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ESTHETICS IN IMPLANT

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DEDICATION

This Book is dedicated to

My family and teachers

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INTRODUCTION

It all begins with the smile. As mouth is one of the focal points of the face, it comes as no surprise that a smile plays a major role, in how we perceive ourselves, as well as in the impression we make on the people around us. A charming smile can open doors and knock down barriers that stand between you and successful life.

The concept of smile is not relevant only in modern times, as we are not the only people to place a high premium on the smile. There are many examples in history where many civilizations noted for their achievements in other areas also demonstrated an interest in cosmetic and restorative density. For example, two false teeth encircled with gold wire, believed to be designed as substitute for missing molars were discovered years ago in the ancient Egyptian cemetery of EI Gigel. At the height of Mayan civilization, a system of dental decoration involved filing the teeth into intricate shapes or decorating them with jadeite inlays have been discovered.

Although times have changed, human nature has not. Fortunately, modern dentistry not only provides us with better material and technology, but also ensures that today's procedures are performed with minimum discomfort and maximum safety. This progress, for years has only been concentrated on the functional aspect with little or no concern regarding the esthetic rehabilitation of the patient.

Some decades ago, esthetics was considered at best, a fortuitous by product of dental procedure. In the years that have ensued, esthetics has taken its rightful place along with function as a bonafide objective of dental treatment.

Today's era of cosmetic and esthetic dentistry has placed emphasis on a confident and captivating smile. A well designed smile is a product of consolidated efforts accomplished by accurate diagnosis, methodical treatment planning and use of advanced materials.

The field of prosthodontics encompasses rehabilitation of patient with complete and partial denture, cast partial denture, fixed partial denture and implant treatment. Though the objective of any treatment procedure is to restore function and esthetics both, but this seem to be a compromise with treatment procedure other than implants.

The use of dental implants has revolutionized oral rehabilitation over the past three decades. Multiple studies have proven the efficacy and excellent long term prognosis with dental implants. While initial research and clinical use were directed primarily toward replacement of the missing teeth, more recent studies have focused on the esthetic use of implants.

The most challenging area of modern implant dentistry is not just achieving the function but also to restore the confidence of the patient by mingling esthetics with the function. With the ever increasing emphasis on the esthetic aspect of the dental implant it is imperative that the dentist should strive to maintain the delicate balance between the soft and hard tissue on one side and sophisticated implant component on the other side.[1]

This library dissertation is an effort to provide a practical and simple approach towards diagnosis, treatment planning and execution of esthetic principles in implant dentistry.

REVIEW OF LITERATURE

This article[2] emphasizes the dynamic relationship of the design and construction of full coverage restorations with regard to esthetic appearance and gingival health. Esthetic appearance with full coverage restorations is dependent on anatomic form, the materials used, and the maintenance of gingival health.

Authors categorize macro-esthetic criteria based on two reference points: the facial midline and the amount and position of tooth reveal. The facial midline is a critical reference position for determining multiple design criteria. The amount and position of tooth reveal in various views and lip configurations also provide valuable guidelines in determining esthetic tooth positions and relationships. He concluded that Macro-esthetic components of teeth and their relationship to each other can be influenced to produce more natural and esthetically pleasing restorative care.[3]

This article[4] describes the morphology of gingival contours as flat or pronounced, scalloped, the gingival reflecting the underlying osseous topography. The flat periodontium is usually thick with the gingival margins being at or coronal to CEJ. A pronounced scalloped periodontium is usually thin, with gingival margins being at CEJ. Author suggests that patients with a thin scalloped periodontium may be susceptible to gingival recession.

The author[5] describes factors associated with health of gingiva

a. Oral hygiene exerts a more important influence on the health of the gingiva and mucosa adjacent to fixed prosthesis than does the height of the embrasure.

b. Poor oral hygiene causes inflammation of the interdental gingiva, mucosa and filling in of the embrasures. Even with ideal oral hygiene, there is a slight increase in the size of the interdental gingiva and mucosa.

c. The oral mucosa is more likely to remain healthy under spheroidal or modified spheroidal pontics than under ridge lap pontics.

The article[6]describes a systematic, orderly approach to the problem of establishing harmonious phonetics, esthetics, and function in fixed restorations has been described. The system requires an initial investment of time in performing an adequate diagnostic waxing, but recoups that time in many clinical and laboratory procedures. The method has proved a valuable asset in fixed prosthodontic care. The technique can be expanded and combined with other techniques with a little imagination and artistic bent.

The author[7] reviewed factors associated with smile. Understanding of smile involves close scrutiny of all elements of the oral region. It is not enough to establish the size of teeth based on the high and low lip lines, size of the mouth, and a shade to blend with the age and complexion. To create a harmonious smile the dentist must maintain or create the normal curvature of lips, proper exposure of the red zone of the lips, an undistorted philtrum, and undisturbed naso labial grooves. These entities, maintained in harmony with the exposed teeth, constitute the anatomy of a smile.

The author[8] suggest that the angulations of the implants and alignment are critical for the success. This problem will be evident on placement of the metal capping inserted within the implant. His article describes a technique allows the removal of the capping from the master cast for modification and provide easy verification for parallelism

between the coping insert and the other abutments by using a dental surveyor. Vertical reduction of coping insert to provide accurate occlusal clearance is also possible after the master cast are mounted in an articulator at the appropriate inter occlusal distance.

The purpose of this study[9] is to present a new flap design for the preservation of post operative gingival recession adjacent to maxillary anterior sites that received dental implants. The results of the study suggest that post operative recession can be significantly minimized. The gingival papilla was released from the adjacent tissues and the labial flap was extended to or slightly elevated crest. They were released from adjacent teeth on the palatal aspect creating a palatal envelope flap. Author also suggested the use of the expanded PTFE (PolyTetraFluroEthylene) which may protect the crest resulting in undisturbed wound epithelisation. Placement of provisional restoration at 2nd stage surgery may support the newly positioned gingival margins.

The author [10] states that replacement of intraoral soft and hard tissue is dependent on careful dimensional considerations. The prosthetic phase of implant treatment frequently involves the restoration of significant amount of soft and hard tissue in addition to the teeth. Although similarities to both fixed and removable prosthesis exist, implant supported prosthesis engender unique problems specific to prosthetic contours. The article depicts diagnostic methods to compare existing prosthesis volume with clinical condition. The proper functional, esthetic, biofunctional design of the definitive prosthesis will be shown to relate directly to understanding to these dimensional requirements.

This article[11] describes a procedure for fabricating an index to accurately transfer the ideal position of several 17 degree angulated abutment from master cast to mounting a predictable way. After the final try-in, evaluation of the space available & angulation of the implant is made to choose the appropriate abutments within the contours of final restoration. A customized index was also developed to accurately transfer the position of those 17 degree angulated abutment from the master cast to the mouth in a precise manner.

The author[12] present a procedure for inserting healing abutments at stage II surgery phase for completely edentulous patients. In situations where the top of the implant is more than 2-3mm sublingual, fabrication of the metal framework and evaluation of the fit of the framework becomes technologically demanding. In such situations, the use of Precison Margin Esthetics (PME) transmucosal abutments may be indicated. PME abutments can be used to elevate the abutment/prosthesis interface from extremely sublingual or even supralingual. PME abutments are available in four heights 3,4,5 &6 mm. The height to be used is usually determined after stage II surgery has healed and before final impression is made.

The author[13] presents a case report where after the healing abutment or provisional restoration is removed, the gingival contour changes quickly. It is important that this contour is maintained so that when the restoration is repositioned, it produces as little pressure & discomfort as possible on the surrounding tissues. When the clinical situation presents a small number of implants, the healing abutments can be repositioned quickly and will maintain the gingival profile. The article describes a simple & quick method of temporarily maintaining the tissue profile. This method is especially effective when a

provisional restoration has been customizes to allow the tissues to take on a particular shape. The method described in this clinical report will maintain any gingival contour. However, care must be taken that when removing the registration, material is not inadequately left behind the implant, which may create an impediment to seating of the fixation screw.

In this article[14], the author describes about the flap technique and graft for both maxilla and mandible. In the maxillary flap region tubed pedicle flap technique performed with a free subepithelial CT graft offers a means to improve the profile of the ridge. In the mandible the goal should be to provide sufficiently broad zone of attached gingival around the implant lingually and buccally.

In this article[15] the author has presented case reports with the use of bone graft to achieve soft tissue aesthetics. Author has concluded that the cortico cancellous graft is to be one of the predictable methods in restoring bony defects as it gives proper bone framing around the implant even after remodeling. Autogenous bone grafts is more predictable than allogenous and it provides better quantity and quality of bone. However the allogenous grafts do not require invasive surgical procedures but at the expense of quality and quantity of the bone. Author emphazises that autogenous graft should be used in situations of extensive bone loss and allogenous bone graft when defects like small fenestration, labial dehiscence or extraction socket are present.

This article[16] describes a new method for fabrication of an index for definitive implant abutment selection, framework design & fabrication. After the interim removable is esthetically & functionally accepted by patient, it can be used as a surgical guide for

implant placement as well as guide for abutment selection, framework, design & fabrication. The concepts used in the fabrication of the cross mounting buccal index include having a reference point, maintaining the VDO & ability to transfer index

Author[17] describes that edentulous patients with optional hard and soft tissues can be treated with a special designed removable prosthesis that will develop gingival contour prior to implant placement. By means of transitional complete removable prosthesis with ovate pontics and no labial flange, a natural looking soft tissues profile can also be developed. The use of ovate pontics in both interim and definitive fixed prosthesis to support facial and interproximal tissues is not a new concept to achieve gingival contours.

The author [18] shows that the use of connective tissue as a graft gives a predictable result because the graft by virtue of being contoured and embedded underneath the tissue, recives a rich blood supply from its recipient site. The reestablishment of normal tissue volume, contour, architecture may require the use of various augmentation techniques. The modified roll technique has been shown to increase the amount of connective tissue. The use of gingival onlay graft can avoid scar formation and prevent apical relapse of marginal gingiva.

This article[19] focuses on the treatment phase in which teeth and/or transitional implant supporting a provisional fixed partial denture is removed. The described technique makes use of healing abutment to support a modified provisional FPD. This protocol ensures patient comfort and allows proper soft tissue healing before definitive implant abutment selection. It also eliminates the placement of interim implant abutment.

The authors described the various prosthetic abutments that are used in implant dentistry and highlightened their various applications. Different types of prosthetic abutments described were: i) Memory abutment, ii) UCLA abutment, iii) Cera One abutment, iv) UMA abutment, v) Esthicone abutment, vi) Miruscone abutment, vii) OCTA abutment, viii) Apic Combo abutment, ix) Procera abutment, x) Atlantis permanent healing abutment, xi) Ceradapt abutment, xii) Ti Adapt abutment, xiii) Aur Adapt abutment, xiv) Multi-Unit abutment, xv) Overdenture abutments. They concluded that no single abutment fulfills the criteria in all possible situations. To achieve the best of the prosthetic results, it is essential to have sound knowledge of different abutment systems and establish a rapport between the laboratory technician and restorative dentist.[20]

Author[21] present review of various approaches for management of interdental papillae. Several reason contribute to the loss of interdental papilla & the establishment of " Block Triangles" between teeth. However, abnormal tooth shape , improper contours of prosthetic restoration & traumatic oral hygiene procedure may also negatively influence the outline of interdental soft tissue. Several surgical & nonsurgical techniques have been proposed to treat soft tissues deformities & manage the interproximal space. The nonsurgical approaches modify the interproximal space, thereby inducing modifications to the soft tissues. The surgical techniques aim to recontour, preserve or reconstruct the soft tissue between teeth & implants.

The article[22] deals with satisfaction and financial aspect of the patient for achieving beautiful smile. Many dental patients are unhappy with their smile but believe a beautiful smile is outside their budget. The first step is to listen to the patient in order to understand what his or her primary concerns are. The second step is to examine carefully and analyze the case to develop a treatment plan that will fulfill as much as possible of the patient's

desires within the context of his or her constraints (financial or otherwise). Also, remember that dentistry doesn't end when the last veneer is placed or the last bill is paid. The final step is to maintain a strong relationship with your patients to ensure good oral hygiene and restorations that are as long-lasting as they are beautiful.

The article[23] describes the influence of lip in achieving optimum esthetics The lipline and lip support influence esthetics & selection of implant supported Prosthesis design for maxillary edentulous patients. This article describes a procedure to analyze the influence of lipline & support of esthetics of an existing maxillary CD, revealing potential limitations when planning a fined implant supported prosthesis.

Article[24] presents an approach is desired for the missing IDP associated with multiple adjacent maxillary anterior implants. The use of one implant instead of multiple implants to support a cantilever FPD with an acute pontic successfully enhanced the soft tissue contours to satisfy the patients aesthetic needs.

The article[25] present the use of the autogenous gingival graft has proved to be an effective and predictable way to increase the amount of keratinized gingival. Acellular dermal matrix(ADM) allograft can be used a donor site to eliminate the need for another surgical site. The purpose of the study was to evaluate the effectiveness of ADM allograft in increasing the width of keratinized gingiva. A patient with inadequate keratinized gingival in maxillary and mandibular anterior region received either an ADM graft or palatal autograft by random allocation. The widths of keratinized gingival and other clinical periodontal parameter were recorded initially & at 3 or 6 months after surgery.

Both graft provided satisfactory result. The width of keratinized tissue was increased by using the ADM allograft, but by lesser amount than with the autogenous gingival graft.

Author[26] describes the use of the provisional restoration as a radiographic guide. Radiographic imaging using radiographic guides provide data to select implant dimension, position and to plan implant placement, angulation in advance. Duplication of provisional restoration to fabricate guides involves lab work, chair side time, material and also endure damage to provisional. Author describes a novel approach in which provisional serves as guide thus eliminating the disadvantages involved in the duplication process.

Procedure is described as:-

- After fabrication of provisional, a rectangular recess is made as the buccal and palatal aspect in each restorative unit to be replaced later by implant supported prosthesis. Ensure that the spaces are 1-2mm deep and not closer than 1mm to the planned implant contact points

- Minimum acrylic resin powder with Barium powder at a ratio of 4:1. Add monomer to create uniform viscous dough.

- Place the dough inside the rectangular spaces.

- After setting, the radiograph is made. Barium markers will be apparent in section as future implant site

Flat platform implants may present a limitation when irregular or scalloped bone topography is encountered resulting in compromised periimplant bone and soft tissue contours. This article[27] describes the success rate and periimplant tissue response of scalloped implants undergoing immediate provisional restoration in the maxillary esthetic zone. The result showed that although favorable implant success rate & periimplant tissue response can be achieved with immediate provisional restoration of scalloped implants in the esthetic zone, bone was not maintained at the original levels around the scalloped area of the implants.

This article[28] describes a technique for fabricating cement retained crowns over a customized gingiva colored composite resin screw retained implant infrastructure. This prosthetic design is not significantly influenced by unsuitable implant position, alignment or angulation. Consequently, the cement retained crown can be reproduced in an esthetically and functionally appropriate morphology, regardless of where the screw access openings are located in the infrastructure.

This article[29] emphasizes about the soft and hard tissue characters and their evaluation for placing implant in an ideal position, so that it can be restored with esthetically acceptable soft tissue contours.

In the article[30] the author presents two clinical cases of single tooth implants placed in the aesthetic region. For both cases a tissue punch technique using a special guide fabricated with the aid of a radiographic stent was performed to provide access for implant preparation and placement. With the planned flapless technique, reduced operative time, accelerated post surgical healing and increased patient comfort and

satisfaction was achieved. Paper also describes the precaution regarding case selection, surgical and prosthetic protocols.

