

University of Basrah

College of Dentistry

Department of prosthetic dentistry

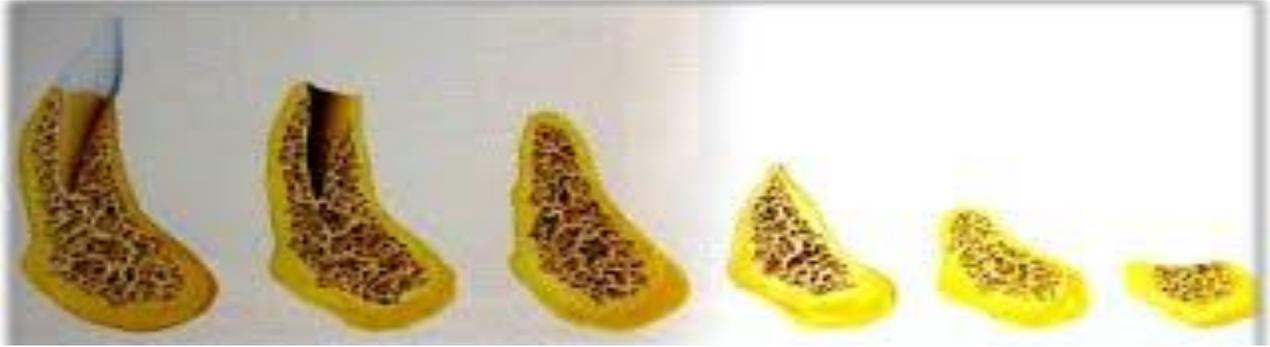
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Residual Ridge Resorption (RRR)

- Alveolar bone: is bony portion of the maxilla or the mandible in which roots of teeth are held by the fiber of the periodontal ligament.
- Residual Ridge: This is a term used to describe the shape of the alveolar ridge after healing of bone and soft tissues following tooth extraction.
- Post tooth extraction, many inflammatory reactions are immediately activated, and the extraction socket is temporarily sealed by blood clotting. Epithelial tissues begin their proliferation and migration within the first week and the disrupted tissue integrity is quickly restored.
- Histologic evidence of active bone formation in the bottom of the socket is seen as early as 2 weeks after the extraction and the socket is progressively filled with newly formed bone in about 6 months, even after the healing of wounds, the residual ridge alveolar bone undergoes a lifelong remodeling. The size of the residual ridge is reduced most rapidly in the first six months, but the bone resorption activity of the residual ridge continues throughout life at a slower rate, resulting in the removal of a large amount of jaw structure.
- The rate of RESIDUAL RIDGE RESORPTION (RRR) is different among persons and even at different times and sites in the same person. Residual ridge remodeling affects the function of removable prostheses. Hence

treatment of edentulous patients requires a maintenance phase that must be carried out throughout the life of a patient. **R.R.R. is chronic, progressive, irreversible, and cumulative.**



- **Structural characteristics of alveolar bone:**

Alveolar bone has two structural characteristics. A hard compact outer layer is superimposed on a spongy somewhat resilient substructure. Beneath the compact bone is the spongy bone. The spaces between the trabeculae communicate throughout the spongy bone. Bone is constantly changing in response to replacement and functional demands.

