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Restorative periodontal interrelationship

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Abstract: *The interrelationship of restorative dentistry and periodontics is ever changing. Various guidelines are set for performing restorations that are compatible to periodontium. In order to achieve superior restorative results periodontal corrective procedures are necessary to take back the tooth foundation to a healthy state. Gingival retraction of implants and Chu's aesthetic gauges are the latest additions. These guideline and corrective procedures pave way to a restorative care that directly aid periodontal treatment by restoring an aesthetically pleasing, comfortable and stable dentition.*

Keywords: *Biologic-width, crown-lengthening, margin fit, gingival retraction.*

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I. Introduction

Periodontal health and requirements of restorative dentistry falls at diametrically opposite ends. The restorative procedures may disrupt the equilibrium between plaque micro-flora and gingival tissues. So long-term survival of restoration depends on periodontal health; for periodontium of restored tooth or entire dentition to be healthy several aspects of restoration will be counted.[1] In clinical situation good restorations will keep the balance of biology and function of periodontium.In certain cases, resorations meant for maintaining/restoring functional and aesthetic needs itself, can cause deleterious effect to periodontium.[2] The characteristics important from a periodontal point of view are margins, contours, occlusion, material, design of bridges, and design of removable partial dentures and procedures of restorative dentistry. Above all, the most important step is patient education and motivation.[3]This article reviews the key areas of restorative management necessary to optimize periodontal health and periodontal considerations before restorative procedures, with a focus on functions and aesthetics of restoration.

Rationale

Why periodontal health establishment should be done before restorative therapy?

- Gingival shrinkage afterperiodontal treatment
- Continuous change in position of teeth in periodontal disease
- Impairment of capacity of abutment teeth in inflammation
- Discomfort perceived by the patient
- Easy and accurate impression procedure
- Precise tooth preparation
- Minimal injury to periodontal ligament

Sequence of treatment

The periodontal preparation for restorative dentistry falls into two phases.

1) Control of active disease / cause related therapy

Extraction of hopeless teeth, motivation for oral hygiene, plaque control, calculus removal, and removal of any inadequate dental restorations in the gingival environment, treatment of food impaction, correction of trauma from occlusion, and orthodontic tooth movement can be done.[4,5]

a) Emergency treatment – to alleviate symptoms and stabilize acute infection.
b) Extraction of hopeless teeth (retention may cause bone-loss) and provisionalization with fixed or removable prosthetics.
c) Oral hygiene instructions – individual based oral hygiene instructions is mandatory as the long term survival of periodontium and the treatment outcome depends on the maintenance by the patient.
d) Scaling and root planning - reduces gingival inflammation and decrease the rate of progression of periodontitis

e) Re-evaluation - after 4 weeks the gingival tissues are evaluated to determine oral hygiene adequacy, soft tissue response, and pocket depth.
f) Periodontal surgery – procedures are intended to treat active disease successfully.
g) Adjunctive orthodontic therapy - orthodontic treatment should be commenced after controlling active periodontal disease. But periodontal pocket therapy may be postponed till the completion of orthodontic tooth movement which allows for the advantage of the positive bone changes during orthodontic therapy.

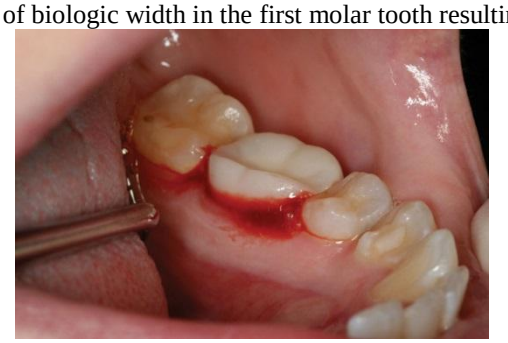
2) **Surgical therapy** – It increases gingival dimensions and achieve root coverage for the purpose of comfort and aesthetics

a) Preservation of ridge morphology after tooth extraction
b) Crown-lengthening procedures
c) Alveolar ridge reconstruction

I) Biologic considerations

The importance of the periodontal tissue is often underestimated. To avoid pathological changes and to predict treatment results more precisely, it is necessary to keep gingival biologic-width unaltered during restorative procedures.[6](fig 1)

Figure1. Violation of biologic width in the first molar tooth resulting in inflammation



Margin placement and biologic width

The location of tooth in oral cavity determines the restoration margin resulting in three options for marginal placement out of which supra-gingival and equi-gingival margin cause least damage to periodontium whereas sub-gingival margins cause impinging on the periodontium leading to biologic width violation. There will be added danger of limited finishing due to inaccessibility.

