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Review Article

METAL DENTURE BASE-HISTORY REVISITED

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ABSTRACT

The metal denture bases are used in dentistry for the durability. The metallic denture bases have certain advantages which can't be accomplished by non-metallic denture base. Patients perceive a more natural feeling from the added weight. Weight may contribute to additional denture stability. It is dimensionally very stable when compared to all-plastic-based dentures during fabrication and over time

INTRODUCTION:

The use of metals is not new to dentistry. It is used as a material for various prosthesis including maxillofacial. It has been described since the time of Egyptian civilization. Since nonmetallic bases (such as ivory, wood, bone) were not dimensionally and biologically comparable with metal bases, metals continued to be the choice of denture bases till the advent of vulcanite in 1851.In the earlier time metal like gold was used as denture base by swaging method. With the advent of casting technique by Taggart in 1887, swaging technique was replaced by casting. Thus, it was possible to fabricate denture bases in hard alloys like chrome cobalt which otherwise cannot be swaged. With the newer generation of materials such as methyl methacrylate resin, poly carbonates, polysulfones and flexible resins, non-metallic denture base materials are also widely used. The metallic denture bases have certain advantages which can't be accomplished by non-metallic denture base. Therefore, metal bases also widely used according to the clinical situations. The metals and alloys which are used today are not the same, as used in prevulcanite era. There has been revolution in metal alloy technology and various combinations of metals and alloys are used today.

HISTORY:

Dentistry as a specialty is believed to have begun about 3000 BC. Egypt was the medical centre of ancient world. The first dental prosthesis was believed to have been constructed in Egypt about 2500 BC. Skillfully designed dentures were made as early as 700 BC. During medieval times, dentures were seldom considered as a treatment option. They were hand carved and tied in place with silk threads and had to be removed before eating.

WOOD: For years, dentures were designed from wood because it was readily available, relatively inexpensive and could be carved to desired shape. However, it warped and cracked in moisture, lacked aesthetics and got degraded in the oral environment.

BONE: Dentures made from bone became very popular due to its availability, reasonable cost and carvability. It is reported that Fauchard fabricated dentures by measuring individual arches with a compass and cutting bone to fit the arches. It had better dimensional stability than wood, however, esthetic and hygienic concerns remained.

IVORY: Ivory denture bases and prosthetic teeth were fashioned by carving this material to desired shape. These were relatively stable in the oral environment, offered esthetic and hygienic advantages compared to wood or bone. However, ivory was not readily available and was relatively expensive.

MATERIALS USED:

Before 18th century	Wood, Bone, Ivory
In the 18th century	Gold, Porcelain
In the 19th century	Tortoise shell (1850) Gutta percha(1851) Vulcanite(1851) Cheoplastic(1856) Rose Pearl (1860) Aluminium(1867) Celluloid(1870)
In the 20th century:	Bakelite(1909) Stainless steel(1921) Cobalt-Chromium(1930) Vinyl resin (1932) Acrylic resin (1937) Self-cure acrylic resin (1937) Epoxy resin (1951) Polystyrene (1951) Nylon (1955) Poly carbonates(1967) High impact acrylic(1967) Poly sulphones(1981) Visible LC acrylic(1986) Pure titanium(1998)

Fig 1- Wooden Teeth And Wooden Denture Base

GOLD AND SILVER

Egyptians had used gold and silver even after ivory and wood, and even now.

Fig 2- Silver And Gold Denture Base

Functions of denture bases: To support artificial teeth and affect the transfer of occlusal forces to supporting oral structures, esthetics and stimulation by massage of the underlying tissues of the residual ridge.

Criteria for an ideal denture base material: it should have natural appearance, high strength, stiffness, hardness and toughness, dimensionally stable, absence of odor, taste, or toxic product, resistant to absorption of oral fluids, good retention to polymers, porcelain and metals, easy to repair, good shelf life, accurate reproduction of surface detail, resistant to bacterial growth, good thermal conductivity, radiopaque, low density and easy manipulation.

Tooth supported partial denture base: It is primarily a span between two abutments supporting artificial occlusal surfaces. Thus occlusal forces are transferred directly to the abutment teeth through rests. It presents horizontal migration of the teeth in the partial edentulous arch. It also prevents vertical migration of the teeth in the opposing arch.

Distal extension partial denture bases: Close to the terminal abutment only a framework supporting occlusal surface is necessary. Support from the underlying ridge tissues is very important. Maximum support is obtained by using broad accurate denture bases, which transmit the occlusal load equally over the entire area. Support should be of primary important in selecting designing & fabricating distal extension partial denture base.