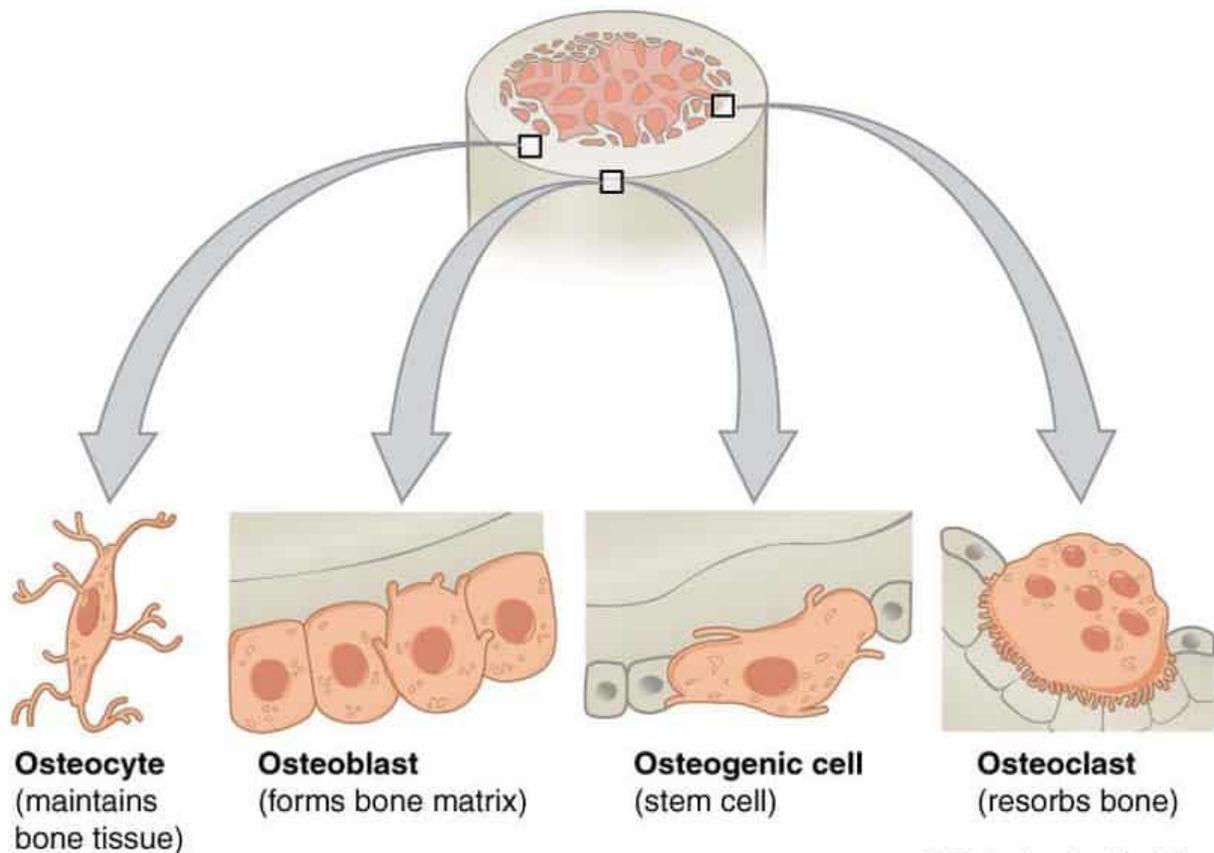
- **The structural elements of bone are:**

1. Osteocytes: These are cells responsible for the metabolic activity of bone.
2. intercellular substance or bone matrix consisting of fibrils or called Calcified cementing substance Mineral salts namely calcium carbonate and phosphates are bound to these protein substances.
3. Osteoblasts: the active bone-forming cells, their function of forming and calcifying the intercellular substance, and surround the bone in a continuous layer. In the course of bone formation, some osteoblasts get engulfed in the intercellular substance and become osteocytes.

4. Osteoclasts: Osteoclasts are the cellular components of bone that are responsible for bone resorption. Bone resorption always requires the simultaneous elimination of the organic and inorganic components of the intercellular substance.

- **Pathology of RRR:**

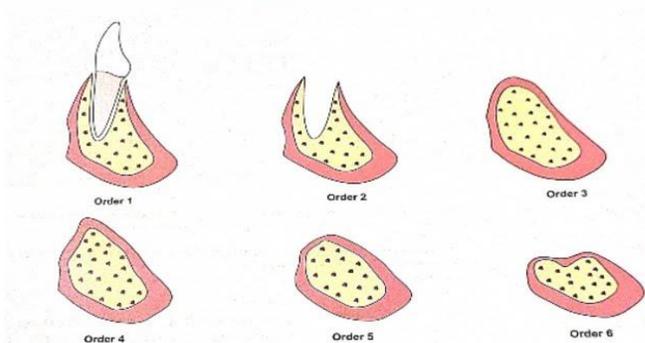
The basic change in RRR is a reduction in the size of the bony ridge under the mucoperiosteum. It is primarily a localized bone structure. Sometimes it may leave the overlying mucoperiosteum excessive and redundant. There exists a wide variety of shapes and sizes of residual ridges.



