

Review Article

RESIDUAL RIDGE RESORPTION AND ITS CLINICAL MANAGEMENT AT VARIOUS STEPS OF DENTURE PATIENTS: A REVIEW

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ABSTRACT:

Resorption of residual ridges is a complex biophysical process, if a measured force is applied on alveolar bone, either through natural teeth or through a denture, different effects are observed in different patients. The key to successful denture therapy lies in precise execution of the treatment plan formulated by evaluation of a complete comprehensive history and through examination. Minimum bone height, unfavourable residual ridge morphology, and/or muscle attachments make the situation more challenging. This article reviews about ridge resorption and its management at various steps of denture fabrication.

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INTRODUCTION

RESIDUAL ALVEOLAR RIDGE is the portion of the residual bone and its soft tissue covering that remains after tooth extractions. After tooth extraction, a cascade of inflammatory reactions is immediately activated, and the extraction socket is temporarily closed by the blood clotting. It consists of the denture-bearing mucosa, submucosa, periosteum, and the underlying residual alveolar bone.^[1]

Resorption of residual ridges is a complex biophysical process, if a measured force is applied on alveolar bone, either through natural teeth or through a denture, different effects are observed in different patients. The force in this second situation is subject to the same physical laws, but in addition, the response of the bone is governed by certain physiologic laws.^[2] The size of the residual ridge is reduced most rapidly in the first 6 months, but the bone resorption activity continues throughout life at a slower rate, resulting in the removal of a large amount of jaw structure^[3]

Long-term edentulism and use of ill-fitting dentures usually result in severe resorption. Mandibular dentures often present greater difficulty in achieving retention, stability, and support than do maxillary dentures, primarily due to the increased number of anatomic limitations. Achieving maximum stability and retention may be especially important for older patients with atrophied mandibular residual ridges^[4].

This article reviews, about residual ridge, various types of ridge defect and its management at various steps of denture fabrication.

PATHOPHYSIOLOGY^[5]

It is a normal function of bone to undergo constant remodelling throughout life through process of bone resorption and bone formation is a localized pathologic loss of bone that is not built back by simply removing the causative factors.

Physiologic process of internal bone deposition will be continued even in conditions of external pathologic osteoclastic activity. It has been shown that remodelling takes place in 3 dimensions such that

certain portions of bone becomes narrower to the extent that all existing cortical bone in the area is removed by external osteoclastic activity and is replaced by new cortical layer that is formed by endosteal formation.

Pathogenesis

RRR is chronic, progressive, irreversible and cumulative usually, RRR proceeds slowly over a long period of time flowing from one stage imperceptibly to the next. Annual increments of bone loss have a cumulative effect leaving less and less residual ridge

Order- I Preextraction :The tooth is in its socket with thin labial and lingual cortical plates merged with the lamina dura.

Order-II Postextraction : The healing period includes clot formation and organization, filling of socket with trabecular bone and epithelisation over socket site. The edges of residual ridge are still sharp.

Order-III High, well rounded : The cortical plates are rounded off by external osteoclastic resorption, narrowing of crest of ridge begins and remodeling of the internal trabecular structure takes place.

Order-IV Knife edge : Sharp narrowing of labiolingual diameter of the crest of the ridge with a compensatory internal remodelling leading to a sharp crest of the ridge.

Order-V Low well rounded : Progressive labiolingual narrowing of knife edge ridge leads to widely rounded and lower residual ridge.

Order-VI Depressed : Eventually further progression of resorption leads to a flat, depressed ridge.

The resorption phase lasts about 8-10 days, presumably the life span of the osteoclast after completion of one resorption lacuna, the osteoclast can move along the bone surface and start resorption or undergo apoptosis.

The rate of reduction in size of residual ridge is maximum in first 3 months and then gradually tapers off.

Tallgren, Atwood and Coy found mean ratio of anterior maxillary to anterior mandibular RRR was 1:4. Therefore, on an average, RRR is greater in the mandible than in the maxilla.

Rate of RRR differs from person to person, time of extraction site, age and also affects the function of removable prosthesis, which relies greatly on quality and structure of bone.

