



DENTAL IMPLANTS: AS AN ALTERNATIVE FOR TOOTH REPLACEMENT

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ABSTRACT

A dental implant is an artificial tooth that replaces a tooth that has been taken out. Implants are natural-looking, can provide support for dentures and do not affect the teeth bordering them. They are as stable as your real teeth and protect you from the loss of jawbone, which occurs when you lose teeth. Endosseous dental implants have revolutionized the fields of implants and periodontics. During the last decade, a great deal of information has been generated concerning the effectiveness and predictability of endosseous implants. Implant placement is a viable option in the treatment of partial and full edentulism and has become an integral facet of periodontal therapy. The available implants are remarkably successful. This review discusses the different aspects of dental implant including its advantages over the contemporary removable implants, its procedure in detail and the financial outlook of the same. The review also has a small consideration on minidental implant.

Keywords: Biologic width, soft tissue, minidental implant, osseointegration.

INTRODUCTION

Dental Implant is a permucosal device which is biocompatible and bio functional and is placed within mucosa or, on or within the bone associated with the oral cavity to provide support for fixed or removable prosthetics.¹

Implant has three parts (Figure 1)

- The implant device itself,
- The abutment, it connects the implant to the third part
- The crown of denture.

Implants today are mostly made up of titanium but can also be made from zirconium in the future. Dental implants are a very popular alternative to dentures. In general, dental implants restore the function of missing or removed teeth. They are anchored in the underlying alveolar bone while protruding through the socket into the oral cavity so as to provide abutment posts for single-tooth, fixed bridge, or full arch appliances.² Dental implants are so natural-looking and feeling; you may forget you ever lost a tooth. Long-term studies continue to show improving success rates for implants.^{1,3,4} Virtually all dental implants placed today are root-form endosseous implants i.e. they appear similar to an actual tooth root (and thus possess a "root-form") and are placed within the bone. The bone of the jaw accepts and osseointegrates with the titanium post. Osseointegration refers to the fusion of the implant surface with the surrounding bone. Dental implants will fuse with bone; however they lack the periodontal ligament, so they will feel slightly different than natural teeth during chewing.^{1,2}

Treatment Options for Teeth

To understand treatment options for your diseased tooth, know about the anatomy of the tooth. Inside the tooth, under the white enamel and a hard layer called the dentin, is a soft tissue called the pulp? The pulp contains blood vessels, nerves and connective tissue, and helps to grow the root of your tooth during development. In a fully developed tooth, the tooth can survive without the pulp because the tooth continues to be nourished by the tissues surrounding it.⁵

Endodontic treatment (root canal): treats the inside of the tooth. Endodontic treatment is necessary when the pulp becomes inflamed or infected. If pulp inflammation or infection is left untreated, it can cause pain or lead to an abscess.

Endodontic surgery: There are many surgical procedures that can be performed to save a tooth. The most common is called an apicoectomy, or root-end resection, which is occasionally needed when inflammation or infection persists in the bony area around the end of your tooth after a root canal procedure. In this the endodontist opens the gum tissue near the tooth to see the underlying bone and to remove any inflamed or infected tissue. The very end of the root is also removed. A small filling may be placed to seal the end of the root canal and few stitches or sutures are placed to help the tissue heal. Over a period of months, the bone heals around the end of the root.

Alternatives to Endodontic Treatment

Though endodontic procedures are intended to help save your tooth, this is not always possible. Often, the only alternative to endodontic treatment is extraction of the tooth. For these reasons, the extracted tooth should be replaced with an artificial one. Implants are a state-of-the-art replacement for missing teeth. A dental implant is an artificial tooth root placed into your jaw to hold a replacement tooth – the crown – in place. The implant emulates the shape of the root and is usually made of titanium and other materials that are well-suited to the human body. The implant is surgically placed into the jaw and incorporates into the bone over time to become a stable base for crowns.^{1,5}

Types of Dental Implant

Endodontic Implant

Endodontic implants are similar to prosthodontic implants in many respects. However, they serve another purpose - the stabilization and preservation of remaining natural teeth, not the replacement of lost teeth.

Sub-periosteal Implant

Of all currently used devices, it is the type of implant that has had the longest period of clinical application. These implants are not anchored inside the bone, such as Endosseous Implants, but are instead shaped to ride on the residual bony ridge of either the upper or lower jaw.