Methods of Attaching Denture Bases: Resin bases are attached to the partial denture framework by means of a minor connector designed so that a space exists between it and underlying tissues of the residual ridge. Relief at least a 20 gauge thickness over basal seat areas of master cast is used to create raised platform on the investment cast. Thus after casting the portion of retentive framework to which the resin base will be attached will stand away from the tissue surface sufficiently to permit a flow of resin base material beneath the surface. The retentive framework for the base should be embedded in the base material with sufficient thickness of resin. (1-5mm).

Fig 3- Metal Denture Base

Thickness of the resin is essential during the denture adjustments or during relining procedures also to avoid weakness and subsequent fracture of resin base materials. Metal bases are usually cast as integral parts of partial denture framework.

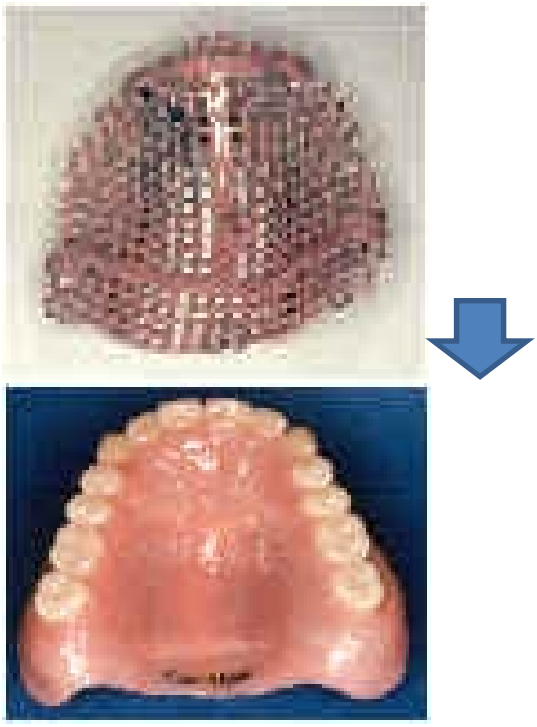

Fig 4- Metal Mesh Framework With Acrylic Resin

Requirements of an ideal denture base:

Accuracy of adaptation to the tissue with low volume change. Dense, nonirritating surface capable of receiving and maintaining good finish. Thermal conductivity. Low specific gravity; lightness in the mouth. Sufficient strength; resistance to fracture or distortion. Self-cleansing factor or easily kept clean. Esthetic acceptability. Potential for Future relining. Low initial cost.

Metal-Based Denture: A metal-based denture is one in which a portion of the denture body is made of a substantial metal casting rather than all plastic (acrylic resin). This procedure is usually done on the lower denture.

TYPES OF METAL BASED DENTURES:

1. Standard metal-based denture: The metal base portion of the denture is in direct contact with underlying supporting tissues. The base is fabricated from a special medical grade alloy that is hypoallergenic and very biocompatible with tissues. Generally, tissues in contact with this type of material are very healthy in appearance.

Fig 5- Metallic Denture Base With Loop Connector

2. Modified metal-based denture: The metal base portion of the denture is not in direct contact with underlying supporting tissues. A soft or hard plastic liner may be interposed between the metal and supporting tissues. A soft liner is generally preferred to hard plastic since it is more comfortable to wear; however, the soft liner usually should be replaced on an annual basis.

Indications: Patients with atrophied ridges. Patient with compromised neuromuscular coordination, who may drop their dentures. Patient with increased rate of residual ridge resorption. Patient with flabby tissues which may require a soft liner. Patient who are allergic to acrylic and repeated history of midline denture fractures.

Contraindications: Recent extractions, where frequent relining is required. Mandibular extreme ridge resorption and allergic to base metals. Extremely reduced vertical dimension with poor denture posterior space.

Advantages of Metal-Based Dentures: Very biocompatible and hypoallergenic with healthy-appearing supporting tissues. May include a soft liner. Can be relined easily. Provides added strength for easily broken narrow dentures. Facilitates fabrication of stable narrow-based dentures that are designed to avoid contact with disrupting muscle forces. Sometimes facilitates the avoidance of surgical procedures to reposition frenum. Patients perceive a more natural feeling from the added weight. Weight may contribute to additional denture stability.

Dimensionally very stable when compared to all-plastic-based dentures during fabrication and over time

Disadvantages of Metal-Based Dentures: Generally difficult to reline standard metal-based dentures; modified metal-based dentures are easier to reline. It is costlier to fabricate. Difficult to repair. Time consuming procedure. Need to frequently reline with soft liner. Tendency of soft liner to support growth of Candida albicans.

ADA Classification System for Cast Alloys

In 1984, the Council of Dental Materials, Instruments and Equipment of the American Dental Association, prepared this based on the noble metal content.

