

Resorption of Residual Ridges under Complete Denture: Literature Review and Treatment Considerations

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Abstract

Resorption of residual alveolar ridge under a complete denture occurs both in edentulous maxilla and mandible. There are many etiological factors that cause resorption of residual ridges. This long-term effect of dentures over bone is the atrophy of the residual alveolar ridge or what Atwood calls reduction of residual ridges (RRR). Although some authors feel RRR as a normal physiologic process associated with bone remodeling, according to Atwood, RRR is a chronic, progressive, irreversible, and disabling disease, probably of multifactorial origin. The present article reviews literatures concerning with the possible mechanism, diagnosis, etiological factors, and many treatment modalities that will manage and prevent RRR in edentulous patients.

Keywords: Complete denture, Edentulous ridge, Residual ridge resorption.

INTRODUCTION

The glossary of prosthodontic terms^[1] defines residual ridge resorption as a term used for diminishing quantity and quality of residual ridge after teeth are removed (GPT. 8).

Retention, stability, and support are the three fundamental objectives of complete denture treatment and are interrelated with each other.^[2] However, in case of mandibular dentures, residual ridge reduction is one of the main causes of loss of denture stability and retention. Success of lower complete dentures has been a challenge for both dentists and patients. This is due to the fact that the edentulous residual alveolar ridge diminishes in size and shape. The long-term effect of dentures over bone causing reduction of the residual alveolar ridge was first studied by Douglas Allen Atwood and called reduction of residual ridges (RRR)^[3] and discusses it as a major oral disease entity.

DISCUSSION

According to studies by Tallgren, Atwood and Coy,^[4,5] mandibular bone resorption is 4 times greater than in the maxilla. The resorption of alveolar bone is more during the 1 year after the loss of teeth.

During the 1 year after extraction, the amount of RRR is about 2–3 mm in the maxilla and 4–5 mm in mandible. Later, the annual rate of reduction of height in mandible is 0.1–0.2 mm,

and it is 4 times less in the edentulous maxilla. Mean ratio of bone loss of anterior maxillary ridge to anterior mandibular ridge is 1:4. This is because mandibular ridge have to withstand more functional forces through the dentures than the maxillary ridge due to its smaller area and less advantageous shape of the lower basal seat. Hence, Tallgren conclude that this continuing resorption, especially of the lower ridge, is a serious prosthodontic problem.^[6]

Careful superimposition of tracings of cephalograms shows gross reduction of bone in size and shape that occurs on the external surface on the labial, crestal, and lingual aspects of the residual ridge.^[7] RRR shows a wide variety of shapes and sizes of residual ridges. To provide a simplified method for categorizing the most common residual ridge configurations, Atwood classified them as six orders, namely, Order I-Pre-extraction, Order II-Post-extraction, Order III-High, well rounded, Order IV-Knife-edge, Order V-low, well rounded, and Order VI-depressed.

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PATHOGENESIS

The pathogenesis of RRR can be well explained by Atwood's six orders. Immediately following the extraction (Order II), any sharp edges remaining are rounded off by external osteoclastic resorption, leaving a high well-rounded residual ridge (Order III). As resorption continues from the labial and lingual aspects, the crest of the ridge becomes more narrow ultimately becoming knife-edged (Order IV). As the process continues, the knife-edge becomes shorter and even eventually disappears, leaving a low well rounded or flat ridge (order V). Eventually, this too resorbs, leaving a depressed ridge (Order VI).

The pathogenesis of RRR is very simple. Wherever there is pressure, bone resorbs due to activation of osteoclasts. Resorption due to pressure is minimal at the stress-bearing areas of the jaws. Hence, excessive pressure applied to the non-stress bearing areas can produce RRR. Continuous pressure is required for activation of osteoclasts.

Patients wearing complete dentures for more than 5 years had significantly more residual alveolar ridge resorption than was found in non-denture wearing edentulous patients.^[8] Furthermore, RRR is common in patients who wear their dentures continuously overnight.

Ridge reduction occurs at all stages of adult life, but for many years reduction may be insignificant. However, there are two periods when resorption of ridge as well as atrophy of mucosa takes place quickly. The first period is at the menopause and the second is when aging atrophy makes a more rapid onset.^[9] The clinical factors which affect RRR, are organized into four major categories: Anatomic, Metabolic, Mechanical, and Prosthetic.^[10]

1. Anatomic factors – Amount or quantity of bone, quality of bone of the residual ridge, shape of the ridge, and total facial height (TFH).
2. Metabolic factors – Systemic, hormonal, and nutritional and other local factors.
3. Mechanical factors – Amount and frequency of force, duration, and area and damping effect.
4. Prosthetic factors – Type of denture base, form, type of teeth, etc.