CONSEQUENCES OF RRR [6]

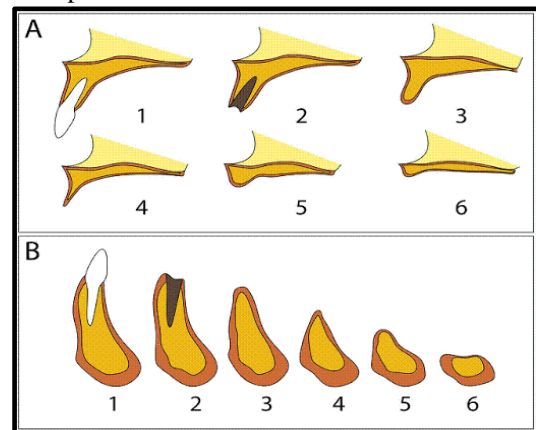
- Apparent loss of sulcus width and depth,
- Displacement of muscle attachment closer to crest of the ridge,
- loss of vertical dimension,
- reduction of lower facial height,
- anterior rotation of mandible,
- increase in prognathism,
- changes in interalveolar ridge relationship,
- morphological changes such as sharp, spiny, uneven residual ridges,

- resorption of mandibular canal and exposure of nerve
- location of mental foramina close to the crest of residual ridge.

CLASSIFICATIONS [6]

a) **Atwood classified residual ridge resorption into: (Fig.1)**

- Order- 1: Pre-extraction Order
- 2: Post-extraction Order
- 3: High, well-rounded Order
- 4: Knife-edged Order
- 5: Low, well rounded Order
- 6: Depressed



(Fig.1)Atwood classification of residual ridge resorption (Aristotle University Medical University, Vol 33,Issue 2,2006)

b) **Neil classified residual ridge resorption in relation with floor of the mouth and mylohyoid ridge-**

Class 1 - 0.5 inch space exists between mylohyoid ridge and the floor of the mouth.

Class 2 - Less than 0.5 inch space exists between mylohyoid ridge and the floor of the mouth.

Class 3 -The mylohyoid muscle is at the same level as the mylohyoid ridge.

c) **Branemark Classification -**

On basis of Bone quality:

Class 1 -Almost the entire jaw is composed of homogenous compact bone.

Class 2 -A thick layer of compact bone surrounds a core of dense trabecular bone.

Class 3 -A thin layer of compact bone surrounds a core of dense trabecular bone.

Class 4 -A thin layer of compact bone surrounds a core of low-density trabecular bone.

d) **American college of Prosthodontics classification based on bone height (mandible only)-**

Class 1 : Residual bone height of 21 mm or greater measured at the least vertical height.

Class 2 : Residual bone height of 16 – 20 mm.

Class 3 : Residual alveolar height of 11 – 15 mm.

Class 4 : Residual alveolar height of 10 mm or less

ACP Classification of edentulous ridge(maxilla)⁷

Type A (most favourable)

- Anterior labial and posterior buccal vestibular depth that resists vertical and horizontal movement of the denture base.
- Palatal morphology resists vertical and horizontal movement of the denture base.
- Sufficient tuberosity definition to resist vertical and horizontal movement of the denture base.
- Hamular notch is well defined to establish the posterior extension of the denture base.
- Absence of tori or exostoses. (Fig.2)



Fig. 2- Type A-Type A maxillary residual ridge.
Type B

- Loss of posterior buccal vestibule.
- Palatal vault morphology resists vertical and horizontal movement of the denture base.
- Tuberosity and hamular notch are poorly defined, compromising delineation of the posterior extension of the denture base. Maxillary palatal tori and/or lateral exostoses are rounded and do not affect the posterior extension of the denture base. (Fig.3)



Fig. 3 . Type B maxillary residual ridge.
Type C

- Loss of anterior labial vestibule.
- Palatal vault morphology offers minimal resistance to vertical and horizontal movement of the denture base.
- Maxillary palatal tori and/or lateral exostoses with bony undercuts that do not affect the posterior extension of the denture base.
- Hyperplastic, mobile anterior ridge offers minimum (support and stability)-of the denture base.
- Reduction of the post malar space by the coronoid process during mandibular opening and/ or excursive movements. (Fig.4)



Fig 4. Type C maxillary residual ridge
Type D

- Loss of anterior labial and posterior buccal vestibules.
- Palatal vault morphology does not resist vertical or horizontal movement of the denture base.
- Maxillary palatal tori and/or lateral exostoses” (rounded or undercut) that interfere with the posterior border of the denture.
- Hyperplastic, redundant anterior ridge.
- Prominent anterior nasal spine. (Fig.5)