- They are categorized into common residual ridge configurations in a system of six orders given by Atwood Order:

- A. order 1 Pre-extraction:** The lower central incisor is in its socket with very thin labial and lingual cortical plates with the lamina dura.
- B. order 2 Post-extraction:** The healing period includes clot formation, clot organization, filling of the socket to the height of the cortical plates with new trabecular bone, and epithelization over the socket site.
- C. order 3:** High, Well-Rounded Residual Ridge: The cortical plates are rounded, narrowing of the crest of the ridge has begun, and remodeling of the internal trabecular structure has taken place.
- D. order 4 Knife-edged Residual Ridge:** There is marked narrowing of the labiolingual diameter of the crest of the ridge.
- E. order 5 Low-Well Rounded Residual Ridge:** The result of progressive labiolingual narrowing of a knife-edged ridge is the disappearance of the knife-edged portion. A more widely rounded, but considerably lower residual ridge remains.
- order 6 Depressed Residual Ridge:** Resorption has continued below the level of the genial tubercle

ATWOOD CLASSIFICATION



LEARN EASIER
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DENTAL CLASSES



- **Pathogenesis of RRR:**

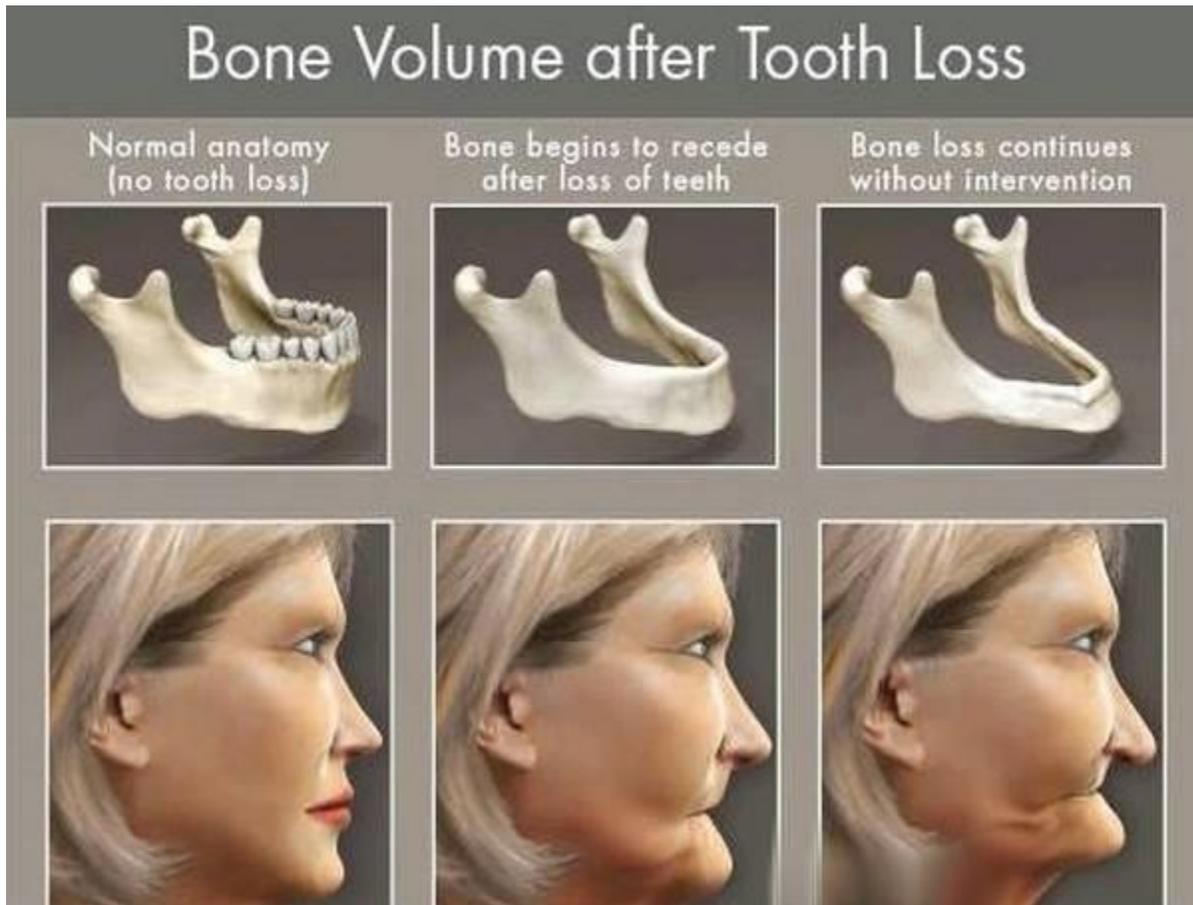
Immediately following the extraction (order II), any sharp edges remaining are rounded off by external osteoclastic resorption, leaving a high well rounded residual ridge (order III). As resorption continues from the labial and lingual aspects, the crest of the ridge becomes increasingly narrow ultimately 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). **RRR is chronic, progressive, irreversible, and cumulative.**