Clinical procedures in margin placement

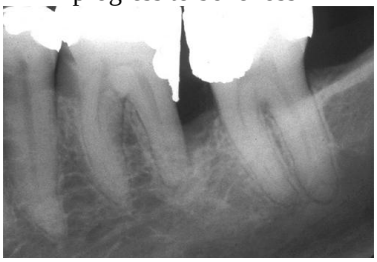
The sulcus depth is used as a guide for placing restorative margin once the gingival tissues become healthy. (Orkins et al 1986) Table 1

Sulcus depth	Margin of restoration
< 1.5 mm	Restoration margin 0.5 mm below the gingival tissue crest.
1.5 – 2 mm	Place the margin half the depth of the sulcus below the tissue crest.
< 2mm	Gingivectomy performed to lengthen the teeth and create a 1.5-mm sulcus.

Interproximal restorations

Overhanging margins (fig 2) contribute to periodontal disease by providing ideal location for plaque accumulation thus shifting the ecologic balance of gingival sulcus area to gram-negative anaerobic speciesat the expense of gram-positive facultative species. Marginal defects turn out to have significant statistical relationship with reduced bone height. The removal of overhanging allows a more effective control of plaque, resulting in the disappearance of gingival inflammation and increasing alveolar bone support.

Figure 2. Overhanging of the proximal restoration in the molar teeth resulting in biologic width violation that progress to bone loss



Biologic width and its preservation

The connective tissue attachment occupies 1.07mm of space above the crest of the alveolar bone and that the junctional epithelial attachment below the base of the gingival sulcus occupies another 0.97mm of space above the connective tissue attachment together constitutes the biological width (Garguilo et al 1961).

Violation of biologic can lead totwo different responses on the involved gingival tissues. There will be a bone loss of an unpredictable nature and gingival recession as the body attempts to recreate room between the alveolar bone and the margin to allow space for tissue re-attachment in areas in which the alveolar bone surrounding the tooth is very thin in width. Second possibility is development of gingival inflammation in areas of thick bone surrounding the restored tooth.

Vacek et al (1994) found that biologic width ranges from 0.75 to 4.3mm. Specific biologic width assessment must be done for each patient to determine if the patient needs additional biologic width, in excess of 2mm, for restorations to be in harmony with the gingival tissues. Bone sounding will determine the biologic width and should be done on teeth with healthy gingival tissues and should be repeated on more than one tooth to ensure an accurate assessment.

Correction of biologic width violation

Violation of biologic width occurs in the restorations which can be corrected either by surgically removing bone to create ideal biologic width for the patient with an additional 0.5mm safety zone or by extruding the tooth orthodontically.