Fig 5. Type D maxillary residual ridge
e) Wical and Scoop Classification [8]

On the basis of OPG Radiograph (Fig.6(A-C))

Class 1, up to one third of the original vertical height lost

Class 2, from one third to two thirds of the vertical height resorbed

Class 3, two thirds or more of the mandibular height lost

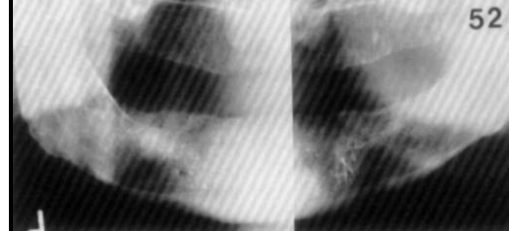


Fig.6A. Class I Wical and Scoop



Fig. 6B Class II Wical and Scoop

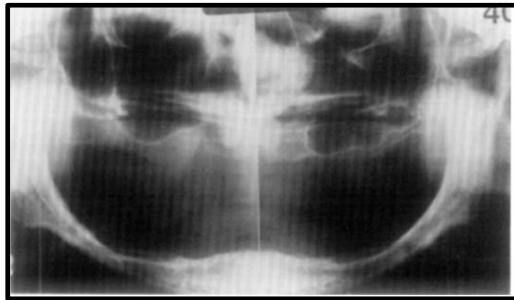


Fig.6C Class III Wical and Scoop

METHODS OF EVALUATION OF BONE LOSS IN RRR

1. Serial examination of diagnostic casts.

2. Lateral cephalometric radiographs- the interocclusal distance amount of resorption can be evaluated .

Advantage- provide most accurate method of determining the amount of residual ridge and the rate of RRR over a period of time. (Fig. 7)



Fig-7: Lateral cephalometric radiograph evaluating amount of resorption by measuring inter occlusal distance

3. Panoramic radiographs- Bone resorption can be evaluated by OPG before the fabrication of dentures and after the follow up of 6 months after the dentures fabricated.(Fig.8)

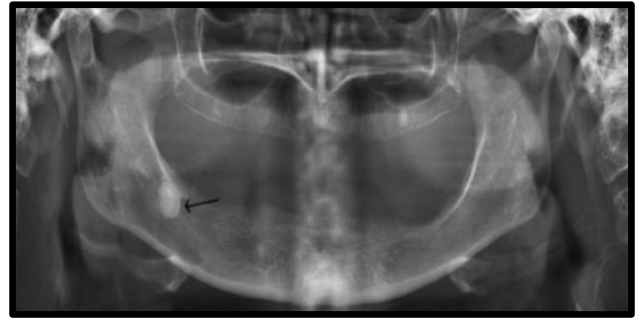


Fig-8: Panoramic radiograph evaluating bone resorption after denture fabrication

A .According to Wical and Scoop-^[8]

Measurements were made on OPG by marking various points. That are lower edge of the foramen, from the inferior border to the upper edge of the foramen, and from the inferior border to the superior border of the alveolar bone .Ratios were expressed between 1. Total height of mandible and amount of bone below the lower edge of the foramen and (2) between the total height and the bone below the upper edge of the foramen. (Fig.9A) The original height is predicted to be approximately three times the height of the bone between the inferior border of the mandible and the lower edge of the mental foramen.

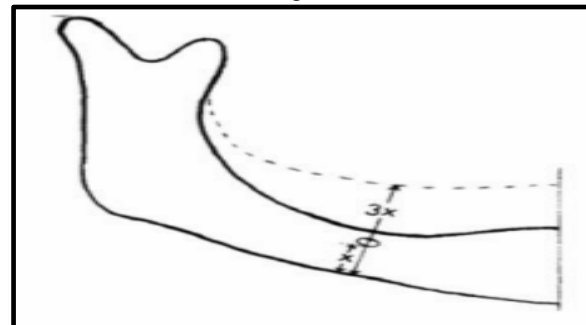


Fig-9A. Wical and Scoop method of estimating the original height. An atrophied mandible is approximately three times the height of the bone between the inferior border of the mandible and the lower edge of the mental foramen