Anatomic factors

Quantity of Bone

Although the quantity and quality of bone can determine the rate of RRR, it is not always predictable. The amount of remaining bone is not a good indicator of the rate of RRR, because sometimes large ridges resorb rapidly and some knife-edge ridges may remain with little change for long periods of time. Ultimately when more bone is there, the more will be the RRR.

Quality of bone

Denser the bone, the slower the rate of resorption, because there is more bone to be resorbed per unit of time. RRR is more in cancellous bone region than compact bone.

Shape of the ridge

RRR is more in mandible due to its smaller denture-bearing area; thus, the stress or force per unit area is much greater for the lower ridge than the upper ridge.

Mandibular edentulous ridge is more likely to respond to the various functional forces transmitted through the dentures than the upper ridge due to its less advantageous shape, whereas large well round ridges and broad palates act as favorable anatomic factors for maxilla.

TFH

The study about relationship between the TFH and the vertical facial type (FMA) shows that more women than men are affected by RRR, because women tend to have, in general, smaller skeletons and shorter faces than men. If the Total Face Height [TFH] is more then face will be longer and there is more alveolar bone to be resorbed. So there is less chance for that individual to reach a stage of severe atrophy by wearing dentures.^[11]

Metabolic factors

RRR varies directly with certain local and systemic bone factors. In osteoporosis, osteoblasts are hypoactive, whereas in hyperparathyroidism, osteoblastic activity is unable to keep up with the increased osteoclastic activity. Hence, in RRR, the normal equilibrium may be upset and pathologic bone loss may occur if either bone resorption is increased or bone formation is decreased.

Systemic factors

<1: 1 ratio of calcium to phosphorus occurs in old age due to lack of absorption. When the intake of calcium from dietary sources is less than the metabolic requirements; then, calcium is withdrawn from the skeleton to maintain the critical concentration of the element in the blood and tissue fluids. The primary source of available calcium is trabecular bone, not cortical bone. The sites of trabecular bone which supply mobile calcium are the jaws, ribs, bodies of the vertebrae, and the ends of the long bones.

Resorption may also be due to may also be due to systemic problems like osteoporosis which occurs commonly in old women. Osteoporosis is a common bone disease involving gradual loss of mineral content and mass of the bones. The study by Shelly Singhal *et al.*^[12] showed that the rate of RRR was more in the osteoporotic group compared with the normal group.

Nutritional factors

The results of the study by Wical and Swoope^[13] show a positive correlation between low calcium intake, calcium/phosphorus imbalance, and severe ridge resorption. Lack of hydrochloric acid in the stomach results in non-absorption of calcium in elderly even if when taken in adequate amounts. Secretion of hydrochloric acid is essential for absorption of calcium and phosphorus from small intestine. This gastric acidity is diminished during middle age and become inadequate during old age.

Hormonal factors

The thyroid hormone affects rate of metabolism of cells in general, and hence, the activity of both the osteoblasts and osteoclasts. Parathyroid hormone influences the excretion of phosphorus in the kidney and also directly influences osteoclasts. The relationship between the height of the mandibular residual ridge and the severity of osteoporosis in elderly edentulous patients was investigated. The parathyroid hormone level was high and the calcitonin level was low in the patients with a low residual ridge.

Local factors

RRR is a localized loss of bone on the crest of the residual ridge. Hence, local bone resorbing factors which include endotoxins from plaque osteoclast activating factor, prostaglandins, human gingival bone-resorption stimulating factor, and heparin with mast cells have been observed in microscopic sections of residual ridges close to the bone margin.

Mechanical factors

Change in distribution of force

According to study by Wlodzimierz,^[14] wearing dentures reduces the height of residual ridges. Clinical observations showed that the greatest atrophy of residual ridges appeared at the beginning of denture wearing. Wearing dentures at night enhance atrophy of residual ridges. Bruxism, which often occurs during sleep, could be one of the causal factors.

When the teeth are present, the pressures exerted on alveolar bone are transmitted in the form of tension to the bone by the periodontal membrane. Once the teeth are extracted, the whole distribution of forces is changed. The load is not directed to the entire bone but is applied only on RRR is due to increased abusive forces from a denture. These forces can be studied under four categories:^[15] (a) Amount and frequency of force, (b) duration, (c) area over which force is distributed (force per unit area), and (d) the damping effect.