- **According to the American College of Prosthodontists: Based on Bone Height (Mandible only)**

1. Type I: Residual bone height of 21 mm or greater measured at the least vertical height of the mandible.
2. Type II: Residual bone height of 16 - 20 mm measured at least vertical height of the mandible.
3. Type III: Residual alveolar bone height of 11 - 15 mm measured at the least vertical height of the mandible.
4. Type IV: Residual vertical bone height of 10 mm or less measured at the least vertical height of the mandible Direction of bone resorption.

- Maxilla resorbs upward and inward to become progressively smaller because of the direction and inclination of the roots of the teeth and the alveolar process.
- The opposite is true of the mandible, which inclines outward and becomes progressively wider.

- This progressive change of the edentulous mandible and maxilla makes many patients appear prognathic.
- **Thus, RRR is centripetal in maxilla and centrifugal in mandible.**



- **Patterns of bone resorption In the Mandible:**

large proportions of bone loss occur in the labial side of the anterior residual ridge, equally on the buccal and lingual side in the premolar region and lingually in the posterior or molar region.

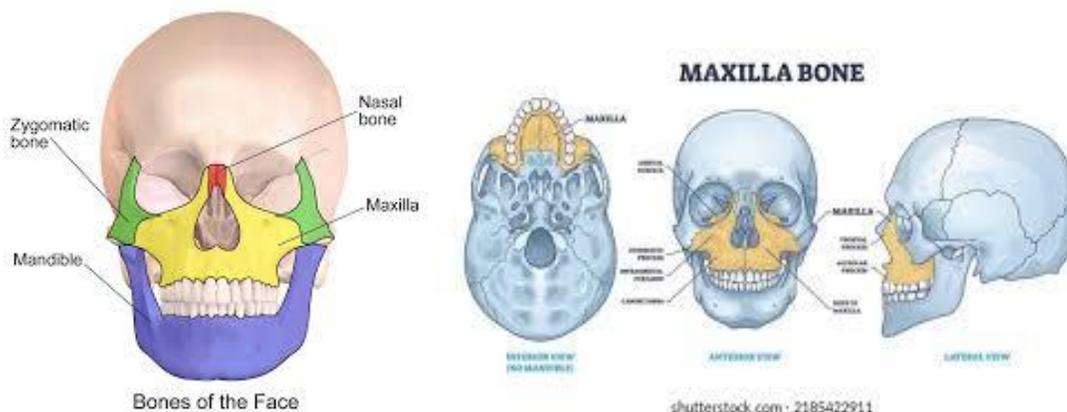
- **In the Maxilla:**

bone loss primarily occurs on the labial or buccal aspect. Therefore, with teeth arrangement, we should try to restore the natural position of the teeth before they are

lost, Hence Teeth in the maxillary arch are arranged slightly labially and buccally. While in the mandible, teeth in the anterior region are arranged labially, on the center of the ridge in the premolar region, and slightly lingually in the molar region.