DISCUSSION

ESTHETIC PRINCIPLES [31,32,33.]

Certain esthetic principles can be applied to the dentofacial complex and thus by combining artistic creativity with science discretion, an esthetically appealing smile window can emerge.

1. COMPOSITION (Fig. 1, 2) : vision is possible only if there is contrast. The relationship between objects made visible by contrasts is called composition, which can be classified as:

a) Dental composition

b) Dentofacial composition

c) Facial composition

2. UNITY : Gives the different parts of the composition the effects of a whole. Unity can be:

a) Static: as seen in inanimate objects like snowflakes and crystals.(Fig. 3)

b) Dynamic: active, living and growing as in plants and animals. (Fig 4)

3. COHESIVE AND SEGREGATIVE FORCES :

a) Cohesive forces: Elements that tend to unify a composition, represented by elements arranged according to a principle.(Fig 5)

b) Segregative forces: Elements that break the monotony of the composition to provide variety in the unity.(Fig 6)

Harmony depends on the equilibrium created by cohesive and segregative forces.

4. SYMMETRY : Refers to the regularity in the arrangement of forces or objects ***(Furtwangler, 1964).*** Symmetry can be:

a) Horizontal/running: occurs when a design contains similar elements from left to right in a regular sequence.(Fig 7)

b) Radiating: occurs as a result of the design of objects extending from a central point with the left and right sides being mirror images.(Fig 8)

Note: Horizontal symmetry that is psychologically predictable tends to be monotonous (cohesive forces); where as radiating symmetry generally represents a segregative force that brings life and dynamism to a composition.

5. PROPORTION & REPEATED RATIO :

a) Proportion: To speak of proportion stems from a notion of relationship, percentage or measure in its numerical determination and implies the quantification of norms that can be applied to every physical reality.

Various philosophers have desired to prove the hypothesis that beauty could also be expressed mathematically.

E.g. GOLDEN PROPORTION (Pythagoras): 1/1.618 = 0.618

BEAUTIFUL PROPORTION (Plato): 1/1.733 = 0.577

The Pythagorean concept can be found in the composition of the great classical painters and a meticulous analysis of some masterpieces has evidenced its master full application.

Although by reason of facts proportion is mathematical, it seems more pertinent today to combine the numerical quantification of beauty with its psychophysical quantification.

b) Repeated ratio: The division of a surface into parts that contrast in shape and size but are yet related to each other through a certain repetitive mathematical factor is called repeated ratio.

6. BALANCE : Stabilization resulting from exact equilibrium between opposing forces. In balance, weight of the elements further from the fulcrum or center grows in importance. If any element is imbalanced on one side:

Move the causative element toward the line of forces or midline to relieve visual tension.

Introduce an opposite element along the same line of forces to promote equilibrium.

7. LINES : Many factors that are part of biologic or structural beauty depend on the visualization of lines. Dental compositions contain a multitude of lines that are more or less expressed as the occlusal plane, midline or tooth direction.

8. DOMINANCE : Implies the presence of subsequent similar elements. The stronger the subsequent element, the stronger the dominating element and more vigorous the composition will be. Colour, shape, and lines are factors that can create dominance. It is the key factor required to provide a broadened appraisal of dentofacial composition and the necessity for a harmonious integration of dental composition into facial structure.

FACTORS OF ESTHETIC DENTOFACIAL COMPOSITION AND THEIR CLINICAL SIGNIFICANCE

An organized and systematic approach is required to evaluate, diagnose and resolve esthetic problems predictably.

The two main objectives in Dental Esthetics are:

To create teeth of pleasing inherent proportions and of pleasing proportions to one another.

To create a pleasing tooth arrangement in harmony with the gingiva, lips and face of the patient.

The esthetic orientation of the dental composition with the entire facial composition can be achieved by taking into consideration the references, smile elements, proportions and symmetry.

Four factors of esthetic composition can be simply and effectively be applied to the smile. They serve to assist the clinician in determining adequate tooth display, tooth size, tooth arrangement and orientation to the face during esthetic diagnosis and treatment.

1. FRAME & REFERENCE
2. PROPORTION AND IDEALISM
3. SYMMETRY
4. PERSPECTIVE & ILLUSION

These factors will be dealt with under various headings relating to the components of the dentofacial complex, namely:[31]

1. FACIAL COMPONENTS

2. DENTAL COMPONENTS

3. GINGIVAL COMPONENTS

4. PHYSICAL COMPONENTS

I. FACIAL COMPONENTS: Frontal view, Lateral view.

FRONTAL VIEW: References, Upper, lower Lip Support.

A) REFERENCES (Fig 9)

The anatomical elements of the face and the biological elements that include the functional and phonetic elements provide the reference frames and guidelines to help the dentist to achieve a general sense of orientation and diagnosis.

References can be classified as:

i)Horizontal References

A horizontal perspective of the face is provided by:

- Interpupillary Line
- Ophriac Line
- Commissural Line

The general direction of the incisal plane of the maxillary teeth and gingival outline must parallel the interpupillary line, whereas the ophriac and commissural lines serve as accessory lines. This harmony must be further reinforced by the incisal plane following the lower lip line during smiling.

Horizontal disharmony:

When an imaginary line drawn across the gingival margins is not parallel to tile interpupillary line, a canting of the maxilla is indicated. Certain amount of canting is considered normal and in such case a mild correction of the gingival margin can be done by surgically elongating the central incisor on the lower aspect. Severe canting may require an inter-disciplinary approach involving orthodontics and surgical repositioning of the maxilla. In some cases the ideal harmony between the interpupillary line, the commissural line, and the horizon is lacking. The first two guidelines, both individually and together, may not in fact be parallel to the horizontal plane. In other cases, these lines, although slanted, are still parallel to each other, creating a generally oblique facial orientation in relation to the horizontal plane

Prosthetic considerations and applications:

The interpupillary line is generally taken as the horizontal plane of reference. However, the eyes, or even the corners of the mouth, are not always positioned at the same height. In such cases, the horizon is taken as the idea reference plane; regardless of whether or not the interpupillary line and the commissural line are aligned with it. The horizon cannot function as an absolute reference, however. In cases of lack of parallelism between the horizontal plane and the inter- pupillary and commissural lines, it the latter lines are still parallel with each other, they can in fact be used as a reference for the pros-thetic rehabilitation.

If both lines are out of parallel with each other as well as with the horizon, the clinician must discuss with the patient which reference line to choose. The correct use of a facebow will allow the clinical situation to be replicated faithfully on the workbench.

ii) **Vertical References**

The facial midline is an imaginary line that runs vertically from the nasion, through the subnasal point and the interincisal point to the pogonion. The T -effect created by the interpupillary line perpendicular to the facial midline, is emphasized in a pleasing face. The facial midline serves to evaluate: the location and axis of the dental midline mediolateral discrepancies in tooth position

Vertical Disharmony:

As already stated, glabella, the tip of the nose, and the chin are the reference points for defining the midline in the lower half of the face. Nevertheless, these do not always provide a reliable reference because they often differ from the main axis .For this reason, the center of the upper lip can be used as the ideal reference for determining the patient's facial midline.

Prosthetic considerations and applications:

From the prosthetic viewpoint, little importance is attributed to any eventual median asymmetry that may exist. Therefore, the reconstructions can be integrated within

the global context of the face without taking this disharmony into account, but giving priority to the verticality of the interincisal line. The clinician should illustrate for patients the parameters that can be considered in their case and evaluate with them the suitability of the solution chosen.

iii) Sagittal References (Fig 10)

The contours of the upper and lower lip are part of the profile analysis and can be used as a guide to tooth positions. Various soft tissue analyses are available for the assessment of the profile convexity, amount of lip protrusion or retrusion, and prominence. For more complex situations and especially those with skeletal abnormalities, an orthodontic consultation with cephalometric analysis is strongly recommended.

Upper Lip Support: Upper lip support is controlled to a certain extent by the position of the maxillary teeth. The gingival 2/3rd rather than the incisal1/3rd of the maxillary central incisors, contributes to the main support of the lip.

According to Pound, tooth position more significantly affects thinner and protruded lips than lips that are thick, retruded or vertical.

According to Maritato & Douglas cephalometric studies, lip support is a better guide of tooth position than incisal edge position.

Lower lip relation: The relationship of the maxillary incisal edges to the lower lip is a guide for the general assessment of incisal edge position and length. When "F" or "V" consonants are pronounced, the incisal edges should make a definite contact at the inner vermilion border of the lower lip. These positions are valuable in determining the facial position of the incisal 1/3rd of maxillary central incisors, which must conform to the path of closure of the lower lip.

Prosthetic considerations and applications:

In patients in whom the vertical dimension is decreased, the variation in height of the lower third of the face is particularly noticeable, thereby emphasizing the strict ratio between the height of the occlusion and that of the lower third of the face. In such patients a reduction in labial visibility is often seen, with the edges of their lips tending to fold inward, along with a deepening of the chin concavity below the bottom lip. Clinical evaluation to quantify the increase in vertical dimension is carried out by the use of phonetic testing, which is normally sufficient to identify the required increase. Recourse to cephalometric analysis can also be useful for this purpose, providing important indications to be integrated with those obtained clinically. The suitability of the choice that is made will be corroborated by the adaptability that the patient shows to the new clinical situation once the provisional restorations are placed in the oral cavity.[40] The new vertical dimension, once tested in this way, must be faithfully reproduced in the final restorations, since it is essential to patient rehabilitation from both the esthetic and the functional viewpoints.

LATERAL VIEW: Profile, Eline: Nasolabial Angle: Labial Philtrum: Occlusal Plane:

A) PROFILE

Appropriate clinical evaluation of the lateral view is a determining factor in successful completion of an esthetic examination of the patient. The natural head posture is checked by using the Frankfort plane as a reference. This is identified at the front by the lowest point of the orbit (orbitale) and at the back by the top of the osteal acoustic meatus (porion). The Frankfort plane represents, by definition, the horizontal plane, even if during clinic observation it is in fact parallel with the horizon only when the patient bends the head slightly forward .Conversely, when the patient's head is held erect, with the eyes gazing towards horizon, the Frankfort plane lifts upward at the front to form an angle of about 8 degrees with the arbitrary horizontal plane that commonly referred to as the esthetic plane.

Normal profile: The profile is evaluated by measuring the angle formed when three reference points on the face are joined together: glabella, subnasale and the tip of the chin.

Convex profile: the size of the angle formed between the three reference points is substantially reduced creating a marked posterior divergence.

Concave profile: The size of the angle formed between the three reference points is substantially greater than 180 degree creating a marked anterior divergence.

B) ELINE:

Esthetic line is an imaginary line connecting the tip of the nose to the most prominent part of the chin. Ideally the upper lip is 1-2mm behind and the lower lip, 2-3mm behind the E-line. Helps in determining profile type.

C) NASOLABIAL ANGLE:

The nasolabial angle is formed by the intersection of two lines at the level of subnasale, one tangent to the base of the nose and the other tangent to the outer edge of the upper lip. The size of this angle is obviously affected by the inclination of the base of the nose and by the position of the upper lip. In subjects with normal profiles, the naso-labial angle is approximately 90 to 95 degrees in men and 100 to 105 degrees in women.

Prosthetic considerations and applications:

Nasolabial angles, like the E-line, can change significantly following restorative-prosthetic treatment.Although it is advisable to maintain the characteristics of the patient's race, care must be taken not to make changes to the dental position that would

interfere with the muscular areas, composed of the tongue internally and the lips and cheeks externally.

D) LABIAL PHILTRUM:

Another interesting anatomic aspect is the height of the labial philtrum, which is measured from the base of the nose (sub-nasale) to the bottom edge of the upper lip The labial philtrum measurement is, as a rule 2 to 3 mm shorter than the height of the labial commissure, which is also measured from the base of the nose.In young subjects it is easy to find a labial philtrum much shorter than this as a result of differentiated vertical growth of the upper lip. This means that the maxillary incisors are much more visible in young people, than adults, the presence of a labial philtrum that is too short creates an inverse line in the upper lip when at rest. This is rarely seen and therefore is perceived as abnormal and unattractive from an esthetic viewpoint.

Prosthetic considerations and applications:

The indications provided by the patient's lips and profile can suggest the ideal shape and size of anterior restorations. Inconspicuous maxillary central incisors can be considered a natural and useful compensation for balancing the esthetic appearance of a patient with a convex profile, especially in the presence of thin lips. Conversely, greater dental dominance can be pleasing in a concave profile, especially if the patient has thick lips.

E) OCCLUSAL PLANE:

The occlusal plane is the common plane established by the incisal and occlusal surfaces of the teeth and conventionally coincides (with minor variations) with Camper's plane, which is a plane extending from the inferior border of the ala of the nose to the superior border of the tragus of the ear.

1.1 Phonetic references

Phonetic tests are a reliable aid in making a correct esthetic and functional diagnosis. They can give useful indications for establishing both appropriate tooth position and length, as well as for determining a suitable vertical dimension of occlusion.

Although they are a valid aid in drawing up a correct treatment plan, the results of the phonetic tests must still be compared with the findings of other dentofacial analyses.

In fact, it may be necessary to choose between apparently conflicting findings; in such cases, after having evaluated the test results as a whole, the clinician will have to make a choice based on clinical experience and insight.

Prosthetic considerations for esthetic rehabilitation(refer table:)

PROSTHETIC CONSIDERATIONS FOR ESTHETIC INCISAL EDGE POSITION

Idealize incisal edge position, evaluating dentolabial. Phonetic (s and f/v), and functional parameters.

PHONETIC TESTS:

Evaluate tooth exposure during pronunciation of phonemes

M-With lips at rest, exposure from 1 to 5 mm

E-80% of interlabial space should show in young subjects, less than 50% of interlabial space in elderly subjects

"F/V: Incisal edge just brushing lower lip.

TOOTH DIMENSION AND PROPORTION:

Optimize dimensions and proportions

Maxillary central incisor: Width from 5.3 to 9.3 mm, length from 10.4 to 11.2 mm

'Width-length proportion should equal 75% to 80%

LENGTH OF ADJACENT TEETH:

Modify tooth length while maintaining harmony with adjacent teeth.

SMILE LINE/GINGIVAL LEVELS (Fig 11,12,13)

Evaluate tooth display during smile and respect tooth dimensions and proportions while making any adjustments to cervical length.

F) Visibility

The amount of tooth exposure when lips and lower jaw are at rest is, like body posture, a muscle determined position. An interesting study related to tooth exposure according to gender, racial factors, 8ge and lip length elucidated the extreme variability of this factor.

Tooth exposure showed an increase from Blacks to Asians and Whites for maxillary central incisors and for mandibular central incisors from Asians to Blacks and Whites.

People with short upper lips expose the maximum maxillary incisor texture, where as people with long upper lips expose predominantly lower incisors.

Lip length (mm)	Exposure of maxillary vertical incisor	Exposure of mandibular central incisor
10-15	392	0.64
16-20	344	077

21-25	218	098
26-30	0.93	1.95
31-36	0.25	2.25

The study evidenced a significant decrease of maxillary tooth length exposure relative to age, predominantly between age 30 and 40 years, and a proportionate increase of mandibular incisor exposure, a situation esthetically, unanimously rejected.

The average maxillary incisor display with lips at rest is 1.91 mm in men and 3.4mm in women.

G) Components of the Smile

The individual's ability to exhibit a pleasing smile directly depends upon the quality of the dental and gingival elements that it contains, their conformity to the rules of structural beauty, the relations existing between teeth and lips during smile, and its harmonious integration in the facial composition.