Classification	Requirements
High noble	Noble Metal >60%, Gold – 40%
Noble	Noble Metal >25%
Predominately Base	Noble metal <25%

Thermal conductivity: Thermal changes are transmitted through the metal base to the underlying tissues, thereby helping to maintain the health of those tissues. Conversely, denture resins have insulting properties that prevent interchange of temperature between the inside and the outside of the denture base.

Accuracy and permanence form: Cast metal bases whether of gold or chrome alloys not may be cast more accurately than denture base resins but also maintain their accuracy of form without change the mouth.

Comparative tissue response: Clinical observations have demonstrated that the inherent cleanliness of the cast metal base contributes to the health of oral tissues when compared to an acrylic resin base.

Attachment of acrylic to metal base:

Mechanical: Acrylic gets embedded in the rough irregularities of the metal. Creating Undercuts in The Metal Base by Channeling, dovetail, attachments of pin head and looping the metal base during its wax up before casting. Metal reinforced denture bases have better transverse strengths and hence better fracture resistance than unfilled acrylic.

Alloys used as denture base are Anodized Aluminum, Type IV gold alloy, Cobalt –chromium alloys, Nickel –chromium, Titanium.

Aluminum denture base: Also, called as the 'war denture' was used by the American army. These were used when the rubber denture bases were in use and were not strong enough to be used under army conditions. They can be easily made, durable and light weight. Has good thermal conductivity. The denture is entirely aluminum including the posterior teeth. Porcelain teeth are used for the anterior. These were in massive production during the world war period.

Compositions are Aluminum-bronze alloy, Copper-81%, Aluminum-7-11%, Nickel -2-4%, Iron-1-4%. Aluminum denture base is susceptible to tarnish and corrosion. However anodized aluminum denture base resists corrosion and tarnish, retained polish. Aluminum is inferior in its strength to chrome cobalt alloy, therefore rarely used.

Gold Type IV: Only Type IV gold is used for casting a denture base. The others are too soft to function as a denture base material. Compositions are Gold -69%, Silver-12.5%, Copper -10%, Palladium-3.5%, Platinum-3%. Properties are density-15.2gm/cm^3, Elongation (ductility)-30-35%, Modulus of elasticity -90x10 3 Mpa. It is resistant to tarnish and corrosion. Casting shrinkage is 1.25-1.65%. They are relatively biocompatible. Melting temperature are 900 C. The main concerning factor in these alloys is the cost.

Heat treatment of gold alloys: This is done to improve the mechanical properties of the alloy.

Two types of heat treatment procedures can be done. 1) Softening heat treatment, 2) Hardening heat treatment.

1. **Softening heat treatment:** In case of softening heat treatment, the strength, hardness decreases while the ductility increases. This is done when structures have to be cold worked either in or out of the mouth.

2. **Hardening heat treatment:** Whereas the hardening procedure increases the hardness and strength. This is done by ageing the casting at a specific temperature (200C-450C) for a definite period of time usually 15-30 mins. It is then cooled slowly. Prior to hardening it should be subjected to softening treatment to relieve the strain.

Cobalt based base metal alloys: Compositions are Cobalt-30-35%, Chromium-23-30%, Nickel-0-20%, Molybdenum-0-7%, Iron-0-5%, Carbon-up to 0.4%, Tungsten, manganese, silicon and platinum in traces. Cobalt provides strength, hardness, and corrosion resistance. Chromium provides hardness and resilience and increases corrosion resistance when present in at least 16 wt%. Nickel increases ductility while lowering melting temperature and hardness. Manganese is a de-oxidizer. Tungsten reduces formation of chromium-depleted zones. Co-Cr dental alloys have an excellent corrosion resistance. Density - 8-9gms/cm^2. Tensile strength -792MPa. Elongation - 1-12%. Casting shrinkage -2.3%. Biologic considerations are beryllium when present causes 'berylliosis'. However, the beryllium free alloys are available that have reduced the risk.

Nickel free CO-Cr alloys: Vitallium Partial Denture Alloys are no beryllium, no nickel, cobalt-chromium alloys. Compositions are Cobalt 63.4%, Chromium 29.0%, and Molybdenum 5.2%. Tensile strength is 855 Mpa. Yield strength is 600Mpa.Vitallium Alloy is available only to licensed vitallium Trademark laboratories, universities and government institutions.