B. According to Wolf et al, For Edentulous jaws.

A reference line (Lo) was drawn joining the inferior points of both the orbits, A line tangent to the mandibular border and the reference line Lo in the maxilla were drawn . According to results from the dentate subjects, 34% of the length of the mandibular body from the midline was approximate to F'P (First premolar) and 53% to FM(First molar) in the mandible (Fig 9B); the infraorbital vertical line and the zygomatic vertical line were approximate to FP and FM, respectively, in the maxilla. The midline was determined by images of the nasal septum, anterior nasal spine, and lingual foramen. The X, Z, and A vertical measurements were made from the alveolar crest. X indicates distances from the alveolar crest to the lower border of the mandible at 34% and 53% of the length of the mandibular body and perpendicular to the tangent; Z is the vertical distance from the alveolar crest to the lower border of the mandible in

the midline; A is the vertical distance from Lo to the alveolar crest. Measurements were performed at the five sites for each jaw and compared at different time interval.^[9]

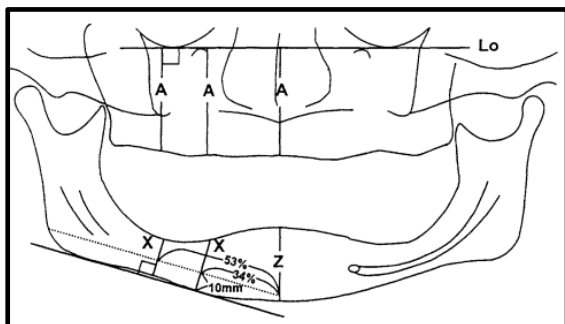


Fig. 9B. Reference lines and measured heights and sites in edentulous jaws.

MANAGEMENT OF RESORBED RIDGES

A. IMPRESSION TECHNIQUE

An impression is an imprint produced by ‘the pressure of one thing upon or into the surface of another’. Recent guidelines from the British Society for the Study of Prosthetic Dentistry (BSSPD) state that the requirements of the primary impressions are that they should accurately record clinical relevant landmarks of the edentulous mouth without excessive tissue distortion. A good impression holds the key to a successful treatment in cases of resorbed mandibular ridges where we have minimum tissue to fulfil the fundamental requirement of retention, stability and support.

PRIMARY IMPRESSION TECHNIQUE

1. Admixed Technique/ Mccord’s Technique-^[10]



FIG.10- Preliminary impression with McCord’s Technique

It has been observed that in cases exhibiting high degree of resorption, more the denture covers the basal seat area, the better the stability of the prosthesis. To gain as much coverage of the basal seat as possible, an admixed technique is advocated .McCord and Tyson’s admixed technique was used for primary impression of flat mandibular ridge. Type I low fusing Impression compound and type I low fusing green tracing stick in the **ratio of 3: 7** parts by weight were placed in a bowl of water at 60°C and

kneaded to a homogenous mass that provides a working time of about 90 seconds. **(Fig.10)**

The philosophy is that a viscous admix of impression compound removes any soft tissue folds and

smoothens them over the mandibular bone;this reduces the potential for discomfort arising from the ‘atrophic sandwich’

- WT- of admix material is 1–2 minutes
- On removal, this impression is chilled in water and then re-inserted.
- **Advantages**
 - Gives reliable guide to the load-bearing potential of the patient’s denture bearing area.
 - The mix of two provides a material which has high flow and thus records the details more accurately.
 - Economical material
 - Easy to manipulate
 - Functional position of muscles are recorded in single step
 - Re usable as thermoplastic
- **Disadvantage-**
 - Over extension of the tray

Admixed Material Using Customized Tray Made Of Orthodontic Wire Technique.

Severely atrophied ridges are a more common finding with the mandibular residual ridges than the maxilla. This is because the mandible resorbs at a faster rate than the maxilla. Achieving maximum stability and retention may be especially important for older patients with atrophied mandibular residual ridges.