Smiles can be classified as:

Passive: slight parting of lips showing incisal portions of anterior teeth.

Active: shows more teeth, some gingiva and negative space with lips slightly stretched at the corners.

Laugh: maximum exposure of teeth and gums in ari enlarged smile window.

i) Lip Lines(Fig 14,15,16)

The amount of tooth exposure during a smile depends on a variety of factors like degree of contraction of muscles of expression, soft tissue levels, skeletal particularities and design of restorative elements, tooth shape or tooth wear.

Upper lip line. Helps to evaluate maxillary incisors exposed at rest and during smile and the vertical position of the gingival margins during a smile.

It can be classified as low, moderate or high depending upon the amount of tooth or gingival display at rest or during a moderate smile.

A smile can be termed "toothy" if more than 6mm of incisal display is seen at rest, or "gummy" if more than 3mm of gingival tissue are displayed in a moderate smile.

The ideal location of the upper lip height relative to the central incisor is at its gingival margin or 1mm above it displaying the interdental papilla between the two central incisors during a moderate smile.

Lower lip line: helps to evaluate the buccolingual position of the incisal edge of the maxillary incisors and the curvature of the incisal plane.

ii) Incisal Plane (Fig 17)

When the incisal edges of the central incisor and the canine are aligned on a convexity, the incisal plane is convex. When the incisal edges of the central incisor and the canine are aligned but are longer than the lateral incisor, the incisal plane has a **"gull-wing"** configuration.(Fig. 18) A combination of these two pleasing arrangements is often observed in the same mouth.

iii) Smile line

An imaginary curved line passing through the incisal edges of the upper anterior teeth, usually parallel to the curvature of the inner border of the lower lip. Degree of curvature of the smile line is more pronounced in women than in men. Youth is expressed with prominent and well developed central incisors, well-defined incisal embrasures and a convex or *"gull-wing"* smile line. A straight smile line is associated with wear and aging.

Accessorily, the convexity of the smile line may be restored to distract attention from displeasing facial features. Riley recommends compensating a pointed chin with a flatter smile curve, or conversely, balancing a square face with a relatively accentuated smile curve.

Displeasing patterns include a reverse or concave smile line, or an excessive convexity.

Upper lip curvature

Is expected to run upward from the central position to the corners of the mouth depending on the sequence and degree of implication of facial muscles in the development of a smile.

iv) Negative space (Fig. 19,20)

Can be described as the dark space that appears between the jaws at the corner of the mouth or around the facial aspect of posterior teeth during laughter and mouth opening. It contributes to the individualization of the dental composition that IS projected by colour contrast. This lateral negative space that results from the difference existing between the widths of the maxillary arch and the smile has been described to be in golden proportion with the anterior smiling segment.

v) Smile symmetry

Symmetry can only be perceived in reference to a hypothetical central point or central midline. It may be horizontal or radiating symmetry depending upon patient preference. In a natural pleasing smile, pleasing tooth symmetry is found close to the midline and pleasing irregularity away from the midline, creating a balance between idealism and diversity.

vi) Smile dominance

Frush & Fisher and Lombard emphasized the need for the maxillary central incisor to be of sufficient size to dominate the smile, because any composition is based on dominance of a major element.

Guidelines for pleasant smile dominance:

- **Dominance of the central element.** Maxillary central incisors exhibit a strong presence by their size and form.
- **Complementary subsequent elements:** Maxillary lateral incisors and canines complement the central incisor in terms of proper shape and form.
- **Pleasing relative proportion:** Although numerically, all proportions of the anterior teeth do not follow the golden rule, the teeth are so placed; they appear in suitable proportion with each other.
- **Order in composition:** Similar recurring ratios are observed in the teeth from the central incisor to the premolar.
- **Dynamism of smile:** Well coordinated movements of the lips with the other peri-oral musculature and corresponding harmonious facial expressions, contribute to the pleasant face during smile.
    - **Centralized element for unity:** The complexion and texture of the face contrast with the lip color, gingiva and teeth leading to a distinct demarcation between the oral and facial frame.

2) DENTAL COMPONENTS: Dental midline, Tooth proportion, Symmetry / Asymmetry, Dental morphology.

A) Dental midline : Both facial and dental midlines are the necessary vectors that enable esthetic appraisal through the perception of the parameters of symmetry and balance. Logically, the dental midline should coincide with the facial midline. However, the lack of coincidence between the location and direction of the two midlines is no esthetic liability unless there is a distinct discrepancy. Verticality of the midline is more critical than its mediolateral position.

Golub cautions against achieving a perfectly centered midline with the face because it creates too much uniformity. Conversely, a vertical and centered midline may be used to avert attention from asymmetrical facial features.

Research has statistically demonstrated using the lip philtrum as a reference guide, that the maxillary midline coincided precisely with the facial midline in 70% of the cases, and that esthetics was not compromised by a slight deviation from the central midline. The same study revealed that maxillary and mandibular midlines failed to coincide in 75% of the cases.

Anatomical landmarks like the incisive papilla or the labial frenum are used to center the midline precisely.

B) Tooth proportion (Fig 21) : Tooth proportion is computed by dividing the width *of* the clinical crown by its length, which is ideally 75% to 80% for maxillary central incisors. Below 65%, the central incisor may appear too narrow, as in Implant crowns or

after periodontal surgery. Above 85%, the incisor may appear too short and square, as in attrition or with altered passive eruption.

i)Proportion determined by statistical averages:

The average WIL ratio of a maxillary central incisor ranges from 0.74 to 0.89. Wheeler suggested a proportion of 0.8 (8.5 mm 110.5 mm) for carving technique and this is consistent with the averages of 0.8 (8.5mm I 10.4 mm) found by Shillingberg et al, 0.8 (9.0 mm /11,2mm) by Bjorndal et al and 0.76 (8.6 / 11.2 mm) by Woelful.

ii) Proportion determined by face form:

There are various theories proposed:

Hall (1887) proposed the "typal form concept' classifying natural teeth into ovoid, tapering and square categories.

Berry's biometric ratio advocated that the outline of the inverted maxillary central incisor closely approximates the out line form of the face. He also postulated with House & Loop that the mesiodistal width of the tooth was 1/16 of the bizygomatic width.

This geometric theory was challenged when Frush & Fisher (1956) introduced the "Dentogenic theory" where tooth selection is governed primarily by SAP (Sex, Age, and Personality).

Scientifically, however, correlating tooth form with facial form has been widely refuted.

iii) Proportion determined by dentist and patient Preference:

Woodhead and McArthur separately demonstrated that molds of maxillary central incisors were narrower mesiodistally than extracted teeth. Kern studied 509 skulls and found the "biometric ratio" of 1 /16 only on 31 % of skulls. 60% skulls revealed ratios of 1/14 and 1/15. Brisman evaluated preferences of, patients and dentists and found preference on drawings of the central incisor for 0.75 or 0.80 W/L ratio. On photographs, however, patients still favored the 0.80 ratio while dentists selected longer and narrower teeth with a ratio of 0.66, possibly conditioned by denture tooth selection.

iv) Proportion determined by anatomic consideration Isolated studies find some relation between the sizes of the maxillary central incisor anc1 various anatomic features. However, the evidence remains too thin to strictly correlate the shape of maxillary central incisor with a facial landmark

"The Golden proportion" [22, 31,33.] (Fig. 22)

The definition of the laws of beauty and harmony been a constant preoccupation of Greek philosophers and mathematicians. The connection of beauty with numerical values conforms to the philosophy that beauty always-appears as fundamentally exact. The finding of an intriguing relationship in the harmony between two parts, which can be described as follows, has been attributed to Pythagoras: the smaller to the larger is equal to the sum of the whole related to the larger

Ever since its formulation in antiquity, this number called the “gold number” or "golden section," has attracted the attention of mystics, artists", and scientists. Johannes Keppler (1611) saw in this golden section an idea used by the Creator to generate the similar form " and its esthetical value was stressed by Luca Pacioli in his book divine proportione (1509) illustrated by Leonardo da Vinci. The extension of the study of the golden number from its linear form to the surface form is attributed to Hambridge,and more recently Le Corbusier developed a scale based on the golden proportions of the human body that he intended to integrate in a dimensional living space in accordance with its movements and positions. Harmony in proportion has been defined as an esthetic principle part of the essential beauty. When considering the size and design of natural elements, we must always keep proportion in mind because this golden relationship has been demonstrated in organic forms of nature and in animal and human forms.

The reason that elements perceived through the envision of this golden number are different from any other

The application of the golden number to dentistry was first mentioned by Lombard and developed by Levin. Levin observed that the most harmonious recurrent tooth-to-tooth ratio was found in the golden proportion. This implies that the maxillary central incisor should be approximately 60% wider than the lateral incisor, which in turn should be 60% wider than the mesial aspect of the canine, the distal aspect of the canine being obscured from the facial aspect. He further demonstrated that the lateral negative space, the area that appears between the anterior segment of the teeth and the corner of the mouth on smiling, is in golden proportion to one half the width of this anterior

segment. He developed a grid to help the prosthodontist detect what is esthetically wrong in the anterior proportional relationship.

C) Symmetry / Asymmetry

Dental symmetry relates to the right and left sides of the midline. The goal is to strike a pleasing balance between idealism and deviation, because naturally esthetic dentitions do have subtle asymmetries.

Rules of symmetry / asymmetry for maxillary anterior teeth :

i) Symmetry: (Fig 23)

- The dental midline is straight.
- The smile line follows the convexity of the lower lip
- The central incisors are symmetrical
- The gingival margins of the central incisors are symmetrical.
- Incisal embrasures gradually deepen from the central incisors to the canine.
- The incisal plane is either convex, sinuous, or a combination of both.
- Mesial tooth inclinations are more pleasing the distal inclinations.

ii) Asymmetry: (Fig 24)

- The dental midline may be slightly oblique in relation to the facial midline.

- The incisal edges of the central incisors may be slightly misaligned if their gingival margins are not level.
- Teeth should not be aligned in all three planes of space to suggest alignment; they should diverge in at least one plane.
- The central incisors may slightly overlap the other or occupy a more facial position or may be slightly rotated facially.
- A central incisor may be more, mesially inclined than the others.
- The distal incisal angle of the central incisor may be bilaterally asymmetrical.
- Lateral incisor may differ bilaterally in shape inclination, abrasion, and gingival rotation their margins do not need to be level.
- The labiolingual inclinations of the canines may be slightly asymmetrical.

iii) Axial inclination(Fig 25) Is the direction of teeth with respect to the central midline. There is a definite mesial inclination of all anterior teeth as well as the premolars and first molars relative to the midline.

Equilibrium is realized around the central fulcrum. In the natural dentition, we notice a wide range of deviation from the standard axial incisal inclination. In the presence of moderate and pleasing axial deviation, these inclinations most often singularize and enhance the personality, provided equilibrium or a balance of lines has been achieved around the central fulcrum. Deviations beyond a certain degree of equilibrium are invariably rated as unattractive. Also, when equilibrium of axial tooth

inclination has not been achieved in the dental composition, the resulting visual tension may also point out a possible factor of occlusal instability.

D) Dental morphology

Teeth have generally been defined according to their two-dimensional outline, but their successful characterization depends on the evaluation and reproduction of three-dimensional characters.

i) Texture

We are able to evaluate texture optically through the amount of light reflected or deflected. The characterization of the tooth surface is a function of two types of convexities and concavities:

Anatomic grooves, facets and prominences that exist in various degrees on any tooth surface.

The perikymatae, stippling and rippling that may affect the enamel surface.

The quality of an artificial tooth directly depends upon the blending of light effects that produce a result similar to that produced by a natural tooth

ii) Shape of teeth

The average tooth outline can be arbitrarily classified as square, ovoid, tapered and mixed because of the influence of laws of harmony proposed in 1914 by Williams, which established a relationship between the contour of the face and the contour of the maxillary central incisor.

Various theories based on osseous and dental landmarks, soft tissue facial contour and tooth contour, and colour of the face and tooth contour have been proposed. In the absence of documentation such as old models or photographs, tooth shape, predominantly maxillary central incisor, not subject to rigid rules, must be selected according to a basic tooth design and evaluated and corrected in regard to its integration with the facial environment.

iii) Diagrammatic tooth contour

Description of the average anatomic feature of anterior teeth is important as it provides the dentist with basic geometric norms, without restricting the esthetic sense.

The influence of a number of authors like Wheeler, Stein, Gypsi, Dawson and Scharer contributed to the design of the tooth morphologies.

iv) Mesiodistal width

This dimension is a much more critical dimension than the incisogingival for anterior tooth placement. Proximal tooth wear seems to affect the aging population. But in restoring teeth, one should not consider the adjustment of teeth to age, rather should strongly recommend that patients be provided with young orthodontic dental elements.

v) Incisogingival height

This dimensional value is less critical than the mesiodistal width as it seems highly dependant on clinical situations. Attention is only focused on tooth length when it passes a certain degree of esthetic tolerance.

The primary determinants of incisal length are:

- Length and curvature of upper lip
- Patient preference
- The accessory determinants of incisor length are
- Posterior plane of occlusion
- Average anatomic crown length values for maxillary central incisor

In giving back full youth, disharmonies will seldom originate from tooth width or length but rather from Inappropriate colour selection, which increases in saturation with the advancement of age.

The simulation of natural appearance that is advocated by the specialists of denture prosthetics is clouded by the rule that the teeth in their length, and width should be related to the patient's age. As a consequence, progressive anterior tooth wear is considered normal, until TMJ problems make both dentist and patient aware of pathology, well present during the years but not recognized as such and left untreated. Therefore, the restoration of anterior teeth in their youthful normality becomes a prerequisite for the restoration of function.

vi) Incisal profile

The pleasing aspect of the natural maxillary central incisor lies in its pronounced facial curvature, in part because it creates varied reflection patterns. The challenge in relocating the incisal edge is to duplicate its original appearance and still preserve a

comfortable and unrestricted anterior guidance. The incisal edge of the central incisor is the cornerstone from which the smile is built, because once it is set, it serves to determine proper tooth proportions and gingival levels.

vii) Characterization of anterior segment

The SAP concept of Frush & Fisher needs to be re-evaluated.The ineluctability of anterior tooth wear, along with the age progression, is no longer compatible with the general desire for youth extension and the therapeutic possibilities of functional maintenance. Therefore, tooth length should be considered a constant value throughout the progression of age.

From a morphopsychological point of view, the centrals focalize the concrete features of personality, strength, energy, authority, magnetism, apathy or retraction, while the lateral incisors concentrate abstracts like artistic, emotional or intellectual elements of the personality. Canines express animal aggressivity and danger, directed by ambition and obstination, which is most often attenuated by age, introducing into the tooth shape a certain "maturity".

3. GINGIVAL COMPONENTS [31, 34, 38, 46.]

FUNDAMENTAL ESTHETIC CRITERIA:

Presentation of oral esthetics should first include objective fundamental criteria related to soft and hard tissues, which can easily be controlled using an esthetic checklist

Both dental and gingival esthetics act together to provide a smile with harmony and balance. A defect in the surrounding tissues cannot be compensated by the quality of the dental restoration and vice versa. The fundamental criteria related to gingival esthetics are well established. Both gingival health as well as gingival morphology have been included among the first parameters to be evaluated .

As far as characteristics of teeth are concerned, their relative importances among objective parameters have been prioritized as follows:

1. Form and dimension
2. Characterization, especially opalescence, translucency, and transparency.
3. Surface texture.
4. Color, especially fluorescence and brightness.