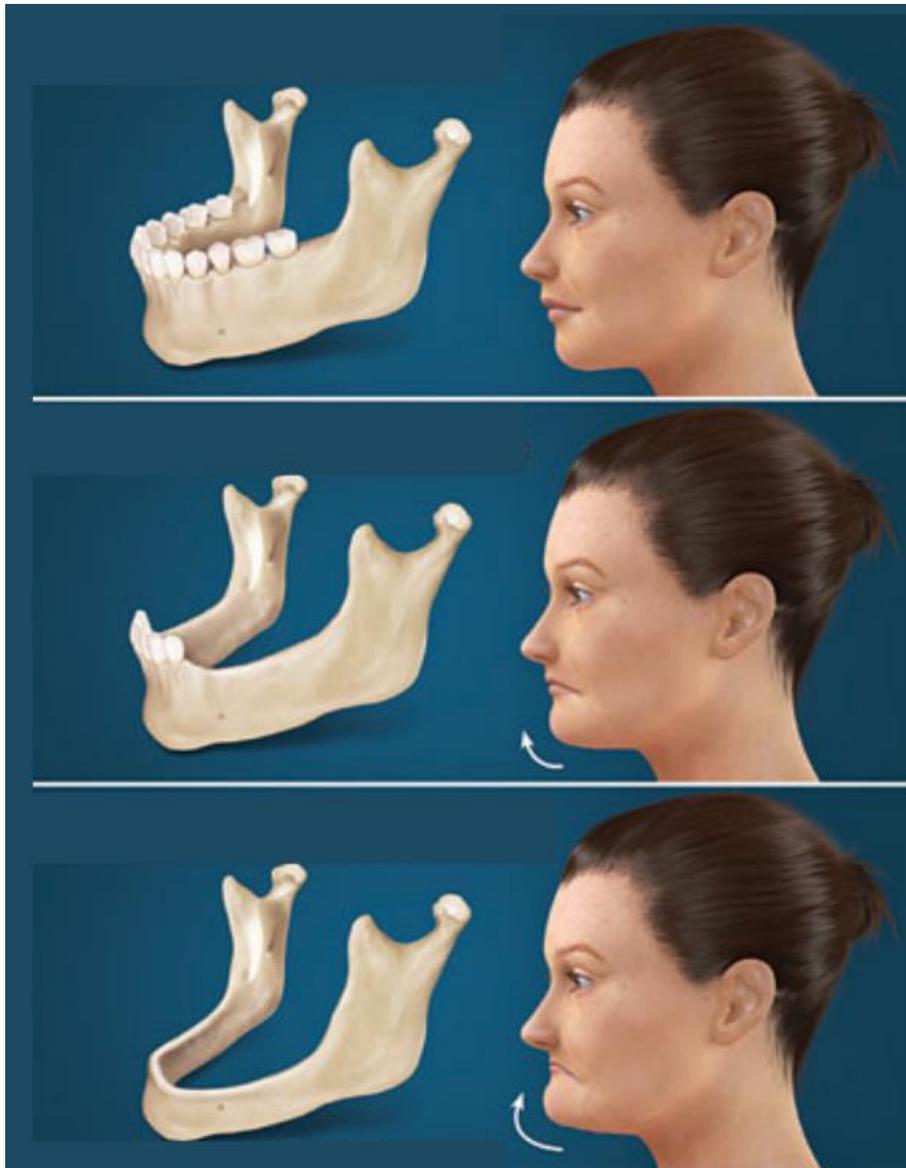
- **Maxilla V/s Mandible**

- It is a clinically acknowledged fact that the anterior mandible resorbs 4 times faster than the anterior maxilla.
- Woelfel et al have cited the projected maxillary denture area to be 4.2 sq in and 2.3 sq in for the mandible; which is in the ratio of 1.8:1. (2-1)
- If a patient bites with a pressure of 50 lbs, this is calculated to be $12(50/4-2)$ lbs/sq in under the maxillary denture and $21(50/2.3)$ lbs/sq under the mandibular denture.
- The significant difference in the two forces may be a causative factor to cause a difference in the rates of resorption.
- Cancellous bone is ideally designed to absorb and dissipate the forces it is subjected to.
- The maxillary residual ridge is often broader, flatter, and more cancellous than the mandibular ridge.
- Trabeculae in the maxilla are oriented parallel to the direction of compression deformation, allowing for maximal resistance to deformation.
- The stronger these trabeculae are, the greater the resistance.