Amount and frequency of force

RRR is directly proportional to amount of force applied. Apart from normal biting forces abnormal parafunctional activities such as bruxism, clenching, and grinding, put high amount of biting forces which lead to RRR. Biting strength is more in bruxers. Hence, abnormal parafunctional forces from clenching and grinding of teeth which may last up to several hours per day cause more resorption than normal functional mastication.

Duration of force

Wearing dentures at night enhance atrophy of residual ridges. In bruxism, which often occurs during sleep, there is change in direction of force resulting in more osteolytic effect due to the torquing or shearing force. Constant pressure on bone causes resorption, while intermittent forces favor bone formation. Hence, a rest period between meals is beneficial.

Area over which force is distributed (force per unit area)

Maxillary denture has an area of 4.2 sq. in and a projected mandibular denture area of 2.3 sq. in (ratio 1.8: 1). If such a

patient bites with a pressure of 50 pounds, this will be 12 lb/sq. in under the maxillary denture and 21 lb/sq. in under the mandibular denture. Hence, there is a tendency of more RRR in the mandible than in the maxilla.

The damping effect

Damping effect in the oral cavity is provided by both sponginess of mucoperiosteum and the trabecular pattern of the bone. Hence, the maxillary residual ridge is frequently broader, flatter, and more cancellous than mandible. This increased amounts of trabeculations help in increasing the distribution of force and thereby reducing the RRR than mandible. The amount of force applied to bone is affected inversely by the “damping effect,” or energy absorption which depends on mucoperiosteum, cancellous bone, etc.

Prosthetic factors

Any error in fabrication of complete dentures starting from impression procedure, jaw relation recording, try in, curing, or post insertion can cause RRR Type of denture base, form, and type of teeth also affect RRR.

Treatment considerations to prevent RRR

Since RRR is a multifactorial disease, its prevention will depend on the correct diagnosis and management of all of the etiologic factors of the disease.

1. Proper dietary counseling: First emphasis should be the importance of considering dietary factors in the diagnosis and treatment of RRR.
2. Systemic evaluation such as osteoporosis, hyperparathyroidism, and diabetes mellitus is done.
3. Abused tissue treatment therapy like flabby tissue is then considered.
4. Prosthodontic management (impression techniques, occlusal scheme, Teeth selection and arrangement, etc.).

Following prosthetic factors are to be considered:

Denture base should cover the maximum area possible to get maximum retention and support. It should be in harmony with tissues that support it (supporting areas and stress bearing areas) as well as the tissues that surround it (limiting areas and relief areas). Least pressure should be applied over non-stress bearing areas by providing relief in the custom tray and more pressure is applied on stress bearing areas. Covering the retro molar pad where muscle and raphe attachments prevent or reduce resorption, and covering the buccal shelf area is necessary to retard bone loss.

Complete denture occlusion must be developed to function efficiently and with the least amount of trauma to the supporting tissues.^[16] In natural teeth, there rarely is bilateral balance during nonfunctional excursions; whereas, in artificial teeth, it is necessary to stabilize the bases by giving bilateral balanced occlusion. Bilateral balanced occlusion helps to distribute the occlusal load evenly across the arch and, therefore, helps to improve stability of the denture during centric, eccentric, or parafunctional movements. However, in patients with

already resorbed ridge like flat or low well-rounded ridge, other occlusal schemes such as monoplane or linguallized occlusion can be given to improve stability thus reducing further resorption, thus slowing down RRR.

In neutral zone technique there is increased stability of the denture because forces generated by the musculature will not unseat the denture and so there is less RRR. Teeth should be placed as dictated by the musculature, and this will vary for different patients.^[17]

Resorption pattern under soft denture liner on mandibular ridge is seen to be significantly reduced compared to the one without denture liner or conventional hard denture bases. However, cushioning effect of soft liner decreases over time; so, they have to be replaced repeatedly.

CONCLUSION

RRR is chronic, progressive, and irreversible. RRR usually proceeds slowly over a long period of time from one stage to the next. Autonomous regrowth of residual ridges has not been reported. Resorption occurs more rapidly in the first 6 months after extraction of teeth and at a slower pace until 12 months. After this period the rate of resorption progress at slow pace.

The aim and ultimate objective of prosthetic dentistry is to restore form, function, and esthetics of the patient,^[18] and it is more important to preserve what already exists than to replace what is missing. Hence, residual ridge resorption under a denture is better prevented rather than curing because autonomous regrowth of residual ridges has not been reported after RRR. Hence, a prosthodontist should preserve the remaining limiting and supporting anatomical structures of the denture bearing area which is the residual alveolar ridge to a great extent rather than destroying it by its resorption with complete denture prosthesis.

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