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Flap Designs, A Crucial Requirement For Aesthetic Zone Implant Placement-A Review

To Raise A Flap Or To Not For Aesthetic Implants?

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Abstract

In recent years, implant placement is the anterior region has been a major concern for implantalogists, as there is an increased demand to maintain the aesthetics in the anterior region. Since a harmonious smile needs to be maintained in the aesthetic zone while placing an implant, the implantologist should devise a treatment plan in advance to decide whether a flap needs to be raised to place an implant, and if so which flap design, the number and type of incisions to be given which entails that flap and whether the patient is eligible for a flapless procedure. The review article aims at knowing the different techniques of implant placement in the aesthetic zone and the decision-making scheme for it.

Keywords: Implants, aesthetics, flaps, flapless, incisions, cosmetic dentistry.

1.Introduction:

In the modern dental practice, implant dentistry is a reliable treatment option that is linked to positive clinical outcomes and has the potential to sustain adequate function for many years.(1) Implant placement in the aesthetic zone necessitates a full understanding of anatomical, biologic, surgical, and prosthetic principles in order to produce a favourable aesthetic result and high patient satisfaction. It can be difficult to develop a prosthesis that is indistinguishable from the surrounding natural teeth in the aesthetic zone. Dental implant placement in the aesthetic zone is a delicate process that leaves little room for error.

2.History of Implant placement in the aesthetic zone:

For the treatment of various clinical conditions involving the replacement of lost teeth in the cosmetic zone, a number of therapeutic approaches are available. 30 years ago, the earliest

articles that described implantology as a predictable and safe approach of treating patients with edentulism when a systematic procedure is followed, with one of the most important considerations being the amount of time the implant remained immersed before loading., were published by Brånemark et al. .(2) After a few years, Albrektsson set the success criteria for all implant-related treatments, stating that implants must not be mobile, painful, or radiolucent surrounding them, and that annual bone loss should not exceed 1.5 millimetres and 0.2 millimetres per year respectively.(3)

Despite the fact that this was a common standard, at the time, aesthetics was, at most, not a need for treatments including implants because they were primarily operational. Three years after , Albrektsson set the success criteria , Smith et al. stated that aesthetic considerations play a crucial role to a successful implant procedure.(4)

The mandible and maxilla are both included in the oral cavity's aesthetic zone, which extends from canine to canine. This area, however, may extend to the first or even second premolars depending on how wide the smile is. The beauty of the smile heavily depends on this region. As a result, implant placement in the aesthetic zone of the dental arch is frequently more difficult and complex.

3.Implant placement in the aesthetic zone:

Due to specific characteristics, the aesthetic region must be carefully considered while preparing for a dental implant procedure. It is crucial for implant restorations in the aesthetic zone to blend in with neighbouring natural teeth so as to not detract from a person's smile since when people smile, the crowns of their anterior teeth as well as some surrounding gingival tissues are usually visible.(5)

In order to achieve successful outcomes, careful treatment planning and risk assessment are required. This is because the objective is to fabricate dental implants and restorations that are aesthetic and harmonious with a patient's natural teeth and adjacent restorations. To ensure overall aesthetic and functional success surrounding implants, it's crucial to have sufficient soft tissue and bone related measurements, adequate dental implant positioning in the corono-apical, disto-mesial, and facio-lingual dimensions, as well as proper angulations of implants. The objective of surgical treatment is a beautiful gingival margin without significant changes in tissue level, retaining an intact papilla, and conserving soft tissue drape while examining bone and soft tissue characteristics around implants.(6) The aim of surgical therapy is to situate implants in such a way that dental implant restorations in the anteriors can successfully match with neighbouring permanent teeth.(6–9) Generally, when inserting and restoring dental implants, dentists have generally focused their aesthetic considerations in the anterior maxilla compared to the mandible.(10) Teeth in the anterior maxilla may be considered hopeless for a variety of reasons, including vertical root fractures, repeated root canal failure, trauma, tooth decay, and periodontitis, all of which can cause a lack of bone and soft tissue support in the area. The following bone defects can affect dental implant sites: intra-alveolar defects, dehiscence, fenestration, horizontal ridge defects, and vertical ridge defects, (11) ; defects in soft tissue include a lack of sufficient tissue quality and volume around the dental implant site. Various studies have demonstrated a very high overall success rate in the anterior maxilla,(10,12–14) , however these