Analytic observation of extracted teeth and natural teeth in vivo is essential. Duplicating the specimens with dental stone can facilitate the appreciation of form and texture. The teeth themselves can be observed in transillumination to determine the effects of light reflection. Better understanding of certain intense colorations inside the tissues, such as dentinal developmental lobes and zones of dentin infiltrations.

Configuration of incisal edges as well as their relationship with the lower lip line and smile symmetry are determinants for the age of the smile and are included among objective criteria

Subjective esthetic integration:

The parameters mentioned above can be controlled, yet not lead to final esthetic restorative success. As a matter of fact, the esthetic outcome depends on the harmonious integration of the fundamental esthetic criteria with the smile and, ultimately, the character of an individual.

Additional criteria must be considered at this stage, such as variations in tooth form, arrangement and positioning, and relative crown lengths, as well as fine-tuning of the so-called negative space.

Fundamental objective criteria

1. Gingival health
2. Interdental closure
3. Tooth axis
4. Zenith of the gingival contour
5. Balance of the gingival levels
6. Level of the interdental contact
7. Relative tooth dimensions
8. Basic features of tooth form
9. Tooth characterization

10. Surface texture

11. Color

12. Incisal edge configuration

13. Lower lip line

14. Smile symmetry

Subjective criteria (esthetic integration):

1. Variations in tooth form
2. Tooth arrangement and positioning
3. Relative crown length
4. Negative space

NATURAL ORAL ESTHETICS[29,34]

FUNDAMENTAL CRITERIA:

Criterion 1: Gingival health(Fig 26)

Healthy soft tissues should display the following elements

▪ The free gingiva extends from the free gingival margin (coronal) to the gingival groove (apical) and has a coral pink, dull surface.

- The attached gingiva extends from the free gingival groove (coronal) to the mucogingival junction and has a coral pink color and firm texture (keratinized and attached to underlying alveolar bone), with an "orange-peel" appearance present in 30% to 40% of adults.

- The alveolar mucosa is apical to the mucogingival junction, with a loose (mobile) and dark red aspect.

During aging, gingival health can be maintained by optimal oral hygiene and periodontal therapy if necessary. To maintain gingival health, atraumatic clinical procedures should be used during tooth preparation and impression taking, respecting the so-called biologic width, and preparation margins should be precise and provisional restorations adequately adapted. Finally, the axial contours of the final restorations as well as the nature of the restorative material chosen will influence gingival health.

Criterion 2: Interdental closure

In the juvenile healthy gingiva, interdental spaces are closed by the scalloping of the tissues forming the papillae. Transient neglect of oral hygiene and periodontal disease can alter this gingival architecture. It may be possible to compensate for loss of attachment and opened embrasures by restorative means alone.

The cervical portion of the contact area, the interproximal wall of the adjacent teeth and the interdental papilla form the interdental embrassure, a segregative esthetic factor assuring harmony in the dental composition. The interdental gingiva follows the shape of the bone. On the anterior region, it appears convex, reduced in width and producing a pyramidal and knife-edge shape; and it becomes more flat in the posterior region. The closer the roots, the higher and more convex the interproximal tissues between them and vice-versa.

Esthetics and accessibility of embrassures for oral hygiene are inversely proportional. In the posterior area, wide open embrassures favor accessibility for oral hygiene and sufficient room for the gingiva, but do not allow for lateral food impaction provided the contact is maintained. In all circumstances, when a normal tooth structure exists along with adequate interproximal root proximity and a sound periodontal state, maintenance of the embrassure space depends directly on the amount of preparation, margin placement, and fitness of restoration, emergence profile, interproximal tooth design and location and width of the contact area.

Criterion 3: Tooth axis

The main axis of the tooth inclines distally in the incisoapical direction. This inclination seemingly increases from the central incisors to the canines. This criterion is mentioned at this stage because tooth position/morphology and gingival contour are interdependent, as shown in criterion 4.

Variations in tooth axis and midline are frequent and do not always compromise the final esthetic outcome.

Criterion 4: Zenith of the gingival contour

The gingival zenith (the most apical point of the gingival outline) usually lies distal to the center of the tooth, which results in an eccentric triangular tooth neck

Tooth preparations for full-crown or veneer restorations must respect this basic shape of the gingiva. Adequate placement of the deflection cord is instrumental in that matter.

The so-called zenith points are the most apical points of the clinical crowns; which are the height of contour. Their positions are dictated by the root-form anatomy, cemento enamel junction (CEJ), and the osseous crest, where the gingiva is scalloped the most. The zenith points are generally located just distal to a line drawn vertically through the middle of each anterior tooth.

According to Rufenacht, the lateral incisors are one exception to that rule, as their zenith points are placed more centrally or on the mid-line of the tooth margin. This rule does not always apply to maxillary lateral incisors or mandibular incisors, for which the gingival zenith can also be centered along the tooth axis.

Clinical application: The positions of the zenith points gain importance when closing diastemas or changing the distal or mesial tilted position of the teeth. In the case of

diastema closure, if the zenith points are not moved mesially from their originally existing positions, the finished porcelain laminate veneers may give the perception of being mesially tilted. In addition, the extreme distal positions of the gingival zeniths will result in an exaggerated triangular form. To prevent these occurrences and to create an illusion of bodily shifted central incisors towards the mid-line, the zenith points should also be moved mesially.

In case where the tooth needs to be shown longer or more tapered at the gingival 1/3rd, the zenith points can be moved apically. Such an apical movement obtains a triangular shape. An equilateral triangle will always appear longer in height than in width and this also proves that a tapered tooth design will make the tooth seem longer than it is. This procedure should therefore be used with shorter teeth, where elongation towards the apical direction is required.

Zenith points can enhance the perception of the tooth axis as well as the length and the gingival shapes, which can be achieved by horizontal or vertical alterations.

Criterion 5: Balance of gingival levels (Fig 27)

The gingival contour of lateral incisors should lie somewhat more coronal compared to that of central incisors and canines. This ideal situation represents the Class 1 gingival height.

Moderate variations related to this criterion are frequent. In the Class 2 gingival height, the gingival contour of lateral incisors lies apical to that of central incisors and

canines; for a harmonious result, lateral incisors with more apical gingiva must feature a shorter incisal edge .Concomitantly, such lateral incisors should slightly overlap the central incisors, providing a natural variety to dental composition (according to Rufenacht).

In case of severe deformity, plastic periodontal surgery must be used to optimize gingival contours for the restorative treatment.

Criterion 6: Level of interdental contact

The position of interdental contact is related to tooth position and morphology. Whereas it is most coronal between central incisors, it tends to progress apically from the incisors toward the posterior dentition.

Marginal ridges, marginal fossae and spillways seem to be helpful aids in preventing food impaction. On the anterior segment and from a frontal view, the contacts are situated a position that seems to go from incisal to cervical from maxillary central incisor to canine.

It is generally accepted to locate the contact between centrals at the most incisal 1/3rd, a point that terminate a long vertical interincisal line of contact. This line serves as a reference for symmetry and balance of the two sides. If an imaginary line is drawn between the anterior contact points, it forms a curvature that greatly reinforces the curve of the incisal line and the lower lip line.

The directional coincidence of contact, incisal and lower lip line provides cohesive forces to the dentofacial composition. At the same time, the degree of curvature introduces segregative forces in the composition.

Anatomy of the Contact Point:

The form of the contact point, or rather contact area, in its oro buccal and coronoapical extension, is directly influenced by the morphology of the teeth, their width and arrangement. The oro buccal shape of tooth contact directly determines the shape of the gingival col, a microscopic depression in the interdental papilla. An orobuccal broadening of contact area favoring formation of an oversized co I is contraindicated.

Criterion 7: Relative tooth dimensions

Due to individual variations and proximal/ incisal tooth wear, it is difficult to provide "magic numbers" to define adequate tooth dimension. Relative proportionality of teeth has long been compared with classic elements of art and architecture. As a result, mathematic theorems such as the "golden proportion"" and the "golden percentage""[0] have been proposed in the determination of so-called ideal mesiodistal spaces. These rules were applied to the "apparent" size, as viewed directly from the anterior.

Gingival symmetry

Gingival symmetry of the central incisors requires special attention. Gingival symmetry between lateral incisors and canines is not mandatory, and unilateral display of free gingival margin of a ateral incisor or a canine in various smile positions is also esthetically acceptable.

5. PHYSICAL COMPONENTS (ILLUSIONS) [33,35,36.] (Fig 28,29,30)

The art of creating illusions consists of changing perception to cause an object to appear different from what it actually is. The use of optical concepts to create optical illusions may be the best way to solve or hide an esthetically difficult situation. The control of the phenomenon of light reflection and colour contrast will provide us with means of creating illusions and thereby, re-establish proportions.

"The cardinal rule is that everything is relative to something else."

The process of perception is an organization of sensory data (sight, hearing, taste and smell stimuli), which are brought to the intellect where an answer is developed in combination with results from previous experiences or beliefs that are unconsciously interpreted. Visual perception is a prerequisite for esthetic appreciation in the same fashion that visual examination is also a routine in normal clinical investigations.

Visual perception is:

- Increased by increasing contrast

- Increased by increasing light reflection
- Decreased by increasing light deflection

A)**Principles of illusions**

Principle of illumination: states that shadows create depth and light creates prominences.

Unidirectional, artificial light throws no shadows, therefore displays only length and width, whereas multidirectional light throws shadows adding a third dimension of depth.

Principle of lines: states that vertical lines accent length and horizontal lines accent width.

B) Law of the face

Suggests alteration of the silhouette form of the tooth, which in turn changes light reflection and creates a perception of a different facial form.

The "face" of a tooth is that area on the facial surface of both anterior and posterior teeth that is bound by the transitional line angles, which mark the transition from the facial to the mesial, distal, cervical and the incisal surfaces. The "apparent face" is that portion of the face that is visible to the observer from any single view. The law of the face implies making dissimilar teeth appear similar by making the apparent faces equal,

by creating similar transitional line angles. When the line angles cannot be repositioned on a restoration, the portion of the tooth can be stained dark, promoting the effect that the tooth is receding.

C) Altering the perception of the maxillary central incisor

These optical principles should be applied by means of *tooth contouring and colour manipulation.*

Initial situation

- labial prominences
- Line angles
- Cervical convexity
- Vertical and horizontal lines or ridges

Narrowing illusion

Tooth contour modification:

- Displace line angles mesially
- Increase convexity of central prominences mesiodistally
- Increase length of central prominence moderately
- Increase facial embrassures
- Highlight texture and gloss with vertical lines and ridges
- Displace proximal contacts palatally

- Rotate distal aspect lingually

Tooth colour modification:

- Increase dark staining of interproximal areas

Applications:

- To close diastemas
- To decrease large pontic space
- To control tooth proportions

Widening illusion

Tooth contour modification:

- Displace line angles laterally
- Decrease curvature of central prominence rnesiodistally / flatten facial outline
- Decrease facial embrassures
- Highlight texture and gloss with horizontal lines and ridges
- Rotate distal aspect labially; overlap

Tooth colour modification:

- Decrease staining of interproximal areas

Applications:

- To correct crowding (limited result)

- To increase narrow pontic space
- To improve tooth proportions
- To correct elongated crowns after periodontal or implant surgery

Shortening illusion

Tooth contour modification

- Adjust incisal incline lingually
- Emphasize and displace cervical convexity coronally
- Decrease length of central prominence
- Flatten middle 1/3rd to broaden surface of light reflection
- Highlight texture and gloss with horizontal lines and ridges

Tooth colour modification

- Darken gingival 1/3rd
- Decrease interproximal staining

Applications

- Asymmetry of maxillary incisors
- Long pontics
- To control tooth proportions
- To correct elongated clinical crowns after periodontal or implant surgery

Lengthening illusion

Tooth contour modification

- Flatten and displace cervical convexity apically
- Flatten labial surface gingivoincisally
- Increase length of central prominence
- Round labial surface mesiodistally
- Highlight texture and gloss with vertical lines and ridges

Tooth colour modification

- Lighten gingival 1/3rd
- Increase interproximal staining

Applications

- Asymmetry of maxillary incisors
- To correct a short maxillary central incisor that cannot be lengthened surgically

D) Altering perception of tooth by making changes in adjacent tooth/teeth

Clinical situation	Effect	Changing perspective
Short lateral incisor	Central incisor appears too long	Lateral incisor can be length-ened
Lateral incisor has same length as central incisor	Central incisors of appropriate size and w/l ratio but the smile lacks central incisor dominance.	Lateral incisors can be shortened to improve proportions
Congenitally missing lateral incisors	Canine in the position of lateral incisor	Make the canine look like lateral incisor and the first premolar as canine
Lateral incisors are palatally placed	Central incisors look prominent.	Laterals can be moved facially to improve alignment
Central incisors are tipped palatally	Lateral incisors appear facially placed	While restoring use lighter shade to move the central incisors facially to emphasize their dominance
First premolar is occupying a more palatal position	A canine looks facially placed and prominent	Move the premolar facially to improve alignment
All teeth have same chroma	Monochromatic appearance of a canine to canine restoration	There should be a smooth transition with progressive shade saturation from the centrals to the canines. (Darker shade of the canine should blend with the premolar)
Higher chroma of endodontically treated central incisors	Discolored central incisors lacking dominance	Central incisor dominance is recreated by lightening the centrals which brings unity to the composition

Basic and general characteristics of dental enamel (Yamamoto et all)

- Presents a very fine surface
- Presents a soft and luminous translucency

- Presents a bluish luminous color
- Presents fine gradations of hue
- Depending on the angle and point from which viewed, presents an orange gloss.

CHARACTERIZATION CAN BE MADE BASED ON THE FOLLOWING:

Basic characteristics of the teeth of "young" patients

- At the age of 10, the enamel presents an almost milk-white hue, brilliant and translucent the surface texture of the enamel accentuated, thereby reflecting more light and appearing whiter and more brilliant the enamel of -the teeth of young patients generally shows a clear, opalescent effect in the region of the incisal edge, the dentinal lobes are completely covered by Enamel the dentin is lighter with only slight color variations the dentinal tubules have a larger diameter

Basic characteristics of the teeth of "adult" patients:

- At about the age of 20, the enamel is less white, it presents increased translucency and the blue and orange content of the light becomes visible.
- At about the age of 40, the blue and orange hues and the greater translucency become clearly visible.

▪ These teeth present a reduced macro and micro texture of the surface enamel, thereby reflecting less light and appearing darker.

▪ The dentin is thicker and darker (saturated) than those of young patients and can be exposed in the region *of* the incisal edge.

▪ The dentinal tubules have a smaller diameter than at the age of 10

▪ On the other hand, the dentin is less opaque than the teeth of young patients.

Basic characteristics of the teeth of "elderly" patients

▪ At about the age of 70, the translucency of the enamel increases and there is a change in the hue from bluish to lilac and gray.

▪ The surface micro texture practically disappears, while the macro texture becomes considerably reduced, causing the teeth to reflect less light and appear darker than at the age of 40.

▪ On the incisal edges, the underlying dentin structure appears as a flat wall.

▪ The individual lobes are hardly recognizable and only slight depressions remain.

▪ Many of the dentinal tubules are obliterated due to dentinal sclerosis.

▪ The dentin is relatively darker and less opaque than in the teeth of young and adult patients.

ANATOMY AND BIOLOGY OF PERI IMPLANT SOFT TISSUES [1,35,37]

Teeth are unique as they are the only structures of the body that penetrates a lining or covering epithelium. Similar as teeth the dental implants are also the examples of structures that pierce the integument. Though proper anchorage of the implant in the bone is the prerequisite for the implant's stability, long term retention of an implant seems to depend on the proper epithelial and connective tissue attachment to the titanium surface.