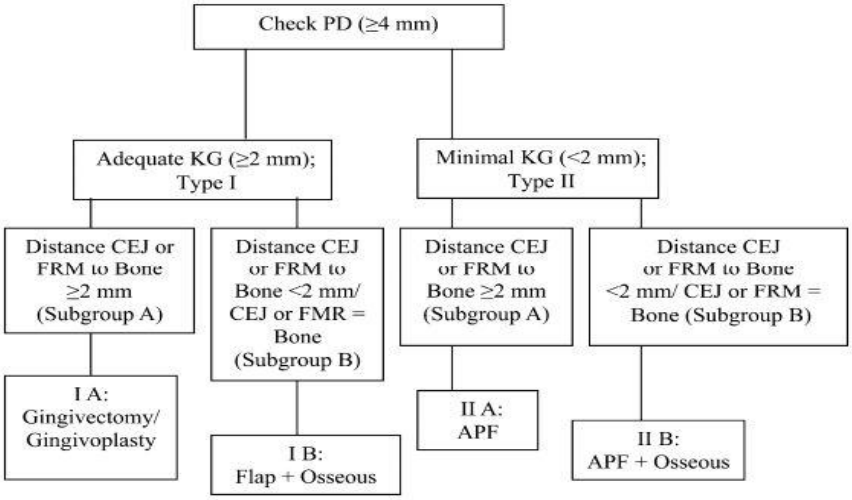
1) Surgical crown lengthening

Surgical crown-lengthening procedures is performed to produce retention form to permit for correct tooth preparation, impression procedures and placement of restorative margins and placement of restorative margins and to adjust gingival levels for aesthetics.[7] Surgical crown lengthening may include the removal of soft tissue or both soft tissue and alveolar bone. Reduction of soft tissue alone is indicated if there is adequate attached gingiva and more than 3 mm of tissue coronal to the bone crest (fig 3).

Figure 3. Crown lengthening by external bevel gingivectomy that may cause biologic width violation

In the case of dental caries or tooth fracture, to ensure margin placement on sound tooth structure and retention form, the surgery should provide at least 4mm from the apical extent of the dental caries or fracture to the bone crest. The decision tree for crown lengthening procedure is given in figure 4.

Figure 4*:* Decision tree for crown lengthening (Marianne Ong, 2011)



a) Soft tissue crown lengthening

1. External bevel gingivectomy
2. Internal Bevel Gingivectomy without ostectomy
3. Apical positioning of flap without ostectomy

b) Hard tissue crown lengthening

1. Internal bevel gingivectomy with ostectomy (flap surgery with osseous surgery)
2. Apical positioning of flap with ostectomy

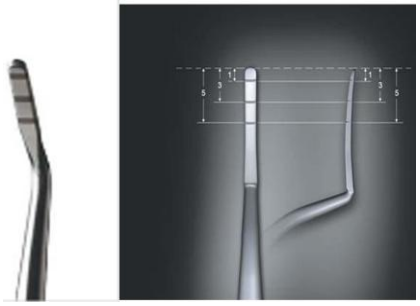
Aesthetic crown lengthening with Chu's aesthetic gauge

Many subjective methods were used in the past for crownlengthening in the aesthetic zone. A series of innovatively designed, colour coded measurement gauges (fig 5) that provide a biologically based, step-by-step approach to periodontal aesthetic crown lengthening of maxillary anterior teeth wasdeveloped by Stephen J Chu.[8–10] The 'aesthetic gauge' includes three set of instruments (5 tips) - Sounding gauge, proportion gauge and crown lengthening gauge.

a) Sounding gauge

It is used in aesthetic periodontal crown-lengthening procedures to determine the level of the bone crest prior to flap reflection. (fig 5 a)

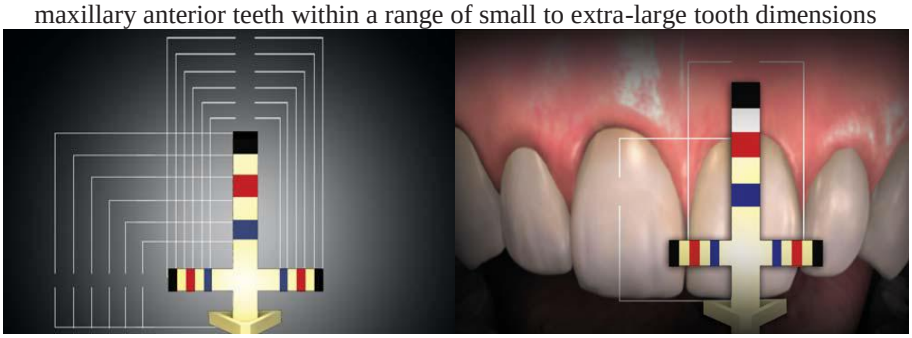
Figure 5a sounding gauge rectangular cross section helps boune sounding more effectively



b) Proportion gauge

The proportion gauge enables an objective mathematical appraisal of tooth size ranges in a visual format for the clinician or laboratory technician. (fig 5 b& c) The instrument includes two types of tip The Proportion Gauge is designed as a single handle, double-ended instrument with "T-Bar" and "In-Line" tips screwed into the handle at opposing ends. The final free gingival margin is determined by the width of the tooth where the width and length are represented by the corresponding same colour in both the arms.