Endosteal or Endosseous Implant

Plate-form Implant

Blade Implants have a long track record, much longer than the Root form Implants. Their name is derived from their flat, blade-like portion, which is the part that gets embedded into the bone. Blade implants are not used too frequently any more, however they do find an application in areas where the residual bone ridge of the jaw is either too thin to place conventional⁵. (Figure 2)

Ramus-frame Implant

Ramus-frame Implants belong in the category of endosseous implants. These implants are designed for the edentulous lower jaw only and are surgically inserted into the jaw bone in three different areas: the left and right back area of the jaw (the approximate area of the wisdom teeth), and the chin area in the front of the mouth.

Root form Implant

Since the introduction of the Osseointegration concept and the Titanium Screw by Dr. Branemark; these implants have become the most popular implants in the world today. Root form Implants come in a variety of shapes, sizes and materials and are being offered by many different companies worldwide.

Transosseous Implant

These implants are not in use that much anymore, because they necessitate an extra oral surgical approach to their placement, which again translates into general anesthesia, hospitalization and higher cost, but not necessarily higher benefits to the patient.

Removable Implant Prostheses

They are of two types:

- Resilient
- Rigid

A removable rigid overdenture will function in a similar manner as fixed implant prosthesis.

Resilient Design

Removable implant prostheses can be restored using a combined implant-retained and soft tissue-supported overdenture.

Rigid Design

The implant-retained and implant-supported removable overdenture (i.e., multiple implant bar overdenture with three or more implants) may or may not require the same number of implants as the fixed and usually has multiple retentive elements.

Disadvantages of Removable Dentures

- 1.32 % less masticatory efficiency with natural teeth compared to complete dentures.
- “Compromised dental function may favour systemic changes creating illness and lower life expectancy”.

- Tissue borne dentures yield: Increased bone loss, increased caries on rest teeth, increased mobility of rest teeth, increased bleeding upon probing, greater plaque retention and non compliance of use, speech inhibition and taste inhibition.

Benefits of Dental Implants

- Overall quality of life is enhanced with replacement teeth that look, feel and function like natural teeth.
- Preserves integrity of facial structures.
- Better health due to improved nutrition and proper digestion.
- Adjacent teeth are not compromised to replace missing teeth.
- Convenience of hygiene.
- Elimination of denture adhesives.
- The mouth is restored as closely as possible to its natural state.
- Increased stability and a sense of security that teeth will not fall out when eating, laughing or sneezing.
- Your smile is improved when replacement teeth look more like natural teeth.⁶

Other Advantages

- Bone maintenance of height and width
- Bite height dimension maintenance
- Ideally aesthetic tooth positioning
- Improved psychological health
- Regained biting awareness

Disadvantages

- Risk of fixture failure
- Length of treatment time
- Need for multiple surgeries
- Expensive.

Factors Affecting Osseointegration

Implant Biocompatibility^{6,7,8}

Materials used are (Cp titanium, Zirconium etc.)

Implant design (root-form)

- Cylindrical Implant
- Threaded Implant

Implant Surface

Pitch, the number of threads per unit length, is an important factor in implant osseointegration. Increased pitch and increased depth between individual threads allows for improved contact area between bone and implant. Reactive implant surface by anodizing, acid etching or HA coating enhanced osseointegration

Bone Quality

- Quality I: Was composed of homogenous compact bone, usually found in the anterior lower jaw.
- Quality II: Had a thick layer of cortical bone surrounding dense trabecular bone, usually found in the posterior lower jaw.
- Quality III: Had a thin layer of cortical bone surrounding dense trabecular bone, normally found in the anterior upper jaw but can also be seen in the posterior lower jaw and the posterior upper jaw.

- Quality IV: Had a very thin layer of cortical bone surrounding a core of low-density trabecular bone. It is very soft bone and normally found in the posterior upper jaw. It can also be seen in the anterior upper.

Surgical Technique

- Minimal tissue violence at surgery is essential for proper osseointegration.
- Careful cooling while surgical drilling is performed at low rotatory rates
- Use of sharp drills
- Use of graded series of drills
- Proper drill geometry is important, as intermittent drilling.
- The insertion torque should be of a moderate level because strong insertion torques may result in stress concentrations around the implant, with subsequent bone resorption.