deficiencies can negatively affect placement, angulation, and having enough tissue support to conceal restorative components.(15) Failure to address them can thereby increase the risk of aesthetic failures in the area. A restorative-driven strategy that involves placing dental implants in surgical sites that will lead to the best possible implant restoration has been suggested during treatment planning in the anterior maxilla.(7–9) To achieve this, implants must be positioned in areas with sufficient bone volume and soft tissue contours. In order to address the lack of bone and soft tissue and provide ideal locations for implant placement, this typically entails the use of bone grafts and soft tissue augmentation. The success of restorative-driven implant placement in the anterior maxilla depends on the achievement of four objectives: placement of dental implants in ideal positions with sufficient bone and soft tissue support, correction of any disparities in soft tissue shape and form, and providing sufficient tissue support for facial aspect and embrasure areas. To accomplish all of this, it is important to plan ahead for the flap design and augmentation procedures.

For that there are some golden rules that every implantologist should manage in order to achieve predictable results on the aesthetic zone(16)

1. The presence of inter-proximal bone around the neighboring teeth decides the presence of papilla in between the tooth and the implant. In the presence of a bony defect papilla generation does not take place. This is also dependent on the space between the point of contacts and the crestal bone. If this interval is ≤ 5mm there is a 98% papillary fill whereas when it increases to 6mm and 7mm the papillary fill decreases to 56% and 28% respectively (Tarnow et al 1992). According to Salma et al. 4.5mm was the approximate amount of papillary height fill that can be expected if there was a space of 1.5mm maintained between the tooth and the implant.
2. The average height of papilla between two adjacent implants is around 3.4mm, which is inadequate in cases to get a proper aesthetic end result. Instead by replacing one implant for a pontic in the anterior aesthetic region, a higher papillary fill of 5.5mm can be achieved (Salma et al. 1998).
3. In patients with thin gingival biotype (<2mm thickness) zirconia abutments should be used instead of metal ones to prevent the color from showing through the gingival tissue. So appropriate abutments need to be selected for the aesthetic regions.(17)
4. Immediate implants are not a probable course of treatment in case of thin gingival biotypes when compared to thick gingival biotypes as there is an increased chance of facial tissue receding due to bone loss after extraction which cannot be avoided. Instead ridge preservation techniques need to be considered in such patients to preserve the bone height while maintaining the aesthetics.
5. As to when is the best time to place an implant there are multiple methods but the most dependable way to achieve the best aesthetic results involves simultaneous ridge augmentation and implant insertion a month after the tooth has been extracted.(6)
6. Preservation of the papillary form and shape is important after extraction and this can be done by either surgical procedures before the final prosthesis is delivered or immediate temporization by providing an interim restoration and then transferring this final emergence profile to the lab for the permanent restoration (Elian 2007).

7. During provisionalization, the gingival contour and shape should be maintained so as to harmonize with the natural teeth adjacent to it, so that a soft tissue volume(concave) can be created and displaced when the need arises.
8. Implants in the aesthetic zone follow the same guidelines as that of the every other implant that can be placed i.e. (6):
    a. Distance from adjacent tooth: 1.5mm (min.) from either side
    b. Distance from the marginal gingiva of the prospective restoration to be placed: 3-4mm
    c. Distance bucco-palataly: 1-2mm palatal to the emergence profile of the neighboring tooth.
    d. Inter implant distance: 3mm

4. Various Techniques of Implant placement

Most implant procedures involve the use of flaps, although flapless procedures too are becoming popular in recent times due to the development of more sophisticated tools. Dental implant procedures involve different extents of tissue incision, reflection and suturing with varying extents of complexities and depending on the case presentation the need to raise a flap arises as given in *Figure 1*.