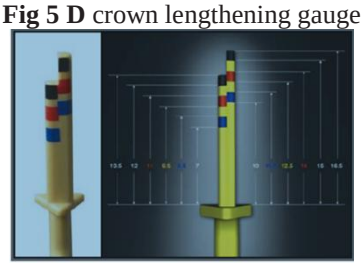
Figure 5b&c, T-Bar proportion gauge tip designed to simultaneous width and length measurements of maxillary anterior teeth within a range of small to extra-large tooth dimensions



c) Crown lengthening gauge

The crown lengthening gauge, a double-ended instrument, has the Biologic perio gauge (BLPG) tip on one end, and the papilla tip on the opposite end. The Biologic perio gauge (BLPG) tip is designed to measure the mid-facial length of the anticipated restored clinical crown and the length of the biologic crown (i.e., bone crest to the incisal edge) at the same time during surgical crown lengthening. The papilla tip follows the use of the BLPG tip to establish the correct aesthetic position of the ID papilla from the incisal edge. (fig 5 D)

Fig 5 D crown lengthening gauge



The various steps in crown lengthening is more narrative in the figures 6a to 6i.

a) Orthodontic extrusion

Traumatic injuries to the teeth in aesthetic region pose challenge for clinician as there is the limitation for surgical crown lengthening. Orthodontic extrusion is done by either removable or fixed appliances, depending on the mobility of adjacent teeth, the anchorage requirements, and the type of force required. Various mechanical strategies are described by Bach and colleagues.[13]

a) Using wires and brackets as a part of mechanotherapy.
b) Extending a rigid wire across the teeth neighbouring the fractured teeth and applying traction force
c) Less conventional methods of forced extrusion include magnets and a "forced extruder".