Loading Condition

Delayed loading

1. A two-stage surgical protocol
2. One-stage surgical protocol

Immediate loading:

1. Immediate occlusal loading (placed within 48 hours post surgery)
2. Immediate non-occlusal Loading (in single-tooth or short-span applications)
3. Early loading (prosthetic function within two months)

Biological Width

It comprises of sulcus depth, junction epithelium and connective tissue attachment up to the alveolar bone crest. Normal, healthy subjects demonstrate an adequate biologic width when a 2 mm to 2.5 mm distance is present from the base of gingival sulcus to the height of crestal bone. In absence of any periodontal disease there is a normal variation in biologic width around a tooth. There are a variety of dental implant systems available on the market. Each dental implant system varies with branding, patented technology and materials, historical case success rates and implant system establishment. A list of brands of implants available is given in Table 1.

Composition

A typical implant consists of a titanium screw (resembling a tooth root) with a roughened or smooth surface. The majority of dental implants are made out of commercially pure titanium, which is available in 4 grades depending upon the amount of carbon and iron contained. More recently grade 5 titanium has increased in use. Grade 5 titanium, Titanium 6AL-4V, (signifying the Titanium alloy containing 6 % Aluminium and 4 % Vanadium alloy) is believed to offer similar osseointegration levels as commercially pure titanium. Ti- 6Al-4V alloy offers better tensile strength and fracture resistance. Today most implants are still made out of commercially pure titanium (grades 1 to 4) but some implant systems are fabricated out of the Ti-6Al-4V alloy. Implant surfaces may be modified by plasma spraying, anodizing, etching, or sandblasting to increase the surface area and osseointegration potential of the implant. (Figure 3)

Treatment Planning

“Diagnosis begins with a complete patient evaluation”, what is the most practical and feasible implant treatment that will produce optimal chewing function and optimal cosmetic results in a timely and affordable manner?⁹ The evaluation of a patient as a suitable candidate for implants should follow the same basic format as the standard patient evaluation, although some areas require additional emphasis and attention:

- Medical History
- Psychological Status
- Dental History

Patient Selection

Several factors determine whether a patient is a candidate for dental implants. These factors can be divided into four categories:

- Surgery-related factors
- Host-related factors
- Implant-related factors
- Occlusion-related factors

Of the factors related to surgical technique, the establishment of primary stability has been described as the single most important variable for success of immediately loaded implants. With the growing marketplace for dental implants and the advent of new technologies, implant design principles can affect success of immediately loaded implants. The screw design type has been shown to have higher mechanical retention and greater ability to transfer compressive forces. Implant length and diameter - critical values for immediate loading - have yet to be defined; however, early reports have suggested that lengths greater than 10 mm provide dramatically higher success rates.¹⁰⁻¹³ Adverse effects on implant survival have been attributed to uncontrolled diabetes, alcoholism, heavy smoking, post-irradiated jaws and poor oral hygiene.^{11,14}

Immediate Implant

If an implant is to be inserted into an extraction site, the timing of the extraction is important due to the potential for post extraction bone resorption and ridge deformation. Insertion of implants at the time of extraction (immediate placement) is viable if mechanical fixation can be achieved.^{8,15}

Dental Implant Procedure

Dental implant procedure is the term used to describe the entire process you go through from the time you walk into the dentist's clinic for the first time, when getting your dental implants, till the last time you walk out of there with your new beautiful smile.⁹ The dental implant procedure involves 2 main stages separated by a minimum of 3 and up to 9 months of healing time:

Dental implant surgery - This is the step where the dentist inserts a metal screw into the jaw bone. This screw (the implant) is inside the jaw-bone and is not visible. There is an abutment that is screwed onto it and it is the abutment that is visible. The next step is the implant restoration.

Implant restoration - It takes time for the implant to take hold. This could range from 3-9 months, depending on the

individual's rate of healing. Once the implant is firmly set inside the jaw bone, then the permanent crown is attached to the abutment. The crown is built of material that will match the surrounding teeth.