- **Consequences of Residual Ridge Resorption (RRR)**

1. There is an apparent loss of sulcus width and depth.
2. Muscle attachments are displaced closer to the crest of the residual ridge.
3. Due to loss of VDO lower face height is reduced and the mandible is rotated anteriorly.
4. The patient may develop a habitual prognathic appearance. The inter-alveolar ridge relationship is altered.
5. Morphological changes in residual ridge may appear such as sharp, spiny, uneven residual ridges.
6. Resorption of the mandibular canal wall and exposure of the mandibular nerve.
7. Location of the mental foramina close to the top of the mandibular residual ridge.
8. Residual ridge resorption provides serious problems to the clinician on how to provide adequate support, stability and retention of the denture.



- **ETIOLOGY AND FACTORS AFFECTING RESIDUAL RIDGE RESORPTION (RRR):**

RRR is a multi-factorial, biomechanical disease that results from a combination of anatomic, metabolic, and mechanical determinants. These factors vary among patients.

- 1. Anatomic Factors:**

RRR Anatomic factors as the amount of bone and quality of bone.

A. Amount of Bone: Some large ridges resorb rapidly and some knife edge ridges may remain with little changes for long periods. Although the broad ridge may have a greater potential for bone loss, the rate of vertical bone loss may be slower than that of a small ridge because there is more bone to be resorbed per unit of time and because the rate of resorption also depends on the density of bone.

B. Quality of Bone: The denser the bone, the slower the rate of resorption because there is more bone to be resorbed per unit of time.

2. Metabolic factors:

RRR varies directly with certain systemic or localized bone resorptive factors and inversely with certain bone factors formation. General body metabolism is the net sum of all the building up (anabolism) and the tearing down (catabolism) going on in the body. In equilibrium, the two antagonistic actions (of osteoblasts and osteoclasts) are in balance. In growth, although resorption is constantly taking place in the remodeling of bones as they grow increased osteoblastic activity more than makes up for the bone destruction.

3. Hormonal Factors:

A. Pituitary Glands and Hypophysis and Thyroid Glands They are responsible for the regulation of the rate of metabolism. Hyperthyroidism increases the metabolic rate leading to negative nitrogen balance. Such a balance is equivalent to protein deficiency, which can be a direct cause of osteoporosis. Thyroxin also has a direct influence on the kidneys, causing an increased excretion of calcium and phosphorus. This depletion of calcium and phosphorus results in decreased bone apposition and increased osteoclastic activity.

- B. Parathyroid Glands: Parathormone maintains blood calcium by mobilizing it from the bones through osteoclastic activity.
- C. Islets of Langerhans: The failure of these glands to produce sufficient insulin for proper utilization of glucose causes diabetes mellitus. The syndrome of poor healing, low tissue tolerance, and rapid resorption of bone is associated with diabetic patients.
- D. Suprarenal Glands: The adrenal cortex produces steroid hormones called corticoids. The prolonged use and administration of such steroids are considered very dangerous to bone tissue. However, one of the beneficial effects of corticoids is to control the defense mechanism of inflammation.
- E. Gonads In general, the sex hormone (androgens and estrogens) promotes a protein anabolic action on all tissues including bone

4. Dietary Factors:

Food is classified as proteins, carbohydrates, fats, vitamins, and inorganic elements.

- A. Protein** is necessary to build and maintain tissue and to supply energy. The synthesis of osteoid tissue in protein-starved people is compromised and calcification is decreased since the protein matrix is embarrassed. Inadequate incorporation of protein in diet (3 ounces/ day) will cause slow growth of bone. Bone apposition cannot keep up with normal osteoclastic activity and a negative bone factor exists.
- B. Vitamins** The action of vitamins in many respects is said to be the same as that of hormones. The relationship between vitamins and hormones can be explained on the basis that the endocrine glands produce intrinsic hormones and the vitamins are extrinsic hormones.
 - Vitamin A: A deficiency of vitamin A may result in poor development and calcification of bone. Prolonged deficiency of vitamin A causes

renal damage by 10 horriffication of tubules, which then lose the capacity to reabsorb phosphorus. The imbalance of the calcium: phosphorus ratio leads to osteoporosis.