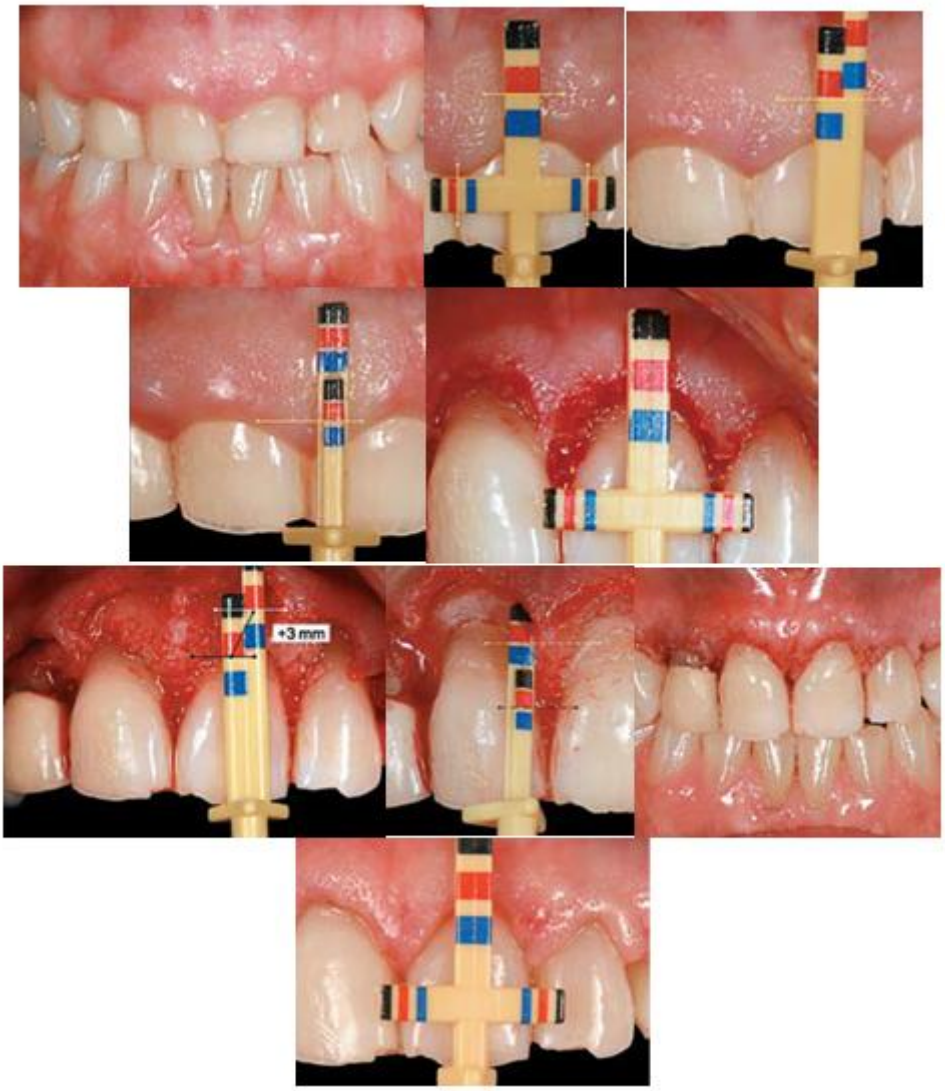


Figure 6a – 6i steps of crown lengthening using chu's aesthetic gauge 6a preoperative appearance. 6b the red area of the horizontal arm of t bar tip (proportion gauge) coincides with the width, the height of crown should be the red area in the vertical arm. 6c the red area of t bar tip transferred to the BLPG tip for mid facial soft and

following hard tissue reduction. 6d the red area of t bar tip transferred to the papilla tip for proximal soft tissue and following hard tissue reduction 6e. soft tissue reduction by internal bevel Gingivectomy.6f hard tissue reduction at mid facial region. black line corresponds soft tissue margin and white line indicates the hard tissue that should be removed. 6g. hard tissue reduction at proximal region.black line corresponds soft tissue margin and white line indicates the hard tissue that should be removed 6h. flap sutured back in more apical position 6i post-operative

Tissue retraction

During subgingival preparation of tooth the surrounding tissue must be protected from abrasion, which will cause haemorrhage and can adversely affect the stability of the tissue level around the tooth. Retraction pastes like Expasyl or Magic foam cord have been found to be better than the normal cord, as assessed histologically, with respect to the periodontium.The retraction of tissues of implant lacks the perpendicular fibres and use of retraction pastes is advantageous in those cases. (Fig 7) (Table 2)

Figure 7 gingival retraction using retractioncord

Table 2 retraction cord for different sulcus depth

Sulcus depth	Retraction cord	During impression
< 1.5 mm	At 0.5 mm.	Second cord is used to displace first cord apically
1.5 – 2 mm	Two larger cords placed at half the depth of sulcus	Third cord is used to at the time of impression

Marginal fit

Opengingival margin leads to inflammation as this space can harbour microbes and the extent of inflammation has a positive association with the level of opening.

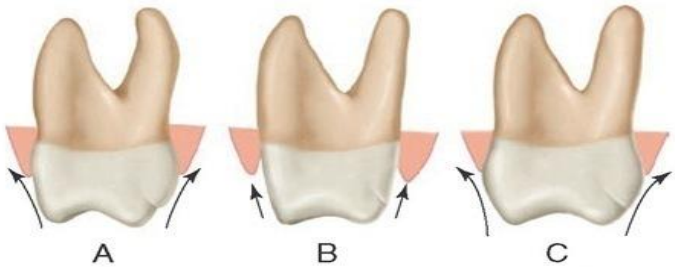
Provisional restorations

The marginal fit, crown contour, and surface finish of the interim restorations must be appropriate to keep up the health and position of the gingival tissues throughout the interval until the final restorations are delivered. The unfavourable tissues changes can compromise the final restoration.