Fig 6- Co-Cr Alloys

Titanium with Co-Cr: The 5% titanium dilution of cobalt-chromium proved to have the best physical properties and was used for comparison with the pure titanium and vitallium. The Co-Cr-5% Ti had significantly better physical properties than pure titanium and a greater flexure fatigue limit than the Vitallium alloy

Nickel based base metal alloys: Nickel yields a softer alloy and lowers the melting temperature. Aluminum (Ni3Al) increases strength and hardness. Carbon may be added to increase strength but increases brittleness as well Beryllium decreases melting temperature and corrosion resistance while improving cast ability and bonding. Titanium and manganese increase corrosion resistance and serve as bonding agents. Iron increases strength. Copper, Molybdenum increases corrosion resistance. Melting Range is 2500°-2550° F. Coefficient Expansion is 7.8°-70° to 200° F. Ultimate Tensile Strength: 85,000-150,000 psi. Yield Strength 0.2%: 35,000-65,000 psi. Elongation: 50-30%

Titanium dentures:

Fig 7 –Titanium Denture Base

A titanium alloy denture base achieved a fourfold reduction in weight compared to an acrylic denture base. Additionally, dental porcelain can be fused and bonded to titanium to produce an esthetic, lifelike restoration. The strength and rigidity of titanium are comparable to those of other noble or high noble alloys commonly used in dentistry. They are tensile strength -240Mpa, Stiffness -117Gpa, Density-4.51gm/cm3, Thermal expansion co-efficient -9.4x10^-6 C has strong resistance to tarnish and corrosion. The low density of titanium provides for high-strength, light weight prostheses. Metal alloy may be cast much thinner than resin and still have adequate strength and rigidity. Denture base contours for functional tongue and cheek contact can best be accomplished with resin base. Esthetics is best achieved with resin base. The principal disadvantage of metal bases is that it can be relined only with difficulty, if at all.

Methods of Attaching Artificial Teeth: Artificial teeth may be attached denture bases with acrylic resin, cemented, processed directly to metal, and cast with framework. Porcelain or resin artificial teeth attached with resin. Porcelain teeth are mechanically retained. Posterior teeth are attached retained by acrylic resin in their diatonic holes. Anterior porcelain teeth are

retained by acrylic resin surrounding the lingually placed retention pins. Resin teeth are retained by chemical union of the acrylic resin of denture base. Attachment of resin to the metal base may be accomplished by nail head retention, retention loop, or diagonal spurs placed at random. Any junction of resin with metal should be at an undercut finishing line or associated with some retentive undercut. Porcelain or resin tube teeth and facings cemented directly to metal bases. Attachment of readymade resin teeth to the metal base with acrylic resin of same shade. This is called pressing on a resin tooth. It is particularly applicable to anterior replacements. After a labial index of the position of the teeth is made. The lingual portion of the tooth may be cut away or a posthole is prepared in the tooth for retention on the casting. Subsequently the tooth is attached to the denture with acrylic resin of the same shade. Since this is done under pressure, the acrylic attachment provides hardness and strength. Some disadvantages of this type of attachment are the difficulties in obtaining satisfactory occlusion, lack of adequate contours for functional tongue and cheek contact and unaesthetic display of metal at gingival margins. This can be avoided when the tooth is butted directly to the ridge. And by selecting tube teeth for width but with occlusal surfaces slightly higher than required. Resin teeth processed directly to metal bases: Occlusion may be created without restoring to the modification of readymade artificial teeth.

Metal teeth: Occasionally a second molar tooth may be repaired as part of partial denture casting. This is usually done when space is too limited for the attachment of an artificial tooth and yet the addition of second molar is desirable to prevent migration of an opposing second molar. Before casting occlusal surface should be waxed properly and the area of occlusal contact should be held minimum the avoid damage to the periodontium of opposing tooth and the associated discomfort to the patient. They should be used only to fill a space and to prevent tooth migration and no more as they are difficult to adjust and objectionably hard for use as occlusal surface.

Chemical bond: Sections of metal framework that are to support replacement teeth can be roughened with abrasives, then treated with vaporized silica coating to direct chemical bonding of acrylic resin metal framework. Upon this surface a resin-bonding agent is applied, followed by thin film of resin to act as a substrate for latter attachment of replacement resin or for processing of acrylic resin tissue replacement.

Need for Relining: The distal extension base differs from the tooth borne base universal aspects, one of which is that it must be made of a material that can be relined or rebased when it becomes necessary to reestablish tissue. Therefore, resins for denture base materials that can be relined are generally used. Loss of support for a distal extension base results from changes in residual ridge form over a period of the time. Loss of support for distal extension base will; Result in loss of occlusal contact between the prosthetically supplied teeth and opposing dentition and a return to heavy occlusal contact between the remaining natural teeth. If evidence of rotation about the fulcrum line with the indirect retainers lifting from their seats as the distal extension base pressed against the ridge tissues.

CONCLUSION

Metal denture base are undoughtedly an ideal denture base, but for some of its limitations, economic feasibility which limits is used only certain individuals. The metallic denture bases have certain advantages which can't be accomplished by non-metallic denture base. Therefore, metal bases also widely used according to the clinical situations.

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