Steps

- Surgical placement of the implant(s) into the bone. This is usually done right in the dentist's office, with a local aesthetic. After surgery, there is a healing period of approximately four months. During this time, the implants fuse to the bone by a process known as 'osseointegration'.
- Next, there is a minor surgical exposure of the top of the implant, whereby the dentist will attach the post to the implant. The function of the post is to become the support for either one tooth or a set of teeth. This is a short procedure that usually requires only local anaesthesia.
- The last phase is the restorative phase. The dentist will take impressions and then make a prosthesis that will attach to the implants. This will require several visits. Once completed, your mouth will be restored to natural looking, strong teeth (Figure 4). Sometimes additional steps and costs are needed to prepare an area of the jaw for placement of dental implants.
- Extraction of a tooth which will be replaced by the implant.
- Bone grafting of an extraction site to allow for a more favourable area for placement of an implant.
- Alveolar ridge augmentation. Grafting bone from other regions of the body to allow more surface area and increased amount of bone for superior implant stability and future success of the implant.
- Sinus augmentation with a bone graft. Specifically done on the upper back teeth. This procedure increases the amount of bone where the implant can be safely placed and provide proper support.

Implant Success

Studies have shown that the placement of endosseous implants is a predictable procedure. Criteria for success include: 1) absence of persistent signs / symptoms such as pain, infection, neuropathies, parenthesis and violation of vital structures; 2) implant immobility; 3) no continuous peril-implant radio lucency; 4) negligible progressive bone loss (less than 0.2 mm annually) after physiologic remodelling during the first year of function; and 5) patient / dentist satisfaction with the implant supported restoration. Many implant systems have shown multiyear success rates of greater than 90 % for fully edentulous patients similarly, multi-year studies of implants in partially edentulous patients have generally reported greater than 90 % success rates for both maxillary and mandibular implants. Dental implant success is related to operator skill, quality and quantity of the bone available at the site and the patient's oral hygiene. The consensus is that implants carry a success rate of around 75 %.¹⁶⁻¹⁸

Failure

Failure of a dental implant is often related to the failure of the implant to osseointegrate correctly with the bone, or vice-versa. A dental implant is considered to be a failure if it is lost, mobile or shows peri-implant (around the implant) bone loss of greater than 1.0 mm in the first year and greater than

0.2 mm a year after.¹⁹ Dental implants are not susceptible to dental caries but they can develop a condition called peri-implantitis. This is an inflammatory condition of the mucosa and/or bone around the implant which may result in bone loss and eventual loss of the implant.

Indication and Contraindication

Indications

- Good general health
- Adequate bone quality and volume
- Appropriate occlusion and jaw relations
- Inability to wear conventional prosthesis
- Unfavourable number/location of abutment
- Single tooth loss

Contraindications

There are few absolute contraindications to implant dentistry. However, there are some systemic, behavioural and anatomic considerations that should be assessed. Uncontrolled Type II diabetes is a significant relative contraindication as healing following any type of surgical procedure is delayed due to poor peripheral blood circulation. Anatomic considerations include the volume and height of bone available. Often an ancillary procedure known as a block graft or sinus augmentation are needed to provide enough bone for successful implant placement. There is new information about intravenous and oral bisphosphonates (taken for certain forms of breast cancer and osteoporosis, respectively) which may put patients at a higher risk of developing a delayed healing syndrome called osteonecrosis. Implants are contraindicated for some patients who take intravenous bisphosphonates.^{20,21}

Other contraindications

- Unrealistic patient expectations
- Alcohol / drug dependence (smoking)
- Para functional habits
- Psychological factors
- Anatomical factors
- Inadequate ridge / interarch dimensions
- Immunosuppression
- Ramus graft
- Inadequate bone at implant site

Evaluation of Dental Implants

Finite element analysis (FEA) has been proven to be a precise and applicable method for evaluating dental implant systems. By means of FEA, a parasagittal model was digitized from a computed tomography (CT)-generated patient data set, and various single-tooth, osseointegrated, two-dimensional dental implant models were simulated. The specific aims are to:

- (1) examine the effect of implant diameter variation (3.8 mm – 6.5 mm) of both a press-fit, stepped cylindrical implant type and a press-fit, straight cylindrical implant type as osseointegrated in the posterior mandible;
- (2) compare the stress-dissipating characteristics of the stepped implant versus the straight implant design; and
- (3) analyze the significance of bite force direction on both implant types.^{19, 22-24}

Clinical Parameters of Evaluation

- Oral hygiene (plaque index)
- Implant stability (evaluate mobility)
- Retrievability

- Peri-implant tissue health
- Crevicular probing depths
- Bleeding
- Radiographic assessment
- Proper torque on screw joints