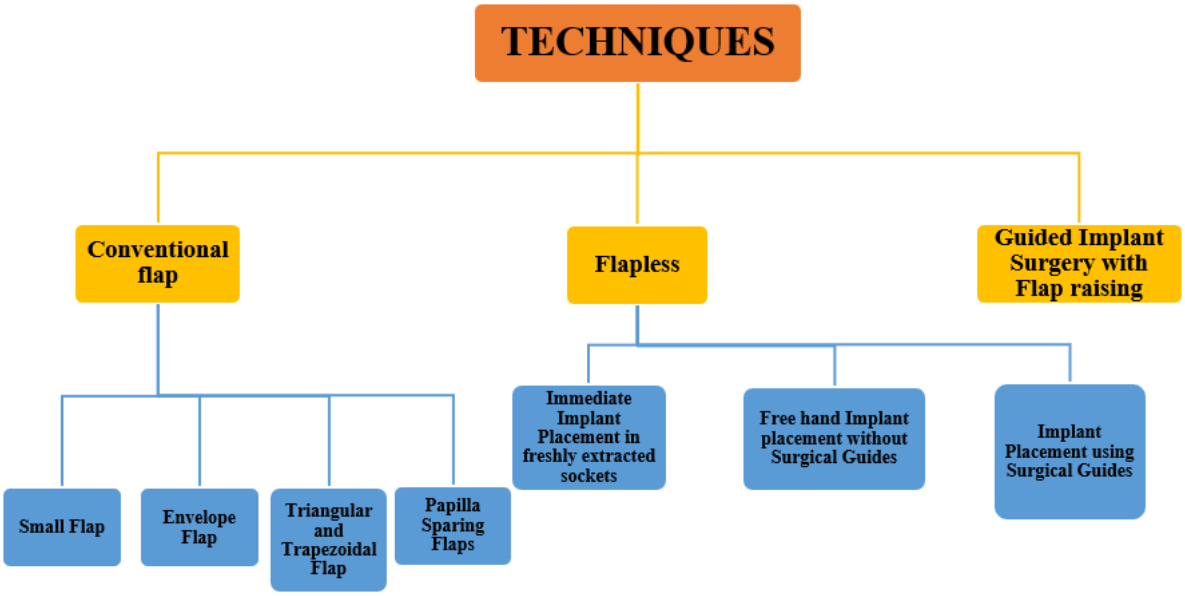


Figure 1: Different techniques to place an implant: Based on the needs the implant can be placed either by raising a flap or by flapless procedures or a combination of both.

4.1 *Conventional Flap Surgeries*

A flap is a piece of tissue from the surrounding mucosal or gingival tissues that are designed to be surgically elevated from the corresponding and underlying tissues, which give a significant access point to the surgeons for adequate management of root and bone tissues.(18)

Conventional Flaps: The conventional flap surgeries can be performed in cases where there has been sufficient time that has elapsed after the loss of the tooth leading to bone resorption. There are various flap designs for implant placement.

4.1.1 *Small Flaps:*

Horizontal or crestal incisions are given on the crest or medial portion of the alveolar ridge. This kind of incision when given alone without contacting the papilla of the adjacent tooth, raises a small flap. Elevating a small flap in the aesthetic zone aids in bone and soft tissue healing, however the accessibility to the surgical site is minimized posing a potential risk of fenestration during implant placement. Furthermore, bone and soft tissue augmentations would be difficult in these flaps due to decreased visibility at the site and mobility of the edges of the flap. After implant placement there is a chance that flap approximation might happen under tension leading to scar formation in the aesthetic zone during healing.(19)