- Vitamin B complex is necessary for bone cell metabolism.
- Vitamin C: Lack of vitamin causes decalcification of the bone and has been held responsible for diffuse alveolar atrophy. The apposition of new bone slows down dramatically because osteoblastic activity is impaired. The collagen content of bones is also reduced in vitamin deficiency. The periosteum thickness and the cells appear immature and resemble fibroblasts. This condition may make the periosteum easily prone to injury by the denture base.
- Vitamin D: The calcium-phosphorus balance must remain within tolerable limits. Vitamin D would be unnecessary if the exact required ratio of calcium and phosphorus were available in the diet. When bone loses its ability to calcify the matrix, administration of vitamin D will cause calcification and denser bone. Moderate overdosage causes excessively mineralized bone, but gross overdosage causes bone resorption.

C. Carbohydrates (Starch and Sugars) They provide the chief source of energy.

They are related only indirectly to bone resorption through association with diabetes and by substitution for more favorable foods.

D. Fats and Organic Substances They are those, which yield heat and energy and only secondarily build/repair tissue.

E. Inorganic Elements Calcium salts (calcium carbonate and calcium phosphate) form the rigid supporting structure of bones. Phosphorus in the form of calcium and magnesium phosphate, gives hardness to bone. Abnormalities of the calcium-phosphorus elements of the bloodstream may

be associated with alveolar resorption or rarefaction. The body requires 0.7 gm of calcium/day, The phosphorus needed is about 1.5 to 3 gm daily depending upon the form. Edentulous patients should follow a prescribed dietary regimen. The normal equilibrium may be upset and pathologic bone loss may occur if either bone resorption is increased or bone formation is decreased, or if both occur. The thyroid hormone affects the rate of metabolism of cells in general and hence the activity of both, the osteoblasts and osteoclasts. Parathyroid hormone influences the excretion of phosphorous in the kidney and also directly influences osteoclasts. The degree of absorption of Ca, P, and proteins determines the amount of building blocks available for the growth and maintenance of bone.

- **Osteoporosis and residual ridge modeling:**

The clinical and pathophysiologic views of osteoporosis have been refined recently to the concept of Type I and II osteoporosis.

- Type I osteoporosis is defined as the specific consequence of menopausal estrogen deprivation, and characteristically presents bone mass loss, notably in the trabecular bone.
- Type II osteoporosis reflects a composite of age-related changes in intestinal, renal, and hormonal function. Both cortical and trabecular bone are affected in Type II osteoporosis.

5. Mechanical:

A. Functional Factors: Functional factors include the frequency, intensity, duration, and direction of forces applied to bone which are translated into cellular activity, resulting in either bone formation or bone resorption, depending upon the patients' resistance to these forces. Wolff's law postulates that all changes in the function of bone are attended by definite alterations in

its internal structure. Forces within the physiologic limits of bone are beneficial in their massaging effect. On the other hand, increased or sustained pressure, through its disturbance to the circulatory system, produces bone resorption. The amount and frequency of stress and its distribution and direction are important factors in treatment planning. Although the total amount of the necessary masticatory stress cannot be diminished, increasing tissue coverage and decreasing the length and width of the occlusal table may lessen the load/unit area. The frequency of stress application modifies the reaction of alveolar bone to external forces. Constant pressure on the bone causes resorption, while intermittent forces favor bone formation. Since recurrent forces over short intervals of time have essentially the same resorbing effect as constant pressure, a rest period between meals is beneficial. For this reason, the patient should be warned that gum chewing has a destructive effect on the bone. Bruxism is an expression of nervous tension, which manifests itself as gnashing, grinding, or clenching of the teeth while the patient is asleep or awake. Since most denture patients do grind their teeth in sleep, the dentures should not be worn during this period. Thus, the supporting structures are afforded the rest period essential to the maintenance of the alveolar bone. While grinding of the teeth when patient 13 is awake may be a habit of tension, it may also be caused by too lack of interocclusal distance. The principal concern should be in the pattern and position of the posterior teeth. There are two mandibular movements associated with mastication: a closing/cutting movement and a lateral or grinding movement. A sharp cusp will penetrate a bolus of food with less force than a flat occlusal form. However, a law of physics explains that forces applied to an inclined plane produce a resultant force or vector perpendicular or right angles to the plane. Applying this principle to occlusal form, the

