitrarily.

Summary

The biological and physical factors influencing impression procedures have been discussed.

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Author Biography

Professor E. G. R. Solomon a student of Dr. Udani during his M.D.S. course at the Government Dental College in 1962 in Bombay continues in Part II with his contribution to the advancements in impression techniques in the early seventies with the introduction of elastomeric Polysulphide and Silicone impression materials. He was the first to introduce polysulfide and silicone impression techniques for complete and fixed partial dentures in India in 1970. The single stage border molding a term coined by Dr. Solomon was an innovation, first introduced to the dental profession by him at the F.D.I. World Dental Congress in 1974 at London. This technique is a precursor to the BPS system of recording closed mouth impression with silicone.