4.1.2 *Envelope Flaps:*

Envelope flap requires a median crestal incision followed by labial and palatal/lingual sulcular incisions to be made that should technically extend at least over one tooth in the mesio-distal direction. Periosteal releasing incisions can be made to increase the passivity of the full thickness flap raised. This flap can be elevated in areas where the mesio-distal width of the edentulous site is reduced to allow the visibility of the alveolar ridge. Envelope flaps provide greater accessibility and mobility when compared to the small flaps with decreased chances of scar formation. But the inadvertent drawbacks of raising one such flap is, the inability to accommodate sufficient graft material in instances of apical bone loss and the loss of interproximal papilla during healing which compromises the aesthetics.(19)

4.1.3 *Triangular Flaps and Trapezoidal Flaps:*

Modifications to the envelope flap can be made by the use of vertical or oblique incisions. Depending on the number of releasing incisions given the flap design changes. Single oblique/vertical incision raises a triangular flap while two oblique/vertical incision makes a trapezoidal flap. These flap designs are mainly used when hard and soft tissue augmentation techniques need to be employed to correct the underlying osseous defect and preserve the gingival contour at the adjacent tooth. The vertical incisions can extend up into the vestibule followed by periosteal incisions to ensure tension free closure of the flap after graft placement. The trapezoidal flap provides better visualization, access and tension free closure of the flap while the triangular flap has better aesthetic results and does not dislodge the graft material easily. The probability of scar formation is equally high in both the flaps so the releasing incisions should be placed in such a way that so as to avoid adjacent root prominences, extending the incision into the vestibule and placing the incisions away more distally.(20)

4.1.4 *Papilla Sparing Flaps:*

This is a modification to all the above-mentioned flaps. When the interdental papilla has a sufficient height and contour papilla sparing incisions are made at the surgical site to preserve the gingival integrity so as to not cause any recession in that region. They are indicated in patients with thin gingival biotype. The flap can be raised by giving a horizontal/crestal incision either on the alveolar ridge or slightly palataly such that a minimum width of 1-1.5mm of the papilla is preserved on the adjacent tooth. This is followed by vertical/oblique incisions towards the mucogingival junction buccally to mobilize the flap for augmentation procedures. These vertical incisions can be extended palataly if required. This method may save more interdental crestal bone than a broader flap that encompasses the interdental papillae. There is a chance for mucosal scaring but the interdental papilla can be preserved along with the width of keratinized tissue.(21)

4.2 *Flapless Surgeries:*

Flapless surgery or Transgingival implant surgery can be defined as a minimally invasive surgical technique in which the implant osteotomy site preparation and placement does not require the elevation of a flap. These techniques require lesser surgical time, causes decreased post-operative bleeding and inflammation, minimal patient discomfort and is more accepted by the patient as a treatment choice in the aesthetic region. It preserves the hard and soft tissue architecture without compromising the blood supply to the tissues allowing faster healing at the implant site.(22)

There are various flapless techniques implant. *Table 1* shows various studies in which flapless technique of implant placement was used.

4.2.1 *Immediate implant placement in an extracted tooth socket (IIP):*

Implants are placed into the atraumatically extracted tooth site with or without grafting depending on the implant size and dimensions. Immediate implant placement is a good option if there isn't any underlying root infection. Otherwise there is a chance for implant failure. IIP helps in maintaining both the soft tissue and bone supports in the anterior region around the implants, by preventing upto 3-4 mm of loss of bone that can occur during the first six months after the tooth has been extracted. An atraumatic extraction, immediate implant insertion followed by an interim restoration/provisionalization determines the optimal aesthetic results that can be achieved. Provisionalization ensures that the restoration applies pressure laterally onto the gingival tissues making sure that the shape, location and emergence of the soft tissue is maintained and prevents the collapse of the gingival tissue surrounding the implant. This makes sure that the permanent restoration integrates well with the adjacent teeth.Also, the success rate of IIP is lesser than early implant placement.(23)

4.2.2 *Free hand implant placement without a surgical guide:*

Free hand implant placement can be done in two ways either by using a tissue punch/circular incision or by transgingival drilling.