An understanding of both periodontal and peri- implant anatomy and biology is necessary for successfully managing the soft tissues during implant therapy. Similarities between the periodontal and peri-implant soft tissues provide the anatomic and biologic bases for applying basic periodontal flap technique and reconstructive periodontal surgery in implant therapy, while differences reveal the limitations that can be expected when various periodontal surgical techniques are used during implant therapy. Armed with this knowledge, the clinician can formulate a soft tissue treatment plan that includes appropriate management procedures to ensure a healthy peri implant soft tissue environment and the successful reconstruction of natural looking soft tissues from which an esthetic implant restoration can emerge.

If it is true that form follows function, as nature often demonstrate, then it should come as no surprise that peri-implant and periodontal soft tissues are remarkably similar. Studies have confirmed the body's ability to organize soft tissue, based on the functional need for transmucosal seal and stability shared by both a natural tooth and a dental implant.

To know more precisely about the peri-implant tissue architecture it is imperative to

have an understanding of periodontal soft tissue anatomy.

Periodontal soft tissue anatomy(Fig 31)

The peridontium consist of the investing and supporting tissue of the tooth. It has been divided into two parts, first the gingiva whose main function is to protect the underlying tissue and the other is the attachment apparatus consisting of periodontal ligament, cementum and alveolar bone. The gingiva and periodontal ligament together forms the investing tissues and cementum and alveolar bone forms the supporting tissues.

The gingiva is the part of the oral mucosa that covers the alveolar process of the jaws and surrounds the neck of the teeth.

The gingiva is divided anatomically in to marginal, attached and interdental gingiva.

Marginal Gingiva: The marginal or unattached gingiva is the terminal or border of the gingiva surrounding the teeth in collar like fashion. In about 50% of the cases it is demarcated from the adjacent attached gingiva by shallow linear depressions, the free gingival groove. Usually about 1 mm wide, it forms the soft tissue wall of the gingival sulcus; it may be separated from the tooth surface from the periodontal probe.

Gingival Sulcus: The gingival sulcus is the shallow crevice or space around the tooth bounded by the surface of the tooth on one side and the epithelium lining the free margin of the gingiva on the other. It is a V shaped structure which barely permits the entrance of the periodontal probe. Under absolutely ideal conditions the depth of the gingival sulcus is about 0. In clinically healthy gingiva the probing depth is 2 to 3 mm.

Attached Gingiva:The attached gingiva is continuous with the marginal gingiva. It is firm, resilient and tightly bound to the underlying periosteum. The facial aspect of the attached gingiva extends to the relatively loose and movable alveolar mucosa from which it is demarcated by the mucogingival junction. The width of the attached is another important clinical important parameter; it is the distance between the mucogingival junction and the projection on the external surface of the bottom of the gingival sulcus or periodontal pocket. Because the mucogingival junction remains stationary throughout the life the change in the width is caused by alteration in the coronal end of the attached of gingiva.

Interdental Gingiva: The interdental gingiva occupies the gingival embrasure which is the interproximal space beneath the area of tooth contact. It can be pyramidal or col shape. In the former the tip of the papilla is located beneath the contact point the latter presents a valley like depression that connects a facial and lingual papilla and conforms to the shape of the interproximal contact.

Gingival Connective Tissue: The connective tissue of gingiva is known as lamina propria and consists of two layers

1) Papillary layer: subjacent to epithelium which consist of papillary projections between epithelial rete pegs.

2) Reticular layer: contiguous with the periosteum of the alveolar bone.

The connective tissue has a cellular and extracellular compartment composed of fibers and ground substance.

GINGIVAL FIBERS: Above the alveolar crest, gingival fiber bundles provide

additional attachment to secure the tooth in the alveolus, they also serve to immobilize the gingival tissue in relation to supra alveolar portion of root cementum. Each gingival fiber bundle has a functional orientation and is identified according to its insertion and the distinct path it follows through the tissue.

Circular group: These course through the connective tissue of marginal and interdental gingiva and encircle the tooth in a ring like fashion.

Transseptal group**:** Located interproximally these form the horizontal bundles that extend between the cementum of the approximate teeth in to which they are embedded. Transseptal fibers contribute significantly for stability of each tooth in the arch.

Page and coworker have described a group of semicircular fibers which attach at a proximal surface of tooth, below CEJ, go around at facial or lingual margin of the tooth and attach on other proximal surface of the same tooth.

In addition to securing the tooth in the alveolus, these fibers play an important role in immobilizing the gingival tissue that surrounds the tooth. This tissue immobility, along with resistance to bacterial and mechanical challenges, contributes to the maintenance of permucosal seal.

PERIIMPALNT SOFT TISSUE ANATOMY

Berglundh etal (1991) compared clinically healthy periimplant mucosa and free marginal gingiva with respect to structure and composition. Histological analysis revealed that each of the soft tissue unit had a keratinized oral epithelium and a junctional epithelium with a length of approximately 2mm, the height of the gingival supracrestal

connective tissue was about 1mm, and as implant lack root cementum, so the collagen fibers bundles in periimplant mucosa run mainly parallel to implant surface and originate from the bone surface.

In general, the similarities between the periodontal and periimplant soft tissue are limited to the form and function of the analogous epithelial structure. The oral, sulcular and junctional epithelia in periimplant soft tissue are nearly identical to form and function to their periodontal counterparts. However periodontal and periimplant oral and sulcular epithelia are supplied by rich vascular plexus, the epithelia surrounding implant that is junctional epithelium do not receive vascular supply derived from vessels of periodontal ligament.

The other important differences between the two tissues about which an implant surgeon should be familiar are:

1) Tissues that anchor the implant in alveolus lack both cementum and periodontal ligament, instead implant is directly connected to bone below the crest.

2) Although there is zone of supraalveolar connective tissue surrounding the emerging implant, there are no gingival fibers analogous to those of natural teeth.

3) The immobility of the attached periimplant tissue is due to the splicing of connective tissue fibers bundles running from crest to the free gingiva and from circular connective tissue fibers bundles circumferentially around the implant.

4) Also the connective tissue immediately adjacent to the implant is relatively acellular and avascular compared with analogues periodontal tissue. Instead, the dense connective tissue histologically is similar to scar tissue that is rich in collagen and poor in

cellular elements.

The difference in periimplant connective tissue renders implant more susceptible than the natural tooth to mechanical and bacterial challenges. When esthetics must be considered, differences in orientation, composition and circulation of the periimplant connective tissue may limit opportunities to surrounding soft tissue architecture, with prosthetic guide soft tissue healing techniques.

Attached Periimplant Soft Tissue

Several authors have presented the sound rationale for the presence of attached tissue around implant restorations. In general, these rationales are based on an understanding of the vulnerability of periimplant soft tissue seal and oral hygiene critical care, in ensuring long term success in implant therapy. Attached periimplant soft tissue provides the clinician a prosthetic friendly environment which does not only provides precise prosthetic procedures but also the oral hygiene maintenance.

Attached tissue resists recession, maintain predictable levels over time and enhance esthetic blending. In addition, those with appropriate contours create a soft cleansing environment by minimizing food accumulation. Whenever an implant is placed in an area of esthetic concern, a certain amount of biologic risk is encountered. An understanding of the concepts encompassed by the term biologic width allows the clinician to calculate the risk for the particular situation. In esthetic dentistry, the goal is to provide excellent esthetic and periimplant soft tissue health and stability with little or no crestal bone loss or remodeling. This can occur only when the biologic width requirement from a particular site is matched exactly with an implant of the appropriate diameter placed at

the ideal depth and angulations to maintain in the 3 dimensional scalloped osseous anatomy and the thickness of the overlying soft tissue drape.

SYSTEMATIC EVALUATION OF ESTHETIC IMPLANT PATIENT[1,32,33,42,43]

In essence, the smile esthetics includes the understanding of how facial features, muscular activity and the relationship between the visible dentition and gingival tissue combine to create the unique appearances of an individual's smile. Although everyone's smile is unique, there are common elements that combine to form a smile that is esthetically pleasing. Similarly there are identifiable elements that detract from the esthetic appearance of a smile. The implant surgeon should be familiar with both the elements that enhance and those that detract from esthetics.

When an implant therapy is contemplated for an area of esthetic concern, the pretreatment evaluation performed by the surgeon must include a complete functional and esthetic periodontal evaluation. Focusing attention solely on the area of planned implant restoration often results in esthetic compromise which could have been avoided. While it is important for the surgeon to be able to quantify dentoperidontal esthetics, it is critical that any existing potential dental and periodontal deficiencies to be identified prior to implant therapy.

Facial and Dental Symmetry

The functional and esthetic dentofacial and dentoperiosteal examination begins with

an evaluation of facial symmetry. The surgeon should begin the evaluation of facial and dental symmetry by determining the position of facial midline. In most cases the, this determination is made relative to interpupillary line the facial midline than forms a perpendicular to the interpupillary line and is located at the midpoint between the patient's pupil in forward gaze.

The dental symmetry is also evaluated relative to the facial midline.

Upper Lip Line: The form of the upper lip and its relationship to underlying dentoperiosteal structures are the most important considerations when evaluating dental esthetics.

Lower Lip Line: The tonicity and control of the lower lip may affect the visibility of the anterior teeth. Along with this, the relationship of the lower lip to maxillary anterior dentitions helps to evaluate the curvature and orientation of the incisal plane.

Incisal Plane: The surgeon should understand that esthetic incisal plane morphology involves more than orientation.

Gingival Plane and Gingival Outline: The gingival plane should be parallel to level of interpupillary line; in addition it should be parallel to the incisal plane.

Periodontal Biotype: The patient periodontal biotype is one of the most important factors in determining the outcome in the esthetic implant therapy. Two distinct periodontal biotypes have been described by Olssson and Lindhe they are

Thin scalloped periodontium and Thick flat periodontium.

Thin scalloped periodontium (Fig 32): This has pronounced positive architecture with a delicate friable soft tissue curtain. Attached soft tissue is minimal and bony dehiscence and fenestrations are defects characterize the underlying the osseous structure.

This periodontal type has been associated with specific tooth morphology by triangular anatomic crowns with small interdental contacts at the incisal third. The clinical crowns either are flat in cervical area or emerge with subtle convexities. The response of this type of periodontium to treatment interventions are soft tissue recession, apical migration of attachment and loss of underlying alveolar bone. In addition the thin maxillary buccal plate underlying the friable soft tissue curtain is predisposed to defect formation secondary to remodeling and resorption of bone following tooth removal or osteotomy prepration and implant placement.

Thick flat periodontium: (Fig 33) A relatively flat soft tissue and bony architecture characterize this biotype. The soft tissue curtain is dense, fibrotic and there is abundance of attached soft tissue. The underlying osseous form is composed of thick dense bone. With this type are teeth associated with square anatomic forms with bulbous convexities in cervical third. The contact point and connector zone are large and often extends into cervical 1/3 area, therefore the interdental papillae are short. When compared to this type, there is significantly less disparity buccal, marginal and interproximal levels.

EVALUATIONS OF ANATOIMICAL LIMITATIONS[1,3,37,]

Vertical Maxillary Deficiency: (Fig 34) The above situation present with a compromised esthetic and functional outcome. The features normally present in these patients are short upper lip,(clinical norm for upper lip length in male is 22mm and in female 20mm) but in such cases there is discrepancy for about 2mm, along with this the deficient vestibular depth, approximation of nasal floor and pirifom aperture to the roots of lateral incisor and canine.

In patient with these anatomic characteristics, there is predisposition of apical migration of soft tissue following implant placement. The proximity of anterior nasal spine and nasal floor significantly limits surgeon's ability to obtain passive flap adaptation. Surgical management includes an exaggerated wide base curvilinear flap design with beveled incisions. It is also necessary to carefully elevate the periosteum from the piriform aperture just entering the nasal floor. Periosteal releasing incisions are sometime made at the confluence of the alveolar ridge and nasal floor periosteum to obtain tension free adaptation of flaps around wound closure. Elevation of periosteum in these areas improves the overall elasticity of the flap, subsequently, localized vestibuloplasty is often indicated to restore the adequate the vestibular depth.

Compromised Bone Height or Width On Adjacent Dentitions: Loss of height or width of the interdental bone between a tooth and implant present another anatomic limitation that can limit vertical hard or soft tissue development from adjacent implant restoration.

These limitation result in blunting or absence of interdental papillae, in most of these instances prosthetic compensation via closure of gingival embrasure can be done, but this may result in compromised oral hygiene.

Tarnow and coworker correlated the loss of interdental soft tissue with the distance in the height between the base of the contact and the interdental bone crest. They found that when the dimension was 5mm or less the interdental papillae would fill the gingival embrassure 100 % of the time. But when the distance is 6 or 7 mm, the chance of papillae filling the gap is 56% and 27% of the time respectively.

In addition, the width of the interdental bone on adjacent teeth appears to be critical as the height in determining the final esthetic outcome. When the interdental bone crest between a natural tooth and an implant site is less than 2mm in width, an esthetic risk exist. And when an implant body encroaches upon the crest area, interdental bone height is lost, thus jeopardizing osseointegration and periodontal prognosis of adjacent tooth.

When evaluating a partially edentulous site for hard and soft tissue, the height and width of the crestal bone are the major criteria to consider. It is seen that, volume outcome from hard tissue site development immediately adjacent to a natural tooth are most predictable when the width of bone on adjacent natural tooth is 2mm or greater.

Marginal Tissue Recession: The evaluation of marginal tissue recession is an important step in pretreatment evaluation. The surgeon must determine the cause of localized

recession defect and when the recession is determined to be progressive, measures to correct the situation should be included in patient's therapeutic plan.

Miller subsequently proposed an expanded classification of marginal tissue recession that not only described the morphology of recession defects but also correlated the morphology with the ability to achieve complete or partial root coverage. Miller's classification also takes into account the relationship of recession defects to the mucogingival junction, the degree of interdental hard and soft tissue loss and the prominence of the tooth in the arch.

Miller's classification[37,38] (Fig 35,36,37,38)

- **Class I**: Marginal tissue recession does not extend to mucogingival junction and there is no loss of interdental bone or soft tissue. Root coverage of 100% can be anticipated.
- **Class II**: Marginal tissue recession extends to or beyond the mucogingival junction and there is no loss of interdental bone or soft tissue. Root coverage of 100% can be anticipated.
- **Class III**: Marginal tissue recession extends to or beyond the mucogingival junction with loss of interdental bone or soft tissue. Tooth malposition prevents 100% root coverage. Partial root coverage can be anticipated.
- **Class IV**: Marginal tissue recession extends to or beyond the mucogingival junction with loss of interdental bone or soft tissue and tooth malposition is severe enough to preclude attempt at root coverage.

Classification Of Alveolar Ridge Defects In Esthetic Implant Therapy[1]

Evaluating alveolar ridge defects and determining whether to reconstruct them in a staged fashion is an important criterion frequently faced by implant surgeon.

Based on the presurgical evaluation, the ridge defects are primarily classified according to the volume (large or small) and nature (hard, soft or combination).

Along with this the morphology of the defect (vertical or horizontal), allow the formation of useful algorithm to guide the implant surgeon in selection and sequencing of reconstructive procedures.

Once the defect is classified, it is correlated with appropriate treatment modalities.

Large volume hard tissue defect: (Fig 39) This defect prevents ideal 3 D implant placement. For reconstruction of these, the use of autogenous corticocancellous block graft in combination with particulate graft is recommended.

When above said defect is horizontal, with no loss of vertical bone height complete restoration can be anticipated? But with vertical bone loss, complete reconstruction is limited. The limiting factor in such defects in edentulous patient is the ability to expand and suspend the soft tissue drape to accommodate sufficient vertical bone graft volume and minimize subsequent graft resorption.