Technique-^[11]

1.A 19 gauge orthodontic wire (S.S smith) was adapted on the mandibular ridge in the form of special tray and handle was fabricated with the same wire. The special tray was checked in the patient’s mouth. **(Fig. 11)**



Fig 11: 21gauge orthodontic wire adapted on crest of the ridge)

2. Primary impression for mandible is made using admixed impression. Admixed impression material is loaded around the special tray made of wire and impression is made with all border and functional movements.(Fig.12)



Fig.12: Making primary impression for mandible is made using admixed impression technique

- Material can be heat moulded in case of deficiency of borders and primary cast is made using dental plaster. (Fig.13)



Fig 13. Primary mandibular impression using admixed technique on wire

The muscle attachments located near the crest of the ridge have greater dislocating effect of the muscles. For these reasons, the range of muscle action, as well as spaces into which the denture can be extended without dislocation, must be accurately recorded in the impression.

- **Advantage-**
 - Avoidance of dislocating effect of the muscles on improperly extended denture borders.
 - Ease of fabrication of tray
 - Easy mouldability according to the shape and size of the residual ridge.
 - Customized wire stock tray having an advantage of lower compressibility.
 - Better flow characteristics
 - Recording the functional position of the muscles in a single step.
 - Less chair side time
 - Economical
- **Disadvantage-**
 - Include discomfort due to heat used during functional molding of impression compound
 - Brittleness of the material during scraping
 - Manipulation of impression material on custom stock tray is difficult.

SECONDARY IMPRESSION TECHNIQUE FOR RESORBED RIDGE

1. Conventional Impression technique-Border Moulding using low fusing impression compound and wash impression using ZOE.
2. All green impression technique
3. Elastomeric impression technique
4. Silicone (Light body) impression material
5. Dynamic impression technique
6. Cocktail impression technique
7. Modified fluid wax impression technique
8. Functional impression technique
9. Modified functional impression technique
10. Flange technique

Some of the above mentioned techniques of secondary impression have been discussed below.

- **ALL GREEN IMPRESSION TECHNIQUE**
Aimed to achieve excellent stability in mandibular denture in poor foundation.

Procedure: This technique requires the custom tray to be adjusted optimally in the patient's mouth. The tray itself is fabricated without any spacer after making cast from primary impression.

- Low fusing compound(Green stick) is heated in a water bath loaded in the custom tray. Sufficient material is taken to provide adequate bulk to mould the borders. The loaded tray is then tempered in warm water (55°C).
- Next the borders are shaped with fingers to mimic the borders of the final denture. The tray with low fusing compound loaded is then inserted in position intraorally.
- All border movements are performed like conventional technique. (Fig.14)



Fig.14. Secondary impression with all green technique

- Once the border molding is completed, it has to be checked for retention, stability and support. Best way to check for retention after border molding is complete is to ask the patient to hold the tip of the tongue against the handle of the lower tray and try to pull the tray out. Final impression(wash impression) is made with ZOE or light body.(Fig.15)



Fig.15. ZOE Wash Impression on all green impression

➤ **DYNAMIC IMPRESSION TECHNIQUE-¹²**

Rationale-Avoidance of the dislocating effect of the muscles on improperly formed denture borders. Furthermore, muscle attachments are located near the crest of the residual ridge and, consequently, the dislocating effect of the muscles on the denture is great. For these reasons, the range of muscle action, as well as spaces into which the denture can be extended without dislocation, must be accurately recorded in the impression. Such impressions can be made by means of dynamic methods.

- **The Impression Tray.-** The impression tray has three functions. These are: (1) the tray must not interfere with active muscle movements, (2) the tray must permit a proper thickness of impression material, and (3) the tray should stabilize the mandible in a correct position in relation to the maxillae.
- Fabrication of the special tray is done. A ridge of self-curing resin is built up in the premolar-molar region on each side to support the thermoplastic material. While the thermoplastic material is soft, the tray is placed in position on the lower ridge in the mouth and the patient is asked to close the jaws slowly. (Fig.16)



Fig 16. Custom tray fabricated with cylindrical mandibular rests in the posterior region at increased vertical height

- The upper residual ridge will form an impression in the soft thermoplastic material at a height corresponding to the rest mandible. A tray is removed from the mouth and cooled. Lingually the mandibular rests should be concave to provide space for the tongue.(Fig.17)



Fig.17. High-fusing impression compound was softened, placed on top of the mandibular rests

- Sufficient amount of an irreversible hydrocolloid is mixed with 50% extra water or impression compound using admixed impression technique and material are placed directly into the mouth to cover all tissues. The tray is pressed through alginate by digital force until the stops are firmly seated on the residual ridge. (Fig.18)