resultant force of the steep incline of high cusps would produce a lateral force, which might cause alveolar resorption. Stress distribution favorable to healthy alveolar bone maintenance is dependent principally upon bilateral balanced occlusion. Balanced occlusion is the arrangement of the teeth, which will permit the necessary mandibular movements without tending to dislodge the denture or traumatize the supporting structure.

B. Prosthetic Factors:

1. Excessive stress resulting from artificial environment
2. Abuse tissues from lack of rest.
3. Long continued use of ill-fitting dentures.
4. Lack of freeway space due to increasing vertical dimension of occlusion
5. Incorrect centric relation record.

TO OVERCOME THESE PROBLEMS

1. broad-area coverage (to reduce the force per unit area).
2. decreased number of dental units.
3. decreased Bucco-lingual width of teeth.
4. improved tooth form (to decrease the amount of force required to penetrate a bolus of food).
5. avoidance of inclined planes (to minimize dislodgement of dentures and shear forces).
6. centralization of occlusal contacts (to increase stability of dentures and to maximize compressive forces).
7. provision of adequate tongue room (to increase stability of denture in speech and mastication)
8. adequate inter-occlusal distance during rest jaw relation (to decrease the frequency and duration of tooth contacts).

- **TREATMENT AND PREVENTION OF RRR**

The best way to manage the problem of residual ridge resorption is by using every means to prevent it.

- A.** prevention of loss of natural teeth. Clinicians must try to retain residual roots whenever feasible.
- B.** proper design of dentures and maintenance which starts from:
 1. Optimal tissue health before making an impression.
 2. Impression procedures.
 - Minimal pressure impression technique.
 - The selective pressure impression technique places stress on those areas that
 - best resist functional force.
 - Adequate relief on non-stress-bearing areas.
 3. During Teeth Arrangement:
 - Avoidance of inclined planes to minimize dislodgement of dentures and shear forces.
 - Centralization of occlusal contacts to increase stability
 - The occlusal table should be narrow.
 - Provision of adequate tongue room to improve stability of denture in speech and mastication.
 - Adequate interocclusal distance during jaw rest to decrease the frequency and duration of tooth contact.
 - The broad area of coverage helps in reducing the force /unit area (Snow Shoe Effect) increased denture bearing area can greatly reduce the load per unit area on the underlying mucosa and improve denture comfort, always assuming that the OVD is not excessive.

C. Nutrition. It has been seen that one of the cofactors in RRR is low calcium and vitamin D metabolism. Diet counseling for prosthodontic patients is necessary. Denture patients with excessive RRR report lower calcium intake and poorer calcium-phosphorus ratio, along with less vitamin.

D. Pre-Prosthetic Surgery

- Excessive RRR leads to loss of sulcus width and depth with the displacement of muscle attachment more to the crest of the residual ridge.
- Osseous reconstruction surgeries, removal of high frenal attachments, augmentation procedures (bone graft) Vestibuloplasty – etc.

E. Immediate Denture. Some authors claim that extraction followed by immediate dentures reduces the ridge resorption.

F. Over-Denture helps to minimize ridge resorption and contributes to enhanced retention, stability, and support of prosthesis along with preservation of proprioception. A study was conducted with overdentures supported by canines and it was seen that, the bone loss was 0.6mm whereas 5mm in conventional complete dentures.

G. Implants. The introduction of dental implants has revolutionized clinical practice. Use of implants for providing implant supported or implant assisted prosthesis also helps.