In case of partially edentulous subjects, the soft tissue considerations along with the coronal level thickness and volume of interdental bone remaining on adjacent natural dentition determine the limit of vertical bone augmentation. Additional limitation should

be expected when bone loss extends to the root surface of natural dentition, since the root surface is avascular and can contribute to the survival of the graft by the bridging phenomenon.

Small volume hard tissue defect: (fig 40) This defect does not affect 3D implant placement or primary stability and thus allows simultaneous reconstruction at the time of implant placement except when these defects involve the alveolar crest. In such cases it should be approached in a staged manner.

The treatment protocol for such defect require the soft tissue grafting to offset the soft tissue shrinkage that occur as a result of initial guided bone regeneration procedures.

Large volume soft tissue defect: (fig 41)This defect prevents the development of the stable periimplant environment or provides inadequate soft tissue coverage for successful hard tissue site development procedures. In addition it prevents the emergence of an implant restoration in harmony with the adjacent dentition.

In nonesthetic areas, these defects are corrected at the time of implant exposure using epithelized palatal mucosal grafts. In esthetics areas, one or more subepithelial connective tissue grafts are usually required, at the time of implant placement or prior to it depending upon the quality of the soft tissue that preexist at the site.

Small volume soft tissue defect: (Fig 42) These defects result in volume of attached tissue surrounding an implant restoration that is less than ideal for predictable long term stability or esthetic emergence. These defects may also result from soft tissue shrinkage

following surgical or restorative procedures commonly performed in esthetic implant therapy.

The defects are most often managed by subepithelial connective tissue graft secures in closed pouch recipient sites or in conjunction with coronally repositioned flap.

Combination hard and soft tissue defect (fig 43) These are the most common defects encountered at the implant site. They are challenging, as they prevent ideal implant positioning, limits the ability to obtain a stable periimplant soft tissue environment and to obtain positive esthetic soft tissue architecture.

The surgeon should evaluate the quality and quantity of existing soft tissue assessment of the width of attached tissue and vestibular depth. In addition if the soft tissues are extremely thin or inelastic then soft tissue grafting prior to bone grafting is strongly recommended. In these instances, performing a soft tissue graft as a first step improves both the volume of soft tissue cover for bone graft and predictable healing at the bone graft site.

Conversely when both of the width of the keratinized tissue and the vestibular depth are adequate, bone grafting can be performed first followed by soft tissue grafting.

In all the instances the use of corticocancellous block graft along with palatal mucosal graft and subepithelial connective tissue graft suffice for the predictable esthetic outcome.

MANAGEMENT OF PERIIMPLANT SOFT TISSUE[1,39]

1) Flap Design In Implant Therapy: An adequate flap design is a prerequisite for success of any surgical procedure. The guidelines for designing mucoperiosteal flap used in implant therapy are as follows:

- Preserve blood supply
- Preserve the topography of the alveolar ridge and mucobuccal fold
- Facilitate identification of important anatomic structures
- Provide ample access for implant instrumentation and use of surgical guides
- Provide access for harvesting of local bone
- Provide for closure away from implant placement or tissue augmentation sites
- Minimize microbal contamination
- Facilitate circumferential closure around permucosal implant structure

The two basic flap design traditionally advocated for use in implant therapy are distinguished by the location of horizontal access incision. The two designs are Vestibular and Crestal

Vestibular Flap: High degree of success is obtained when used for localized ridge augmentation in mandible, but it is difficult to execute as it requires large amount of

periosteal stripping, interferes with the use of surgical template and alters topography of the ridge.

Branemark and Buser have advocated is use in mandible rather than in maxilla.

Crestal Flap: Provide a practical and effective approach as it is easily modified to suit for both submerged and nonsubmerged implant surgeries.

2) Flap Management Consideration: To achieve a healthy periimplant soft tissue environment, circumferential adaptation of attached tissue around the permucosal implant structure is required. Therefore the flap is designed in such a manner that an adequate band of attached, good quality tissue should surround the implant.

Flap management forSubmerged Implant Placement: When placing a submerged implant the buccal flap must be designed to preserve the blood supply and topography of the ridge and mucobuccal fold. The pericrestal incision is beveled to the lingual or palatal to the ridge and the blade is angled to make contact with the underlying bone. This provides ample accessibility for instrumentation and also preserves periosteal circulation and also facilitates attached tissue to anchor the buccal flap during closure.

Nonsubmerged Implant Placement: The pericrestal incision is initiated in apposition that ensures the maintenance of approximately 3mm apicocoronal dimension of attached lingual/palatal tissue. In general the incision will be located close to midcrestal position than the incision made for submerged implant placement. The blade is held so as to create a buccal bevel. The buccal bevel helps in abutment connection and implant placement

while preserving periosteal blood supply minimizing the need for lingual or palatal flap reflection. Additionally the buccal bevel maximizes the amount of attached tissue reflected with buccal flap.

3) Surgical Maneuvers For Buccal Flap

Once the flap has been outlined in a manner that ensures an optimal lingual soft tissue environment, the surgical maneuvers that will be used for managing the resulting buccal flap is determined by the apicocoronal dimension of attached tissue remaining on buccal flap margin.

Surgical maneuvers can be done individually or combined as the width of attached tissue varies.

Papilla regeneration[41]: When the width of gingival tissue on the buccal flap is 4-5 mm, papilla regeneration as advocated by Palacci is recommended. The maneuvers facilitate primary closure and circumferential adaptation around the permucosal implant structure, while maintaining adequate band of attached tissue around the emerging implant structures.

This surgical also involves the contouring of buccal flap tissues. Attached mucosa is taken from the top of the ridge and moved in buccal direction while maintaining approximately 3mm of attached lingual tissue. Subsequently, a fine blade is used to dissect the tissue to create pedicles in flap, which are passively rotated to fill the implant spaces. The tissues are than sutured avoiding tension within the pedicles.

The papilla regeneration facilitates circumferential adaptation with less tissue resection than done in resective contouring maneuver, as the resulting soft tissue pedicle is used to obtain soft tissue coverage and primary closure in interimplant areas.

Lateral Flap Advancement[1]: When the width of the gingival tissue remaining on the buccal flap is 3-4 mm, the lateral flap advancement is used to facilitate the primary closure and circumferential adaptation is advised. This maneuver is specially sited for completely edentulous or posterior partially edentulous implant cases. This maneuver required that flap be designed to extend beyond the areas of implant placement to include attached tissues present in adjacent edentulous areas.

DIFFERENT FLAP DESIGN FOR ESTHETIC IMPLANT THERAPY[1,34,37]

In areas of esthetic concern, there are 3 distinct approaches for inconspicuous management of soft tissue

- an exaggerated curvilinear beveled flap
- a U shaped peninsula flap
- a tissue punch

Each of these approaches has particular indications and is suitable for management of soft tissue around submerged and nonsubmerged implants placed in esthetics areas.

PRESERVATION OF SOFT AND HARD TISSUE

Importance of site preservation: In its simplest term, site preservation involves the use of surgical and prosthetic technique to preserve both the volume and architecture of hard and soft tissue at the implant site. Careful attention to site preservation at the time of tooth removal often reduces or eliminates the need for subsequent site development procedures. Furthermore and of greater significance is that failure to preserve the site at the time of tooth removal increase the complexity many fold, as there is collapse of soft tissue into the osseous defect. Subsequent contraction of the reconstructed soft tissue envelope and loss of elasticity of soft tissue cover often necessitates additional soft tissue grafting procedures to provide coverage for hard tissue reconstruction that will be required to create the natural alveolar ridge anatomy at the site. Finally, the use of site preservation technique is especially important for patient with thin, scalloped periodontal biotype because of their predisposition for soft tissue shrinkage and concurrent alveolar bone resorption.

Alveolar ridge collapse after tooth removal

Healing of an extraction socket is usually uneventful, but eventually only partial bone fill of the socket generally occurs. There is gradual resorption in both buccolingual and apicocoronal dimensions. Studies have shown that 3-4mm of bone loss occurs in 6 month period after extraction particularly of anterior region. This resorption leads to an esthetic compromise.

The eventual shrinkage is related to trauma of tooth removal and the environment in which natural healing take place. Early clot retraction and accumulation of oral debris in the socket may limit the potential of alveolus to fully exhibit its regenerative potential.

Clinical goals and rationale for ridge preservation

The primary goal is to preserve both hard and soft tissue volume and architecture. It is essential to maintain a stable osteoconductive environment or scaffold within the entire area of socket as well as to isolate this scaffold from deleterious effect of oral cavity during healing. It is also necessary to maximize the supply of osteoprogenitor cells and their ability to invade the area occupied by the osteoconductive scaffold. In all esthetically important areas the use of large mucoperiosteal flap should be avoided to preserve the circulation and natural soft tissue anatomy.

The rationale for ridge preservation is based on understanding that post extraction bone resorption and soft tissue collapse could be reduced by

- Minimizing trauma to surrounding tissue during extraction

- Preparing and grafting a bleeding socket with an ideal osteoconductive material that is slowly resorbed and replaced by vital bone.

- Technique to isolate the surgical site that avoids the esthetic disfigurement commonly associated with advancement and closure of large flap over a membrane.

- The prosthetic preservation protocol includes the use of provisional restoration immediately to support the soft tissue especially supracrestal gingival tissue.

- The rationale of combining surgical and prosthetic protocol depends highly on genetic make up, general health and regenerative potential at the particular site rather than the properties of bone graft material used as scaffold.

SOFT TISSUE AUGMENTATION IN IMPLANT THERAPY[1,9,10]

The soft tissue around implant should be similar to that of natural dentition. This can be considered that a zone of attached tissue with a free gingiva and sulcular depth is essential for esthetics and subsequent maintenance.

Despite the many similarities between periodontal soft tissue and periimplant soft tissue, they are not identical. The lack of connective tissue attachment and the differences in the composition, vascularity and orientation of connective tissue surrounding the implant, makes them more susceptible to diseases. Thus it is imperative that soft tissue augmentation in implant therapy is essential for esthetic as well as long term success of the implant supported prosthesis.

Goals of Soft Tissue Grafting[15]

a) To create a stable periimplant soft tissue environment by providing adequate zone of attached nonmobile tissue with intimate adaptation to emerging implant structures.

b) Inconspicuous reconstruction of natural soft tissue architecture to enable the emergence of harmonious implant restorations.

Principles of Soft Tissue Grafting

a) Prepration of recipient site:

- Adequate vascularity to support the graft.
- Means for rigid immobilization of the graft.
- Uniform surface for intimate graft adaptation.
- Obtain homeostasis.

To achieve the above requirement, a mucoperiosteal flap is elevated, then the apical portion of flap is split by cutting through the periosteum. This technique minimizes tension and does not jeopardize the survival of the graft. The dissection can be extended laterally to allow optimal adaptation of the lateral portion of the flap to the adjacent sites.

b) Management of donor tissue

- Harvest graft of adequate size to take advantage of peripheral circulation.
- Ensure uniform graft surface adaptation of recipient site.
- Ensure adequate thickness to obtain desired volume augmentation.

The most frequently used donor sites are

- Palatal area mesial to upper 1st molar: here a split thickness flap is elevated and underlying connective tissue covering the bone is harvested.

- The posterior ridge areas: a wedge technique is applied. In ridge areas, two bevel incisions are given in labial and palatal direction and the tissue located at the top of the ridge and laterally will be used as graft material.

- Maxillary tuberosity areas: according to thickness of tissue in maxillary tuberosity areas, a wedge or gingivectomy technique is used to harvest the graft. Usually when thickness is more, wedge technique is applied. It is also that a graft harvested from one tuberosity area can be used to recreate an adequate ridge corresponding to one tooth.

When an extensive area is to be augmented, several donor sites can be used in conjunction.

c) Prepration of the graft: the harvested graft must be placed on a recipient site to enable visualization of its proper size and position. If needed the graft is trimmed before placement.

d) Placement of graft: according to the need for augmentation (in vertical/ horizontal direction) the graft can be placed and sutured in more or less apical portion of the inner surface of the flap.

e) Suturing of the graft: optimal stabilization is essential to obtain adequate result. Different suturing techniques are used to secure the graft on the recipient bed. The thickness of the graft also Influences the healing to some degree. Although a higher percentage of success with thin and intermediate split thickness flap has been seen, the use of thicker graft yields excellent results. When root coverage, abutment coverage or

soft tissue augmentation at implant site is desired, graft with thickness greater than 1.25mm is preferable.

PROSTHETIC GINGIVAL RECONSTRUCTION IN IMPLANT PROSTHODONTICS

Maxillary anterior tooth loss results in bone resorption in the direction and inclination of the roots, shortening the ridge and reducing the perimeter of the arch. To compensate for this vertical loss of the ridge and gingiva, the surgeon will typically first place grafts to gain essential height in hopes that this will recreate satisfactory papilla form for the restorative phase. What the authors have seen most often is a shortened arch horizontally and vertically reestablished height, but unsatisfactory papilla and gingival esthetics. This is the worst-case scenario for the ceramist. Usually in these situations, if the restorative dentist and ceramist opt for a conventional partial prosthesis without prosthetic gingiva, the following problems are likely (Fig 44,45,46).

1. Narrower teeth caused by reduced mesiodistal circumference and arch space.

2. Longer teeth toward the apical aspect that appear to reach out to the still-inadequate ridge height, even after surgical augmentation.

3. An inverted smile line.

4. Rectangular teeth without correct natural tooth anatomy because of longer extended contact points in the interproximal area. This lack of papilla volume often

requires the ceramist to create these longer contact areas in an effort to avoid the "black triangles" inter-proximally.

Diagnosis and treatment plan for artificial gingival reconstruction

First appointment

The first appointment should include a comprehensive clinical exam. This should incorporate a clinical examination (Fig 47), impressions for study models, bite registration, photographs, and recording of the patient's dental ("white") and gingival ("pink") structures, with special attention paid to the expectations of the patient.

Dental gingival diagnostic wax-up

The diagnostic wax-up is critical for the reconstructive team, as it helps to define the indications and limitations of surgical techniques or prosthetic procedures (Figs 48 and 49). Moreover, it has several other functions: *(1)* it provides data that are needed to create accurate radiographic and surgical stents; *(2)* it provides a matrix for fabrication of a provisional restoration;

The dental-gingival wax-up should seek the ideal position of teeth, without reference to the current position of the alveolar ridge. For the latter, Principles of teeth setting for dentures, such as the ideal distance between the incisive papilla and the buccal surface of the central incisors (7 to 8 mm), are important guidelines to incorporate.

When analyzing the preoperative study models and wax-up, the amount of pink wax will indicate clearly the amount of tissue that has been lost in all three dimensions. This

will establish the prognosis for the surgical techniques that might be necessary to reconstitute ideal ridge and gingival form. This allows for a more realistic discussion with the surgeons involved regarding the volume of bone and tissue necessary for a successful outcome. Diagnostic mistakes occur in a large number of patients that were not planned for artificial gingiva, but end up with this kind of restoration (a prosthetic gingival "patch"), which limits the esthetic result.

If planning is poor, complications can occur later in the treatment process.

Computed tomographic scan and initial planning

Computed tomographic (CT) scans should be performed. With the radiographic stent created from the diagnostic wax-up (Fig 50), one can then evaluate, with three-dimensional (3D) simulation software, the 3D positions of implants that are needed and the number of implants required.