Tissue punch: Using the tissue punch or circular incision the gingiva covering the implant surgical site can be removed following which using the osteotomy drills can be used to prepare the site to place the implant. The tissue punch technique can be used when the width of the gingiva covering the implant site is >4-5mm. (24)

Transgingival technique: The transgingival drilling is done using either a round bur or a pilot/lance osteotomy drill using appropriate drill stoppers. This can be done in areas where the gingival thickness is <4mm.(25)

The advantage of free hand implant placement is that it is cost effective, decreased blood loss, no disruption to the crestal and interproximal bone and papilla. But it comes with drawbacks of its own that a certain amount of clinical experience is required before it can be done, there is an inability to visualize the complete submergence of the implant, the amount of heat produced due to the oseteomy drilling can cause some amount of necrosis to the underlying bone because of the heat generated and the inability of the penetration of the coolant(saline/water) into that osteotomy site.(25)

4.2.3 *Implant placement using a surgical guide:*

The conventional technique involves the fabrication of a surgical template in the lab using acrylics on prepared casts of the maxilla and mandible after taking impressions. Drill holes are created on the acrylic stent corresponding to the site where the implant will be placed. It is easy to prepare and is cost effective but there is a chance for the acrylic shavings to enter the osteotomy site during drilling which can affect the osseointegration of the implant.(26)

More recently a 3-D Navigation technique has come into play in which using CBCT imaging, various software's for virtual implant placement, 3-D stent printing (stereolithography) the implants can be placed accurately. The stents prepared have sites/holes for the osteotomy drill, a vent for the needle to enter the anesthetize the site and have locking screws to hold the stent in place. This technique is more precise than the conventional technique but is more expensive at the same time.

Table 1: Studies conducted showing the efficacy of the various flapless implant surgeries

Study conducted by	Efficacy of flapless surgeries
Daryoush Karami et al in 2017(27)	The success of the in office guided implant placement(iGIP), was established by the 3-D positioning of the implant in both cast models and in the oral cavity by both direct visualization and CT scans taken postoperatively. This technique enhances the implant placement by driving the implant in a more prosthetically sought arrangement and also decreases the risk of unintended outcomes as the thickness and form/outline of the soft tissues are taken into consideration while the stent is being fabricated.

Tim Joda et al in 2018(28)	The difficulties associated with s-CAIS is insignificant and can be compared to conventional flapped implant surgeries and it is more beneficial in cases where a flapless implant treatment is possible.
He Cai et al in 2020(29)	The free hand flapless technique both with or without a surgical guide does not differ in their prospective results .
Mario Romandini et al in 2022(30)	Adequate selection of cases and case considerations need to be taken into account to maximise the potency as well as be minimally invasive in both free hand and guided flapless implant surgeries.

There were various studies conducted which assessed the efficacy of flapless surgeries over conventional flap surgeries as shown in *Table 2*.

Table 2: Studies comparing conventional flap surgeries to flapless surgeries

Esposito et al in 2012(31)	Concluded in their study that there isn't enough information to say which flap design is best, which soft tissue augmentation technique is best, or which incision/suture techniques are best.
Bashutski et al in 2013(32)	Implants placed by flapless technique showed decreased bone resorption when compared to the flap technique with no significant changes in the soft tissue.
Wang F et al in 2017(33)	Minimally invasive flapless technique showed improved patient comfort and decreased post-implant placement soft tissue reaction compared to the flap surgery group.
Stuart J et al in 2017(34)	Implants placed by flapless and flap technique showed similar bone and soft tissue changes
O Llamas-Monteagudo et al in 2017(35)	Implants placed by flapless approach healed better than the flapped approach in animal studies but in human studies they had similar results.
Kalpana Singh et al in 2019(36)	The survival rate of dental implant placement by conventional and flapless techniques is similar.
Bassir et al in 2019(37)	Significantly less marginal bone loss was seen in implants placed by flap and flapless technique using early implant loading protocol compared with those placed immediately in the extracted socket
Lemos et al in 2020(38)	The implant survival rate, marginal bone levels, and complications of flapless surgery were similar to those of open-flap surgery