Fig.18 Wax spacer was removed, this homogenous mass (admixed compound) was loaded and single step, functional final impression was made by performing functional movements

- Then, the patient is asked to close his mouth slowly until the mandibular rests have obtained firm contact with the maxillae. The patient should swallow three to four times at 10 seconds interval while the final impression material is still in a moldable condition. (Fig.19)



Fig. 19 Final impression using dynamic impression technique

- This procedure develops a registration of the denture space which ordinarily results in a proper extension of the lingual flanges of the finished dentures. Forceful protrusion of the lips brings the mentalis and orbicularis oris muscles into

action and is responsible for forming the labial part of the impression.

➤ **FUNCTIONAL IMPRESSION TECHNIQUE**

Closed mouth functional impression technique was given by **Winkler**.^[5]

- In this technique, denture bases with occlusal rim were fabricated on primary cast. Jaw relations were done to record appropriate horizontal and vertical dimensions.
- Tissue conditioning material was applied on the tissue surface of mandibular denture base and patient was asked to close the mouth in the pre-recorded vertical dimension and do various functional movements such as puffing, blowing, whistling, and smiling.
- Three applications of tissue conditioner material were done at an interval of 8–10 minutes and functional movements were made by the patients.
- Final impression was made with light body addition silicone material with closed mouth technique. (Fig.20)



Fig.20 Functional Impression Technique

Advantages: Better surface contact, Improved retention, Interference due to tray handling is eliminated, Less chances of over and under extension as movement is performed by patient.

Disadvantages: Restriction of tongue movement, Completely dependent on patient.

MODIFIED FUNCTIONAL IMPRESSION TECHNIQUE

- The mandibular primary impression is made with irreversible hydrocolloid in a stock tray modified with putty-consistency elastomeric impression material. The primary cast is poured in Type III dental stone and a tray devoid of spacer or relief wax is fabricated over the primary cast using autopolymerizing resin.
- The crest of the ridge is marked using an indelible pencil and is transferred to the tray via placement of the tray on the ridge. A window is cut in the tray using a straight bur outlining the marked area, corresponding to the crest of the ridge.(Fig.21)



Fig.21 Custom tray with a window on the crest

- The tray is then seated onto the cast, and softened modelling wax is placed into the window, thereby replacing the eliminated acrylic resin, and shaped to form a handle.(Fig.22)



Fig. 22. Softened modelling wax is placed into the window, and shaped to form a handle

- Putty consistency elastomer and tray adhesive on the borders and intaglio surface of the custom tray are placed on the tray. The tray is seated onto the ridge, and the labial and lingual borders are molded.(Fig.23)



Fig. 23 Putty consistency elastomer placed on the tray

- Areas of overextension indicated by exposure of the tray borders are corrected by removing the putty in the corresponding area and trimming the tray. A second application of putty is made over the first, and the borders are molded again. The borders of the impression are carefully re-examined for any over- or under-extensions and are corrected accordingly.(Fig.24)



Fig.24.

Second application of putty is made over the first, and the borders are molded.

- The borders of the impression are trimmed by 0.5 mm using a sintered diamond bur mounted in a micromotor handpiece (Fig.25)



Fig.25. The borders of the impression are trimmed

- The wax handle is removed and the putty material over the window is cut out using a sharp Bard-Parker knife. Light-body elastomeric impression material is loaded into the tray, which is then seated on the ridge. Additional light-body material is then expressed into the window. (Fig.26)



Fig.26 Light-body elastomeric impression material is loaded

- Lingual and facial borders are molded, ensuring the tray remains steady until the impression material sets. (Fig.27)



Fig:27.Final impression with light-body elastomeric impression material

Advantages: Patient friendly and more convenient for the operator, minimal pressure is applied on the crest

of the ridge by providing a window on the custom tray and handle helps in stabilization of the tray and makes it convenient for the operator to handle.