The positions of the implants in the arch, the number of implants, and their inclination and depth are specific for prosthetic gingival restorations and can be determined on the computer screen(fig 51).With 3D simulation software (Simplant 11.0, Materialise), the implant team can plan the implant locations precisely according to the ideal teeth and gingival positions shown on the radiographic stent.

The esthetic quadrant concept

The image on the computer screen will present the actual patient ridge, the ideal positions of the crowns, and the ideal profile of the artificial gingiva. Historically, these stents focused on crown and implant positioning only. The authors have originated the

"esthetic quadrant plan," which brings into consideration all four aspects of the restoration (Figs 52,53,54):

- The lip zone
- The hard and soft tissue in the implant-surgical zone
- The visible esthetic zone
- The restorative zone

Virtual lines are drawn between these zones to clarify the prosthetically ideal positions of hard and soft tissue.

The intersection of the lines of the actual ridge and ideal gingiva will give an approximate location of where the restoration will end apically . Three millimeters above this point should be the head of the implant. The patient's upper lip line when smiling should also be markedon the radiographic stent. Transferring this information to the screen will also enable the implant team to plan the edge of the restoration ideally relative to the lip line, bearing in mind the fact that the ideal situation is to hide this limit beyond the lip perimeter. In patients with very high lip lines (vertical maxillary excess), this is not always possible, thus increasing the challenge for the ceramist. The image on the screen will also allow a better understanding of the necessity of other procedures such as bone grafts and particularly ridge reshaping. Bone grafts, in these situations, are directed mostly *horizontally,* with *bone reduction vertically* and gingival reshaping often needed to *flatten* the surface of the ridge receptor area. This will provide more space for

artificial gingiva, hide the limits of the restoration, and enable efficient hygiene procedures.

This combination of grafts and correct depth of implant placement by the surgeon should allow for a more ideal artificial gingival profile that is not too steep and thereby avoids food entrapment and decreased mobility of the upper lip. The angle of the artificial gingiva with the occlusal plane should not exceed 45 degrees .

Surgery for artificial gingiva

Implant placement should closely follow the dental-gingival wax-up and surgical stent. The surgical stent will guide the axis of the implant, and the dental-gingival stent will guide the depth of placement (Figs 53 and 54). From a surgical standpoint, it is preferable to place the implants deeper in the bone, with the goals of lingual screw access and as many pontics as possible (based upon sound biomechanical principles) rather than multiple adjacent abutments.

Following the same surgical philosophy mentioned earlier, the ridge width needs to be restored more horizontally and less vertically. In contrast to the classic goals of most implant surgeons, who attempt to reestablish interproximal vertical support for the papilla, bone reduction or reshaping is often necessary with artificial gingiva to create a flat ridge between the implants. This will help create an esthetic and cleansable relationship between the natural ridge and the pontics.

All these procedures are planned and determined precisely with the 3D software simulation surgery (fig 55)

Grafts that seek to establish the optimal foundation for an artificial gingival(fig56,57,58,59)restoration should mainly gain volume horizontally. Vertical increases in volume hinder the esthetic result in most instances. From

an esthetic standpoint, this provides a higher degree of predictability, as most often it is the vertical dimension that cannot be predictably recreated surgically in conventional implant tooth replacement.

Psychologic factors are very relevant to the present treatment. As mentioned earlier, the patient may have a negative predisposition toward artificial gums. This makes the presentation of the case a most important step. The approach needs to be supported by technical information, followed by visual examples. The authors normally guide the patient in relation to the complexity of the case, the esthetic limits, advantages, and disadvantages. Advantages include fewer surgical procedures, more predictable pink esthetics, and decreases in the time and costs of overall treatment. However, patients may show resistance to artificial gums. Also, to develop the artificial gingiva, a framework that will join all the implant abutments must be created, so routine flossing is impossible delicate hygiene will be required for some patients

BONE AUGMENTATION PROCEDURES[1,4,15]

The progression of periodontal disease results in loss of hard tissue. The resultant defective alveolar ridge presents a difficult problem for implant placement. When the volume or contour of bone is inadequate, bone augmentation procedures are necessary to

reconstruct the deficient alveolar ridge, thus allowing adequate osseous anchorage and permitting the placement in proper position and alignment.

CLASSIFICATION OF DEFICIENT RIDGES

In 1985, Lekhholm and Zarb presented a classification of the jaw bone based on shape and quality, to be used to analyze implant anchorage.

They described 5 groups of mandibular and maxillary cross-sectional shapes:

a) Most of the alveolar ridge is present

b) Moderate resorption has occurred

c) Advanced resorption has occurred such that only basal bone remains

d) Some resorption of basal bone has started

e) Extreme resorption of basal bone has occurred

Leckholm and Zarb also described 4 groups of bone quality

1) Almost the entire jaw bone is composed of homogenous compact bone

2) A thick layer of cortical bone surrounds dense trabecular bone

3) A thin layer of cortical bone surrounds a core of dense trabecular bone

4) A thin layer of cortical bone surrounds a core of low density trabecular bone

ANTERIOR MAXILLA CLASSIFICATION

The use of classification of the overall shape of anterior maxilla will help the practitioner evaluate the anatomical conditions in implant treatment in the esthetic zone. The classification is based on the amount of vertical and horizontal loss of soft tissue, hard tissue or both.

It is divided into 4 classes according to horizontal dimension and into 4 classes according to vertical loss.

Based on vertical loss:

- Class I: Intact or slightly reduced papillae
- Class II: Limited loss of the papillae
- Class III: Severe loss of papillae
- Class IV: Absence of the papillae.

Based on Horizontal loss:

- Class A: Intact or slightly reduced or buccal tissue
- Class B: Limited loss of buccal tissue
- Class C: Severe loss of buccal tissue

- Class D: Extreme loss of buccal tissue often in combination with limited amount of attached mucosa.

In patient different combination of these classes occur, so each patient must be considered as unique.

MANAGEMENT OF MAXILLARY RIDGE DEFICIENCIES

The correction of alveolar ridge deficiencies in the maxilla can be seprated into two categories because of differences in anatomy, masticatory forces and resorption patterns. The surgical procedures to correct osseous deficiencies must be customized for the particular region of maxilla.

ANTERIOR MAXILLA

The bony deficiency in the anterior maxilla requires different approach and techniques. Restoration in the anterior zone often requires augmentation in both vertical and horizontal dimension. However, the alveolar crest in this region does not provide a natural cavity to contain the particulated graft.

The corticocalnellous block is most often used for grafting in the anterior maxilla. The techniques which are commonly used are venner graft, onlay graft and saddle graft. Each type of graft is used to augment the ridge in different direction depending on the type of the defect. Generally, veneer grafts are used to restore isolated horizontal defect,

onlay graft to correct vertical deficiencies. Saddle graft is used to correct deficiencies in both height and width.

To rigidly stabilize the corticocancellous block of donor bone, both the graft and recipient bed must be prepared to minimize the gap or dead space. The recipient bed should be relatively flat and decorticated. Fixation screw must be placed in sufficient numbers and be inserted in proper position to ensure rigid stabilization of the graft. Drilling through both the cortices with a 1mm fissure bur will create vascular channels. These bleeding sites from the recipient bed will hasten neurovascularization of the graft and enhance adherence of the overlying soft tissue. Increasing vascularity will enhance platelet adhesion thus improving stability of the grafted bone and reattachment of the periosteal layer of the soft tissue flap. Finally, bone chips may be added to the edges of the grafted bone to fill in spaces between bone graft and recipient bed.

PROSTHETIC FACTORS IN IMPLANT SELECTION

Before the implant type, number, and location, selection of a final prosthesis design is mandatory. The patient presents with either a completely or a partially edentulous arch. Either condition may be restored with removable, fixed-detachable (removed only by the dentist), or cemented prostheses, which are placed directly into or onto die implant or implants or onto a bar that has been attached to them. When planning final restorations, determine whether the prosthesis is being designed to replace teeth, teeth and soft tissue, or teeth, soft tissue, and bone. The more soft tissue and bone to be replaced, the greater the height that is required of the restoration. Depending on how

much hard and soft tissue need to be replaced, planning is necessary to include more implant support in direct relationship to prosthesis size and height. Restorations supported solely by implants always require a greater number of them then the implant and soft tissue-supported prosthesis.

OVERDENTURES

Overdentures can be classified as either soft tissue-borne and implant- or tooth-borne or purely implant-borne. Soft tissue/ implant-borne overdentures are supported by the implants and the soft tissues and retained by the implants. In order for this to be practical in the parasymphyseal area, the retainers (implants or teeth) must be in a position that allows the construction of a straight bar (Fig. 5-3). This permits several internal clips to rotate around the bar and allow the posterior overdenture saddles to be soft tissue-borne so that they may take some of the stress from the implants or teeth. If the bar is placed in the anterior region and because of implant location, must be curved to conform to the shape of the arch, the over-denture will not rotate on the bar, and the posterior saddles may act as levers tending to loosen the retaining screws, cement, abutments, or the implants themselves Whenever possible, splinting of implants with bars and copings rather then using them individually is the preferable approach from an engineering point of view. Depending on the location, number of implants placed, their length, the percentage of surface area surrounded by bone, and type of retention devices selected (clips, O-rings. Zest, Ceka, ERA . various mesostructure bar shapes and configurations are available. Bar-bornee overdentures are both supported and retained by

their bars which, in turn, should be supported by four or more root form implants of 10 mm length or greater, by transosteal, or by subperiosteal implants.

FIXED BRIDGES

Fixed bridges may be supported completely by implants, or they may be used in conjunction with natural tooth abutments. In both instances, construction is begun after transepithelial abutment (TEA) placement and completed using the prosthetic techniques with which the clinician is most comfortable. Various attachments or interlocks between the implants and the natural abutments may be chosen. These provide stress-breaking features that may be important, since the support mechanisms differ so dramatically between implants and natural teeth.

FIXED-DETACHABLE BRIDGES

The fixed-detachable bridge is a prosthesis that may be removed by the dentist but not by the patient. The method of fixation is by screws that attach the bridge to the implants, to their abutments, or to an interposed mesostructure bar. These prostheses are most often completely implant borne. However, natural tooth abutments may be incorporated into implant bridges by the use of semiprecision attachments or internally threaded telescopic copings. The techniques used in producing fixed-detachable bridges are by far the most complicated one to perform, and the opportunities for error are hig. The benefits of being able to remove these bridges must be equated with the difficulties

in fabrication, the costs, the potential for postinsertion complications, and the restoring dentists willingness to manage them.

SINGLE CROWNS

Single tooth prostheses maybe fabricated in one of two ways. An implant-borne crown should be made that does not involve rigid dependence on any of the adjacent teeth**.** It must merely abut to a single implant. Such implants must possess antirotational features (i.e., hex, spline, cold weld). If there is a question of adequate support, an implant-borne crown may be connected with a semiprecision attachment to one or even several adjacent crowns Fixed rigid attachment is to be discouraged, however, unless the natural abutments are protected with telescopic copings. When such placement is performed, the practitioner must become aware of the phenomenon of natural tooth root intrusion, particularly when temporary cements have been used

IMPLANT PLACMENT: ESTHETIC PERSPECTIVE[1,45,46]

Proper implant treatment planning is important in obtaining an acceptable final result. From surgical point of view, the need for precision in implant placement varies according to the individual case. In most of the cases it is dictated by amount of bone remaining, the soft tissue architecture, position and inclination of the neighboring and the opposing teeth.

Presurgical planning is usually based in empirical evaluation of the patient. Cast of maxilla and mandible are mounted in an articulator and the diagnostic evaluation is done for the mesiodistal width and buccolingual width for implant placement. Analysis for horizontal and vertical overlap is also required for anterior restoration.

Spacing and Angulation between implants:

- Mesiodistal position of implant
- Buccolingual position of implant
- Apico-coronal placement

MESIODISTAL POSITION OF IMPLANT IN BONE(Fig 60,61)

A minimum of 1.25mm clearance is required between the implant fixture and adjacent teeth for proper osseointegration and decreased risk of damage to adjacent natural teeth.

However, an average crestal bone loss of 1.04mm is seen when interimplant space is 3mm or less compared with 0.45mm crestal bone loss when this distance is greater than 3mm. When calculating the mesio distal distance to select the appropriate implant diameter, one also has to consider the space required for the fabrication of contact point between crowns. Thus a minimum of 1.5-2mm clearance from the adjacent tooth is recommended to obtain optimum esthetics with appropriate space for prosthetic devices related to various implant design and also for periimplant tissue health.

BUCCOLINGUAL POSITION OF IMPLANT IN BONE(Fig 62)

Two factors play an important role in clinical decision regarding buccolingual position of implant in bone:

- Bone thickness with adequate blood supply
- Appropriate angulation for the proper emergence profile

An implant should be surrounded with at least 1mm thick bone on both buccal and lingual aspect. When a mean facial bone thickness of 1.8mm or larger remains after site prepration, the potential for bone less decreases significantly and bone apposition is more likely to occur.

In addition, the implant body should be aligned with the adjacent teeth as well as with the dentition in the opposing arch.

TRAJECTORY OF THE IMPLANT (EMERGENCE PROFILE)(Fig 63)

The emergence profile of a dental implant depends on both implant body angulation and existing status of the periodontal tissue. The previous clinical parameters discussed are considered for emergence profile. In regard to implant angulation implant bodies should be placed at an angle less than 25 degrees since esthetic need cannot be fulfilled easily with implant placed with wider angle. The clinician should carefully evaluate the soft tissue characteristics including the amount of keratinized tissue, periodontal biotype and papilla form.

It is important to remember that soft tissue augmentation is not possible without hard tissue support. Therefore a ridge deficiency at the implant site should be within 3mm of its optimal contour to allow the clinician to modify soft tissue suitably to have an esthetically pleasing emergence profile. To have an ideal localization, implant placement in bone requires placement of implant platform 3-5mm from CEJ of the adjacent tooth. Furthermore, both buccal and lingual walls should be at least 1-2mm in thickness.

ABUTMENT DESIGNS RECOMMENDED FOR ESTHETIC IMPLANT SITES

Ceramic abutments:

3 different types are:

1) CerAdapt(Nobel Biocare)(Fig 64) consists of internally hexed high strength aluminum oxide cylinder that is shaped and prepared with diamond tooling and copious water.

2) CreaOne abutment has prefabricated aluminous oxide caps that are used as a core for the production of all ceramic crown.

3) CeraBase uses a metal screw seat and platform with a preparable high strength ceramic cylinder.

CERAONE ABUTMENT:[47,48(Fig 65)]

The CeraOne (Nobel Biocare, Goteborg, Sweden) abutment was originally designed for anterior maxillary single-tooth cementable porcelain restorations. The male hex of the implant provides a nonrotating interface with the CeraOne abutment. The 3.61-mm parallel hex walls of the top portion of the abutment offer many useful clinical advantages. The gold alloy abutment screw facilitates maximum preloding force when tightened using electronic or mechanical torque drivers.

A ceramic cap, available in a cylindrical form for the posterior arch and a tapered form for the anterior arch, fits over the CeraOne abutment. The cap is made of densely sintered semitranslucent aluminium oxide, which is designed to be fused with porcelain and cemented permanently to the abutment. Porcelain is fused directly to the ceramic cap, which provides considerable resistance to lateral force

THE PROCERA ABUTMENT:[20] (Fig 66)

Recently, custom abutments in titanium have entered, where an abutment can be designed by a computer. The Procera abutment (Nobel Biocare, Sweden), provides the clinician with the opportunity to obtain an "abutment solution for every situation.