Problem in Dental Implants

- soft tissue reactions
- fractured or loosened screws
- failing or failed fixture
- broken attachments / components²⁵

Soft Tissue Reactions

Most common due to loose screws poor oral hygiene can lead to “peri-implantitis” - may result in progressive bone loss lack of attached periabutment soft tissue failed or failing implants. Treatment: remove offending screw, tighten abutment and reinsert prosthesis, reinforce oral hygiene, soft-tissue auto graft, replacement of failed implant

Fractured or Loosened Screws

1st suspicion when complaint of “loose” implant or discomfort if retrieving (“teasing out”) fractured screw caution not to damage hex.

Filing or Failed Fixture

Failing Implant

Clinical signs: Progressive crestal bone loss; soft tissue pocketing; possible purulence; tenderness to percussion or torque. Causes: surgical compromises (bone overheating, lack of initial stability); non passive superstructures; too rapid initial loading; functional overload; inadequate screw joint closure; infection

Treatment: Remove and replace with larger diameter fixture; or treat infection and re-evaluate interim - remove prosthesis and abutments and irrigate area; disinfect components and reinsert

Broken attachments / components: Remove offending attachment (if possible) and replace or provisionalize be careful not to damage external hex or scratch titanium fixture or abutment

Minidental Implants

The idea of using a smaller implant (1.8 mm to 3.0 mm) is very interesting for some clinical cases where the buccolingual and mesio-distal space is limited as for an anterior-inferior tooth. The most interesting aspect is that, because of its smaller diameter, the insertion protocol is much easier and simpler compared to the standard implants.^{7,26} (Figure 5). Due to the elastic property of the jaw bone and their smaller diameter, it is not necessary for mini-implants to go through a surgical phase of bone trepanation and having to wait months for the bone to heal. After a simple perforation of the cortical through the gum, the implant is screwed into the bone very slowly. This new implant has only one part (radicular and coronal), contrary to the standard implants, which increase the resistance to fatigue and strength. They show many advantages:

- Reduction of chair time
- No healing time
- Less risk of infection

- Less pain post-op
- More affordable for the patient and less costly for the dentist.

The principle of mini-implants is based on three basic criteria essential to reach long-term success.

First, we need primary stability. This is assured by:

- Good bone quality
- Good choice of implant (smaller diameter in harder bone and larger diameter in softer bone)
- A maximum length of the implant (10mm, 11.5 mm, 13 mm, 15 mm and 18 mm) to anchor in cortical bone as much as possible
- An implant surface treated for best osteointegration (Osseon surface of Calcium Phosphate with Intra-Lock implants)
- The anchorage in cortical bone as much as possible.

Second, we need to make sure that the implant is immobile (max 28 microns). This is assured by:

Primary stability

- A good insertion technique (10 RPM-35 Newton/cm)
- A good restoration technique
- A perfect ideal group function occlusion
- A maximum quantity of implants to reduce the load on each

Third, we need to make sure that the prosthesis is also supported by the soft tissue to reduce the stress on the mini implants. These are the three essential basic criteria that will determine if mini-implants will be an alternative for a long-term or just temporary use. Every time there is a failure of a mini-implant, it is because one of these criteria has not been respected.

Applications

One of the principal and most encouraging applications of the mini-implants is for the stabilization of lower complete prosthesis no matter the amount of bone resorption. Due to the quality of the bone of the lower jaw between the two mental nerves, the success rate, when performed in accordance to the basic principles, is exceptional. However, with time their use spread to other purposes, such as:

- Upper complete prosthesis stabilization
- Upper and lower partial stabilization
- Single and multiple fixed tooth replacement
- Orthodontic anchorage
- Temporary stabilization during the standard implant phase
- Maxillofacial prosthesis stabilization

Future

The future now seems to be looking to nanotechnology, as illustrated by the recent introduction of a chemically-modified implant surface, or biotech concepts such as the possible incorporation of bone morphogenetic proteins onto the implant surface. Certainly it seems there is more development and evolution to come, which will ultimately add to the history of these small metal devices, but only until such time as the very notion of screwing metal into bone becomes historical itself, which it surely will as genetic engineering gathers pace.²⁷⁻²⁹