➤ **COCKTAIL TECHNIQUE:** ^(13,14)

The technique described here utilizes the customized tray fabricated according to Dynamic impression. Technique described by **Tryde et al.**

- Impression material recommended by McCord and Tyson's technique for atrophic mandibular ridge.
- Functional impression as in closed mouth impression technique.
- So the word "Cocktail" refers to the combination of different impression techniques to obtain a definitive impression

Technique-

- Preliminary impression is made using patient's previous denture with Irreversible hydrocolloid by open mouth technique.
- Customized tray is fabricated with autopolymerising acrylic resin according to Dynamic Impression Technique. Tray with 1 mm wax spacer and cylindrical mandibular rests in the posterior region are made at increased vertical height.(Fig.28)



Fig.28 .Custom tray fabricated with mandibular rests

- High-fusing impression compound is softened, placed on top of the mandibular rests and inserted in the patient's mouth. Patient is advised to close his mouth so that the mandibular rests fit against the maxillary alveolar ridge. This helps to stabilize the tray in position by preventing anteroposterior and mediolateral displacement of the tray during definitive impression. (Fig.29)



Fig. 29. Impression compound on mandibular rests with maxillary ridge indentation

- Lingual surfaces of mandibular rests are made concave, to provide space for the tongue to move freely during functional movements.
- McCord and Tyson's technique for flat mandibular ridges is followed for definitive impression. Wax spacer is removed, this homogenous mass is loaded and patient is guided to close his mouth on the mandibular rests and functional movements are performed.(Fig.30)



Fig.30. Recovered single step, functional definitive impression

Advantages-Dislocating effect of muscles on the tray is avoided, rest made on the mandibular tray prevents displacement of the tray, better retention, stability, support and economic technique.

Comparison of Different Final Impression Techniques (Fig.31)¹⁵

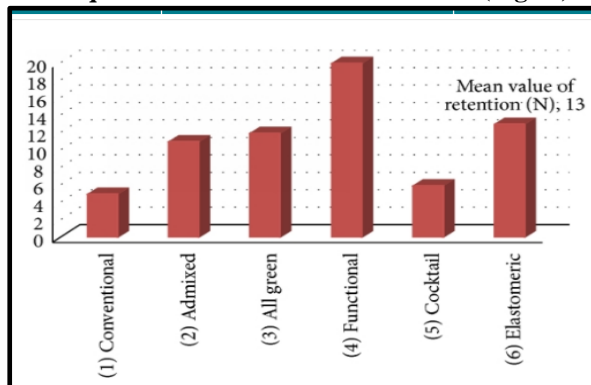


Fig.31 CONSIDERATIONS IN JAW RELATION FOR RESORBRD RIDGES

1. **Generous freeway space should be provided** - It decreases the frequency and duration of functional and parafunctional tooth contacts.
2. **The vertical dimension should be decreased** in order to place the occlusal table closer to the alveolar ridge. (must be decreased towards the weaker ridge - As it creates more stable lower denture by reduction in the height of the denture and also decreases the leverage effect.

3. Neutral zone recording is must-

- The denture which is in harmony with its surrounding musculature provides optimum stability, retention and comfort.

- Posterior teeth will be correctly positioned such that it allows sufficient tongue space.
- Improved esthetics due to facial support

TEETH SELECETION CONSIDERATION

- Monoplane/0° teeth or Semi anatomic/20° teeth must be used-Increases stability and exert less forces on the ridge.
- Decrease in number of dental units 6-6 (short arch concept)- Reduce the force per unit area.
- Decrease buccolingual width- To reduce the force required to penetrate food.
- Avoidance of inclined plane- To minimize dislodgement of denture and shear forces.
- Centralisation of occlusal contacts- To increase stability of denture and maximize compressive forces.
- Provision of adequate tongue room- To improve stability of denture in speech and mastication.

CONCLUSION

The key to successful denture therapy lies in precise execution of the treatment plan formulated by evaluation of a complete comprehensive history and through examination. Such a treatment plan must be based on Devan's principles concerned with rehabilitation that is, preservation of what already exists than the mere replacement of what is missing.^[15] To a large extent, the impression determines the retention and comfort of dentures made for patients with unfavorable residual ridges. Minimum bone height, unfavorable residual ridge morphology, and/or muscle attachments make the situation more challenging.^[4] Various surgical procedures have been advocated to manage the severely resorbed ridges. Surgical reconstruction such as vestibular extension procedures, autologous overlay grafts, osteotomy procedures, alloplastic grafts, and implants have been advocated. However, these are not always feasible due to the patient's compromised health, preferences, and/or financial considerations^[4]

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