Gao et al in 2021(39)	The flapless procedure showed a superiority in preserving gingival papillae, while exhibiting comparable effects on Survival Rate, Keratinized width changes and Crestal Bone Loss when compared to flap technique. Flapless technique is more recommended at the ideal soft and hard tissue implanting sites.
Krishankumar Lahoti et al in 2021(40)	Flapless placement of implant can positively influence crestal bone loss in comparison with conventional flap technique.

5. ***How to determine which flap technique should be used:***

Risk assessment of the interproximal papillary height, the shape and size of the tooth to be restored, CBCT evaluation of the underlying bone and vital structures should be done to determine the whether a flap needs to be raised or not and the type of flap to be raised.

Classification of soft tissue loss:

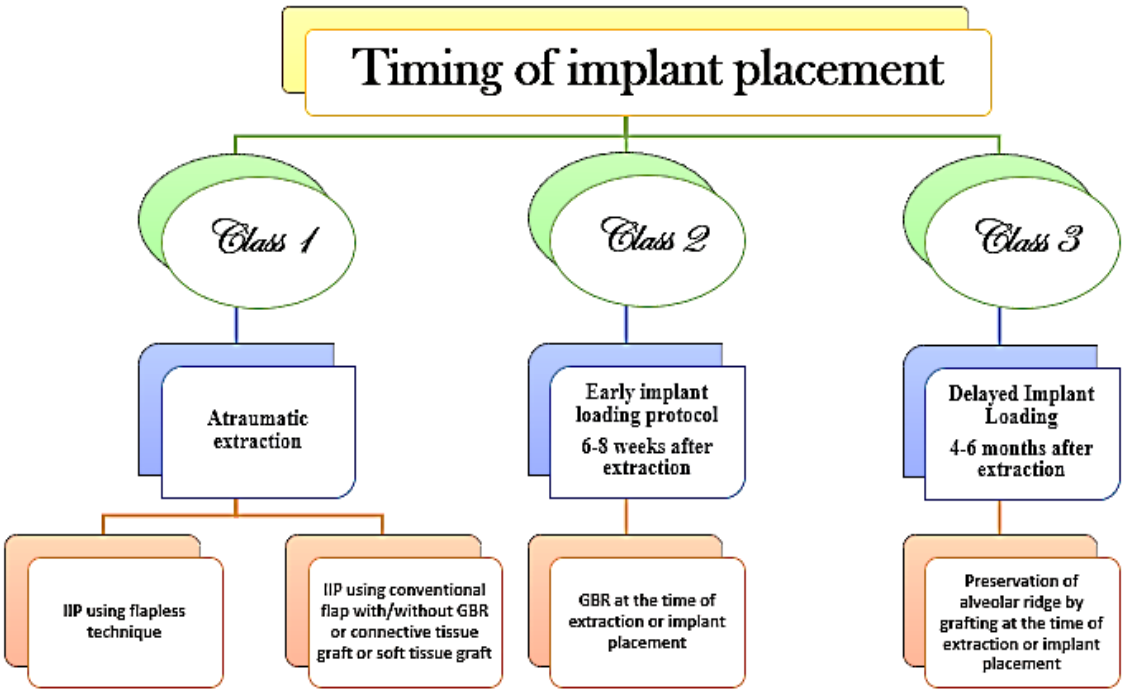
When assessing the aesthetic zone, tissue loss also needs to be considered as the amount of tissue loss corresponds to the underlying bone height/level. Based on the classification of the loss of tissue, the time elapsed since tooth loss the type of implant placement required is determined. *Table 3* and *Table 4* show the classification of soft tissue loss.