Table 1: List of Brands of Implants Available

Logo	Brand	Country of Origin
	Straumann	Switzerland
	Nobel Biocare	Sweden / USA
	AstraTech	Sweden
	BioHorizon	USA
	Intralock	USA
	3i	USA
	Zimmer	USA
	Bicon	USA

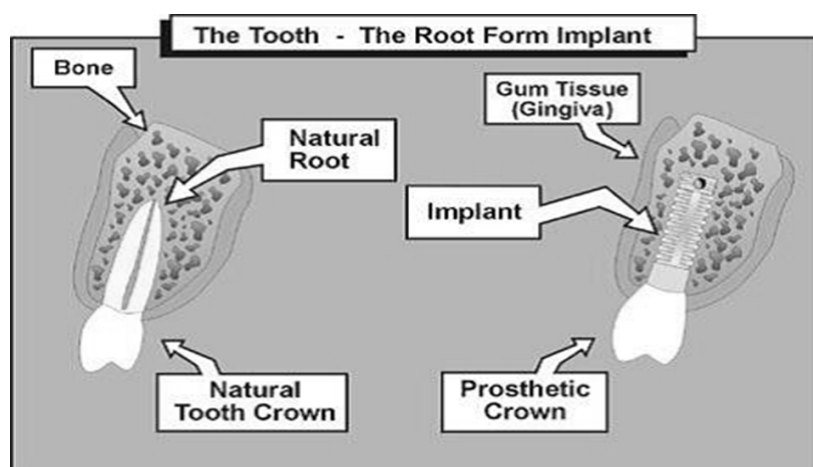


Figure 1: Normal teeth and Implants

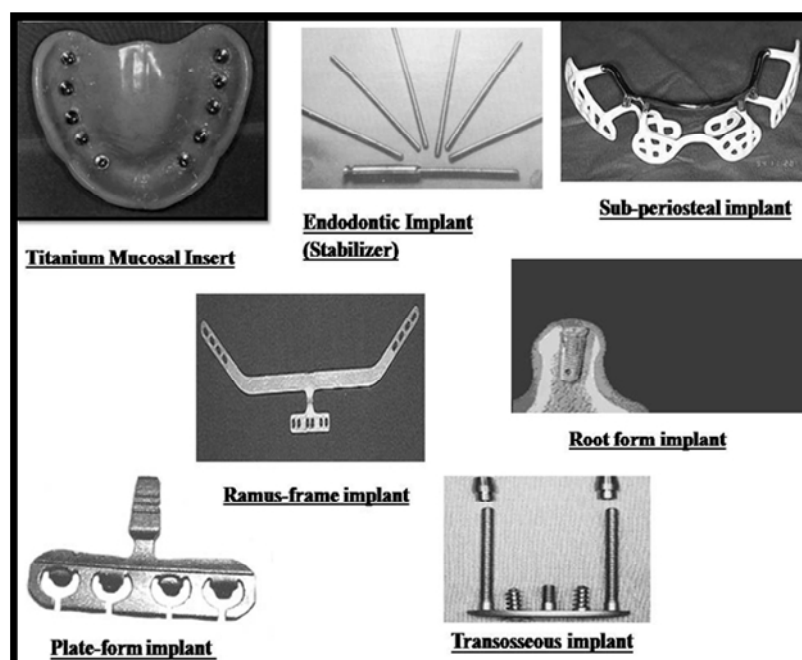


Figure 2: Types of Dental Implants

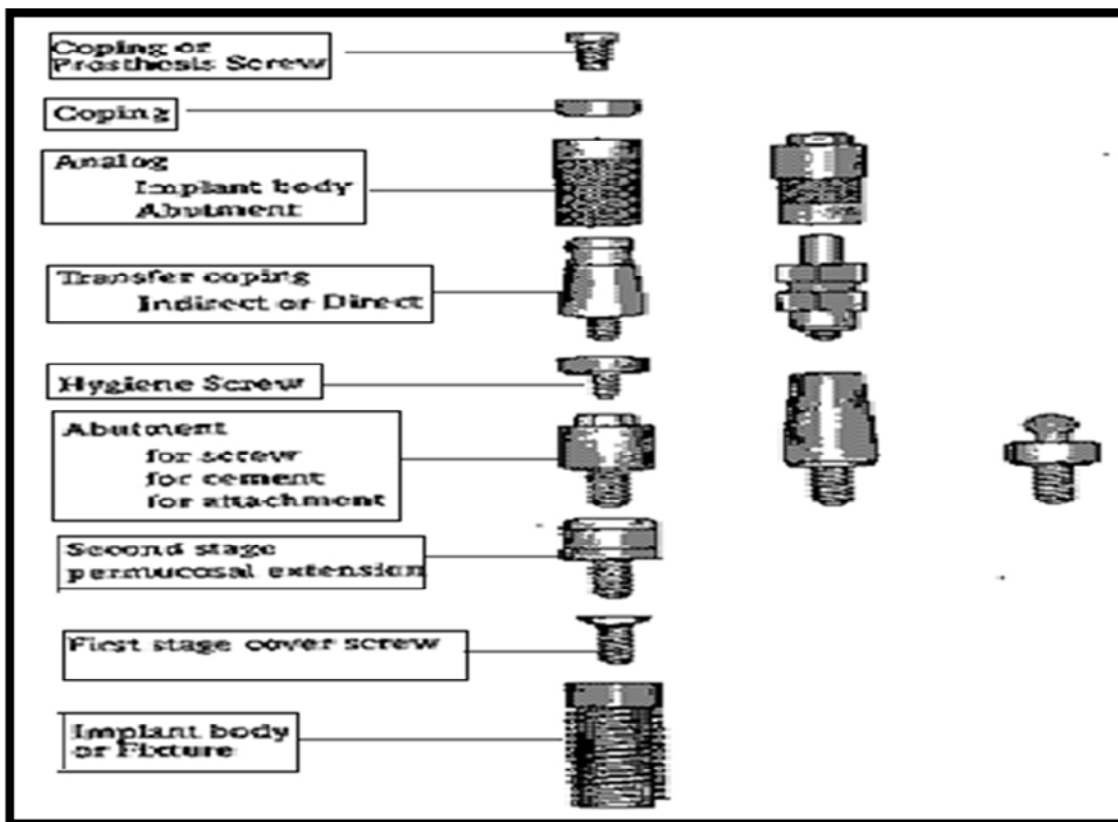


Figure 3: Components and Terminology in Dental Implants

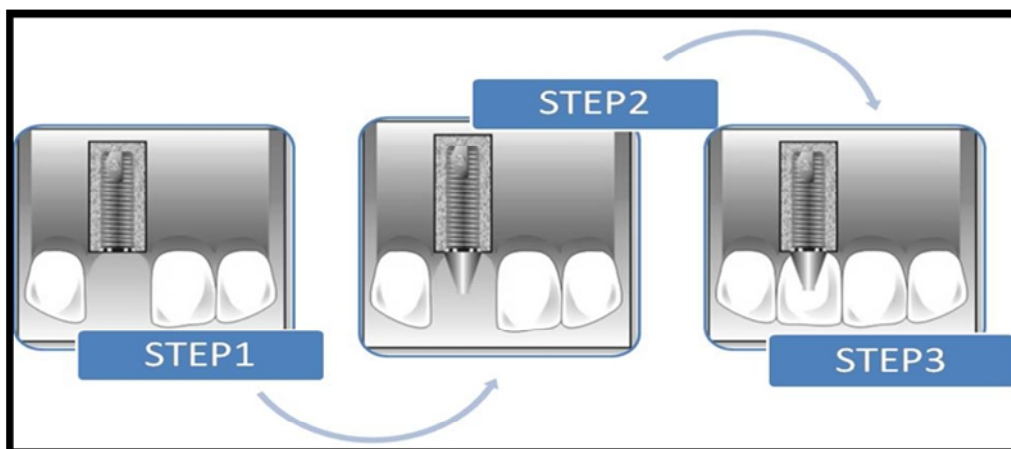


Figure 4: Steps in Placing Dental Implants



MINI IMPLANTS

Figure 5: Mini Dental Implants

CONCLUSION

In conclusion, the placement of implants and their immediate restoration, whether provisional or final, can be very advantageous. However, care and appropriate surgical and prosthetic considerations need to be highly contemplated when performing these procedures. As we perform these procedures, we're increasing the possibility for complications as more aspects of treatments are being rendered. Its success rate may differ slightly from completing procedures in a more conventional way. Of the greatest and most advantageous application of immediate restoration of implants are those cases in which aesthetic needs and soft tissue preservation are most important.

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