Implant abutments created with the Procera system were introduced in 1998. These abutments were designed to allow the use of an internal counter torque device to protect the implant-bone interface while the abutment screw is tightened. The external surface could now be modified as required by the restorative dentist. The modified screw design

makes insertion of the head of the screw drivers easier. The countertorque device has been improved to fit different sizes of implants and different lengths of abutments.

The Procera abutment is individually designed using the computer-assisted dental design (CADD) technique or a special wax-up technique.

ESTHETICONE ABUTMENT:

The Estheticone abutments are pure titanium, as are all Branemark abutments, have a hexagonal base, and are tapered in shape. There are three sizes; each size corresponds to the height of the collar at the bottom of the abutment. The sizes are 1, 2, and 3 mm, and each has a corresponding titanium abutment screw, which is tightened at 20 Ncm. The restoration begins at the top of the abutment collar. Therefore, depending on the abutment size selected, the restoration may begin 1, 2, or 3 mm from the implant fixture. The EsthetiCone is designed for aesthetic restorations.

CERADAPT ABUTMENT: [44]

The CerAdapt abutment system was developed to simplify the most challenging esthetic implant restorations. The abutment is an all-ceramic alternative to metal abutments. The CerAdapt abutment is a premachined, precision-milled abutment made to fix the implant hex. The abutment cylinder (12 mm high and 6 mm in diameter) is obtained through a technique using densely sintered and highly purified alumina.

Alumina has been used for the fabrication of CerAdapt abutments because of the good mechanical properties and the esthetic possibilities for crowns and FPDs when using densely sintered alumina as a core material.

APIC COMBO ABUTMENT: (Fig 67)

(Asia Pacific Implant Centre) Achieves the dual roles of impression coping and permanent abutment.Pure titanium allows ease of modification with burs. Allows drastic angle modification thereby disposing of the need to use angulated abutment.

STRAUMANN ABUTMENTS:[42] (Fig 68)

1) Synocta Abutment: The synOcta 1.5mm abutment is the primary abutment of choice for esthetic screw retained restorations. The abutment can be placed on the implant and the impression is made or, an implant level impression is made initially which is followed by placement of abutment on master cast.

2) Solid Abutment: The solid abutment is the most frequently used abutment in Straumann implant system. It is the primary abutment for posterior single and multiple tooth restorations in partially edentulous patients. It may be used in anterior region if the interproximal margin is deep. The solid abutment is inserted into the implant and torqued to 35Ncm. A impression cap is inserted and the positioning cylinder is seated. An impression is made and sent to the laboratory for crown fabrication.

The CAMLOG abutments: [49] (Fig 69)

1) Esthomic abutments:

Esthomic Abutments are used in the fabrication of cementable restorations and are available in both straight and angled versions. The angled version is available in 15° and 20° angles as Type A and Type B and is distinguished by a 60° offset cam. This makes six rotation positions possible. An optimal prosthesis axis is more easily achieved.

2) Logfit™ abutment:

The Logfit™ abutment is used in the fabrication of cement-retained restorations prepared with the help of prefabricated burn-out plastic copings. The color-coded abutment is a component of a standardized prosthetic system and is available in 3.8, 4.3, 5.0 and 6.0 mm diameters and in gingival heights of 0.8 and 1.5 mm.

3) Telescope abutment:

The design of the telescope abutment enables the fabrication of double crowns even in heavily unparallel placement of implants. The customizable abutment has an occlusally widened cone angle of 5°. The color-coded telescope abutment is available in 3.8, 4.3, 5.0 and 6.0 mm diameters.

4) Universal abutment:

The customizable universal abutment is used in the fabrication of double crowns. The color-coded abutment is available in 3.8, 4.3, 5.0 and 6.0 mm diameters.

5) Ceramic abutment:

Ceramic abutments are used whenever particularly high quality esthetics are called for. Because zirconium oxide is used, the indication is not restricted to the anterior area but extends to the entire dental arch. The ceramic abutment consists of a titanium base, a zirconium oxide sleeve, and an abutment screw. After preparation on the model, the zirconium oxide sleeve is bonded to the titanium base. The procedure enables optimal esthetic results to be obtained and tailored to individual situations by trimming, firing, and tinting the ceramic abutment. Gingiva height is 4.0 mm.

6) Esthomic® abutment, Inset:

The Esthomic® Abutment, Inset is ideal for narrow gaps through its slender straight shape (no flare). The shoulder is anatomically contoured. The gingival height is 1.5-2.8 mm.

7) Temporary abutment:

The temporary abutment consists of a high stability PEEK (polyetheretherketone) resin that is easy to work with in grinding or the application of self-curing polymer. It is especially suited to immediate provisional restorations in addition to long-term provisionals. Gingiva height is 4.0 mm.

THE UCLA ABUTMENT: (Fig 70)

Abutment design: After the implant level impression is made, when the master cast is fabricated with implant fixture analogues in proper position, the plastic patterns can be

placed and wax pattern developed. The pattern is then invested; wax and plastic will burnout resulting in a casting that fits directly onto the implant fixture.

Types:

i. Posterior UCLA custom reangulated abutments.

ii. Posterior UCLA custom abutments (with out reangulation).

iii. Anterior UCLA custom reangulated abutments.

iv. Anterior UCLA custom abutments (with out reangulation).

HEALING ABUTMENT

Healing abutment can be custom or prefabricated kinds.

Prefabricated/Anatomic healing abutment: Custom tooth form healing abutments are beneficial with unusual size or shape according to area of esthetic concern. These abutments closely approximates the cross sectional anatomy of the lost tooth or the planned replacement at the gingival level. These also provide a scaffold for guided healing of soft tissue immediately following implant emergence.

The most important consideration in their use in esthetic areas is to avoid introducing excessive labial contouring which can result in soft tissue recession. Furthermore, when an anatomic abutment is too small to adequately support adjacent papillae or interimplant tissue, the loss of scalloped soft tissue architecture may not be recoverable. Similarly when an abutment is too large, it can embarrass the circulation to

the adjacent papillae or interimplant soft tissue leading to loss of tissue volume which can be irreversible.

In most of the instances a prefabricated abutment that closely approximates the mesiodistal dimension of the tooth that is being replaced and that incorporates the labial bevel, thus preventing recession of labial tissue and gives esthetic result.

Custom healing abutment: A prosthetic technique used by the surgeon to initiate early guided soft tissue healing involves the use of custom tooth form healing abutment. Since every anterior maxillary teeth form is unique in morphology, a prefabricated abutment is unlikely to yield an ideal result in terms of tissue support and guided soft tissue healing in every instance.

The early introduction of anatomically correct prosthetic elements takes advantage of the available healing dynamics and translates into optimal soft tissue contours and periimplant soft tissue stability.

The use of custom healing abutment though very useful for enhancing esthetic outcome, they require laboratory work, chair side time is more and it is important to avoid unwanted loading custom tooth form healing abutments.

PROVISIONALISATION AND IMPLANT ESTHETICS

Replacement of missing and hopeless teeth with implant-supported fixed restorations in the esthetic zone is a complex treatment. It consists of a number of

common treatment steps that includes implant site development, implant placement surgery, provisionalization, and fabrication and maintenance of the definitive restoration. Despite excellent success rates, implant treatment presents with some obvious challenges in the esthetic zone. The common sequelae of tooth loss, which include resorption of the alveolar bone and apical migration of the gingival tissues, present a considerable challenge for the attainment of the ideal soft tissue esthetics. Potential deficiencies of the soft tissues can range from minor discrepancies to severe defects. Numerous treatment protocols and techniques have been developed to counteract this problem and may include immediate placement and provisionalization of the dental implants, soft and hard tissue augmentation of the edentulous ridge and extraction sites, and orthodontic site development. Provisionalization is an integral part of implant treatment in the esthetic zone, and several types of provisional restorations have been described. These are soft tissue and/or tooth-supported removable prosthesis, tooth supported fixed prosthesis, and implant-supported fixed prosthesis.

The obvious goals of provisionalization include the esthetic and functional substitution of the missing dentition during treatment. Provisional restorations can also be utilized for the shaping/preservation of the soft tissues in the coronal portion of the peri-implant mucosa. Finally, the provisional restoration can also serve the important functions of esthetic and functional prototyping, thus acting as a blueprint in the fabrication of the definitive restoration. Selection of a specific type of provisional restoration is based on individual case requirements and chosen treatment plan. It is also obvious that some cases may require several different types of provisional restorations during the course of the treatment.[45]

Esthetics Requirements/Functions:

The provisional restoration should restore the position of the missing tooth (pontic), normal contours, shape and size of the abutment tooth.

- Color matching should be good
- Color should be stable for certain period of time
- If patient desires, characterization of the provisionals should be done
- The provisionals can be used to select the shade for the definitive prosthesis
- The provisionals can be used as a diagnostic tool for evaluating the response of the patient as well as the adjacent tissues before the fabrication of the definitive prosthesis
- The provisional restoration should establish the emergence profile in case of implant supported fixed prostheses as well as immediate fixed partial dentures

Techniques for provisionalization in different clinical conditions:[50]

Several methods of implant provisional restoration have been described in literature. For the ease of understanding, these techniques for different clinical conditions can be divided in two: for partial edentulism, for complete edentulism.

Table: Techniques for different individual conditions

For partial edentulism
• At stage I surgery • At satge I using solid abutments • At stage II surgery • At stage II with improved gingival management • Before implant placement • Indirect technique • Direct technique • For optimum emergence profile • Using impression copings • Other techniques ○ Burn out technique ○ Resin coping ○ Impression cap technique ○ Protective cap
For complete edentulism
• Immediate provisionalization • At stage II surgery • Using existing prosthesis • Conversion prosthesis

For partial edentulism

At stage-I surgery:

Proussaefs and lozada described a technique for immediately loading single root form implants with a provisional screw-retained restoration using a custom acrylic stent. In this technique a diagnostic wax up of the prospective restoration was done, its irreversible hydrocolloid impression was made and poured in high strength stone(Fig. 69). Transparent vaccum stent(TVS) was fabricated on this cast. A drill longer and wider than the anticipated implant size was used to ensure space adequacy. A recipient site for an implant analogue (RSIA) is created (fig 71).

A photopolymerized acrylic resin template is fabricated on the duplicate cast (Fig. 71). An access hole was maintained at the occlusal surface of the prospective restoration. The template was used as a guide during implant surgery (Fig. 72). A threaded HAcoated root form implant was placed. utopolymerizing acrylic resin wass applied between the access hole of the template and the implant mount.

After polymerization of the acrylic resin, the template was removed. An implant analogue was screwed onto the implant mount, and the stent placed on the original cast. The analogue was inserted into the RSIA, and the space between the analogue and stone was filled with autopolymerizing acrylic resin (Fig. 73).

After polymerization of the acrylic resin, a temporary hexed abutment was placed, and the implant position was confirmed with the TVS (Fig. 74). The abutment height was reduced according to the interocclusal space.

After the appropriate tooth color selection, autopolymerizing acrylic resin was inserted into the TVS and allowed to autopolymerize onto the cast. Separating medium was applied previously.

The provisional restoration is trimmed in the laboratory (Fig. 75) and adjusted intraorally out of occlusion. The buccolingual size was then reduced to minimize bending moments

At stage I using solid abutments:[51]

David Kaiser and John Jones presented a technique which made use of solid abutments. For this they made diagnostic casts to determine preoperative clinical conditions. (Fig. 76). Diagnostic wax-up was developed to be certain regarding emergence profile, tooth contours, and position of the tooth to be restored. (Pre-made provisional crowns are encouraged for predictable results [Fig. 77].)

Matrix was made from a previous cast or a selected polycarboxylate crown. Addition of resin to the provisional crown or crown matrix was done and positioned it approximately over the dental implant (Fig. 78). Excess interproximal resin was removed, crown was loosened during the initial set and then replaced. Remove provisional crown from the mouth when resin begins to generate heat and verify the desired position of the provisional crown.

Marginal adaptation of crown to abutment analog was checked [Fig. 79].) Refinement of the margins of the provisional crown was done. Trim margin to the collar of implant under magnification with the use of an acrylic resin trimming bur and contour the restoration. (This sustains the form of the gingival tissue on insertion [Figs. 80 and 81].) Polish with wet muslin wheel and fine pumice. Adjustment of occlusion was done and can be adjusted if progressive loading is desired.

Fabrication of provisional restoration before implant placement:[52]

Impressions are made of the maxilla and mandible, and a stone cast is poured. A wax-up of the missing tooth is made, and the cast is duplicated. A vacuum formed stent is made over the duplicated cast, and the missing tooth site is filled with resin and then return to the master cast.

The position of the implant to be placed is marked, and a hole is drilled through the stent and into the stone cast. The stone above the analog is shaped to allow for an emergence profile of the provisional restoration.

The vertical position of the implant analog in the model is then marked on the cast, anticipating approximately 1 to 2 mm of gingival thickness.

An analog of the implant to be placed is positioned in the hole, with its vertical position placing the top of the implant at the anticipated level of the bone (Fig 82). The analog is cemented with cyanoacrylate glue. The analog should be positioned with retentive feature facing the labial.

A prepable abutment is placed in the analog and prepared in the laboratory to allow for placement of a provisional crown. The abutment margins should be at the level of the gingiva to avoid deep subgingival margins and to allow for ease of cleaning after the implant and provisional crown are placed.

A small groove or dot should be placed on the labial surface of the abutment to allow for accurate orientation and additional retention of the provisional crown. The prepared fixed abutment should be left with a rough surface to allow for retention of the temporary cement to the provisional crown. The abutment preparation will result in a shorter abutment than the final abutment, to allow for 1 to 2 mm of interocclusal space between the provisional crown and the opposing restoration (Fig 83).

This is important to avoid loading of the implant during the immediate healing period. These crowns are provisional and are not placed in occlusion. After the abutment has been prepared, either a hollow denture tooth or a hollow shell crown is relined over the abutment with the use of the opposing model (Fig 84). The provisional crown is adjusted to avoid occlusion. It is useful to leave 0.5-mm to 1-mm space at the mesial and distal marginal ridges. The provisional crown margins are smoothed and polished to optimize the soft tissue response. A hole is made in the occlusal aspect of the provisional crown to allow for access to the retaining screw, which secures the abutment to the implant, and to allow for excess cement to vent (Fig 85).

The abutment retaining screw is removed, and the abutment and provisional crown are removed as 1 piece. At the time of implant placement, the surgeon will have the prepared provisional abutment, provisional crown, and the screw to retain the abutment

into the implant (Fig 86). In addition, the surgeon will receive a stent that will have full arch coverage to guide the surgeon at the time of placement (Fig87).

ESTHETIC RISK FACTORS

- **Local risk factors-**
  - *Quantity and the type of bone.*
  - *Oral hygiene levels.*
  - *Previous periodontal disease and current disease status.*
  - *Occlusal patterns and habits.*
  - *Peri-implant soft tissue.*
  - *Implant surface technology.*
  - *Immediate versus two stage placement.*
  - *Implant location.*
  - Systemic risk factors-
  - *Age.*
  - *Sex.*
  - *Rheumatoid disease.*

- *Long term steroids.*

- *Reduced salivary flow.*

- *Menopausal status*

CONCLUSION

Synchronizing the relationship between the periodontal tissues and an osseointegrated implant must be organized not only to anchor the implant in the bone but also to form a protective soft tissue seal around the implant as it emerges in the oral cavity. The patient's expectations for esthetics with function are higher than ever before, and in this era of modernization the clinician must realize that importance of good esthetic outcome. The goals for esthetic implant therapy are achieved by careful diagnosis with well planned and executed surgical and prosthetic protocol. The aim must not be only anchorage of the implant but to provide a life like esthetic effect thereby improving the overall well being of the patient.

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