Table 3: Classification of papillary tissue lost according to Palacci et al.*(41)*

Class of vertical papilla loss	**Amount of papilla lost**
Class I	Intact/slightly reduced papilla
Class II	≤50% papilla loss/ limited loss
Class III	≤75% papilla loss/severe loss
Class IV	100% papilla loss/ complete absence of papilla

Table 4: Classification of facial soft tissue lost according to Palacci et al.*(41)*

Class of facial tissue loss	**Amount of buccal tissue lost**
Class A	Intact or slightly minimized facial tissue
Class B	Restricted facial tissue loss
Class C	Excessive facial tissue loss



Class D	Excessive facial tissue loss along with insufficient width of attached keratinized epithelium

Funato and Salama et al. (7) evaluated the timing of dental implant placement and stressed its importance to overall implant success in the aesthetic region in Figure 2.

Figure 2:Classification of Implant placement according to time of loading

Based on this the type of surgery to be done can be determined as shown in *Table 5*.

Table 5:Determining the type of surgery to be done in the anterior aesthetic zone based on the presence or absence of soft and hard tissue defects

Class	**Amount of hard and soft tissue present**	**Type of surgery to be done**
Class 1a	Facial bone is intact with thick gingival phenotype	Flapless Surgery using Immediate Implant Placement
Class 1b	Intact facial bone with thin gingival phenotype	Flapless Surgery, Conventional Flap surgery using Papilla Sparing flaps
Class 2	Involves facial bone loss	Conventional Flap Surgery with bone augmentation and guided bone regeneration followed by early implant placement. If severe bone loss is present then delayed implant protocol is followed.

Class 3	Involves facial bone loss and soft tissue loss	For implant success 3-D planning, CT's X-Rays/ RVG, surgical stents and extensive augmentation by guided bone regeneration techniques, followed by soft tissue augmentation is required following which delayed implant protocol is followed.

6. ***Future prospects in dental implant surgery***

Computer Guided implant surgery with/without raising a flap:

Guided implant surgery is a more advanced technique of implant placement in which surgical stents / guides / templates are used to place an implant.(42)

Using computer aided surgery to determine the angulation the precision and accuracy of the implant placed can be increased and this technique can even be used by both experts and amateurs alike to give the same results in the implant success but the drawback is the step rise in price for the treatment. Group 5 ITI Consensus Report in 2018(43) stated that Static computer-aided surgery(s-CAIS),was more favourable to the traditional implant surgeries involving the raising of a flap, in terms of soreness, pain, cost and problems that arise both during and after the surgery. Intraoral scanning techniques and CBCT scan measurements are not precise enough to achieve the accuracy, and hence s-CAIS should be used as an added aid for a complete and inclusive examination and diagnosis. It can cause a breach in the area of keratinized gingiva if not done with absolute care. Gunalan Kalaivani et al in 2020 concluded in their study that Computer-guided approach offers a highly-predictable, secure and speedy implant surgery with better results, along with the position and outcome of the final prosthesis being determined before hand with the help of digital plans and correct positioning of the dental implants when compared to flapless and conventional flap surgeries for implant placement.(44)

7.***Conclusion***:

Treatment planning is crucial for the favorable outcome of surgical and implant placement procedures and a clinician must devise a specific flap design strategy well in advance. Several decisions determine the choice of flap design and the final outcomes of the surgical procedures. The flap design is also affected by the number of the implants, and the potential of simultaneous bone augmentation or the anticipation of a peri-implant imperfection occurring after implant placement. Recently flapless techniques are the preferred technique for implant placement even in the Indian scenario as there is a decrease in the surgical time, decreased post-operative inflammation and increased patient satisfaction and compliance. Appropriate patient selection is a main criterion for flapless surgery. But irrespective of the flap design chosen, soft tissue must always be handled with extreme caution. The final decision of the necessity to raise a flap especially in the aesthetic zone lies in the hand of the implantologist.

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