Crown contour

Ideal contour provides access for hygiene, has the fullness to create the desired gingival form, and has a pleasing visual tooth contour in aesthetic areas.Overconturing has shown gingival inflammation in animal studies wherasundercontouring has neutral effect. Overcontouring is a result of inadequate tooth preparation that forces technician to produce a bulky restoration. (Fig 8)

Figure 8. Normal contour physiological massaging b. under contoured crown cause trauma to the attachment apparatus c. over contoured crowns cause decresed gingival stimulation and plaque retension occurs.



Physiologic tooth contouring

This allows self-cleansing mechanisms of cheek, tongue, etc. For instance, the bucco-lingual bulge should be less than 0.5 mm wider than the cemento-enamel junction. Insufficient preparation of abutment teeth is often done to preserve sound tooth structure, but often results in over contouring.

Problems with over contouring

- "Food traps" from open contacts, overhangs, or plunger cusps may occur
- Poor occlusal design, and poor aesthetics
- When the coronal contour of a restoration prevents access for oral hygiene or creates mechanical pressure on the gingival tissue, gingival health is likely to be compromised
- Un-aesthetic emergence profile of restoration

Design of fixed and partial dentures and crowns for root-resected teeth

A bridge should be designed to minimize accumulation of dental plaque and food debris and to maximize access for cleansing by the patient. It should also provide embrasures for the passage of food and protection of gingival crevices

Subgingival debris

Retraction cord, impression material, provisional material, or either temporary or permanent cement left inside the gingival tissue during restorative procedures cause adverse periodontal response. The management includes examining the sulcus surrounding the restoration with an explorer, removing any foreign bodies, and then monitoring the tissue response.

Hypersensitivity to dental materials

Non-precious alloys like nickel in dental restorations results in gingival inflammation. Hypersensitivity responses to precious alloys are extremely rare, and can be used as an alternative.

II. Aesthetic tissue management

Managing interproximal embrasures

The interproximal papilla is a very important part in creating aesthetic result especially in maxillary anterior teeth. The interproximal embrasure created by restorations and the form of the interdental papilla have a unique and intimate relationship. Papillary height is established by the level of the bone, the biologic width, and the form of the gingival embrasure. The ideal interproximal embrasure should house the gingival papilla without impinging on it and should also extend the interproximal tooth contact to the top of the papilla. The free gingival margin averages 3 mm above the underlying facial bone, the tip of the papilla averages 4.5 to 5.0 mm above the interproximal bone.

Correcting open gingival embrasures restoratively

Two causes of open gingival embrasures

- The papilla is inadequate in height because of bone loss
- The interproximal contact is located too high coronally

The treatment of open embrasures may require restorative, orthodontic and periodontal considerations depending on the underlying etiology. Restorative dentistry can correct this problem by moving the contact point to the tip of the papilla. To accomplish this, the margins of the restoration must be carried subgingivally 1.0 to 1.5mm, and the emergence profile of the restoration is designed to move the contact point toward the papilla. This can be accomplished easily with direct bonded restorations.

Managing gingival embrasure form for patients with gingival recession

Management of the gingival embrasure form for patients who have experienced gingival recession varies, with anterior and posterior teeth. In aesthetic areas, it is necessary to carry the interproximal contacts apically toward the papilla to eliminate the presence of large, open embrasures. In the posterior areas where the inter-root widths are significantly greater, it is often impossible to carry the proximal contacts to contact the tissue without creating large overhangs on the restorations. The contact should be moved far enough apically to minimize any large food traps.

Pontic design

Mainly pontics are four types - sanitary, ridge-lap, modified ridge-lap, and ovate design. Regardless of design, the pontic should provide an occlusal surface that stabilizes the opposing teeth, allows for normal mastication, and does not overload the abutment teeth. The primary method for cleaning the under-surface of

pontics is to draw dental floss mesio-distally along the under-surface. The shape of this under-surface determines the ease with which plaque and food debris can be removed in the process. The sanitary and ovate pontics have convex under-surfaces, which makes them easiest to clean whereas ridge-lap and modified ridge-lap designs have concave surfaces causing difficulty with oral hygiene.

Occlusion

Traumatic occlusion may lead to radiological widening of periodontal ligament space or pronounced cervical abfraction. Also it leads to hypermobility which needs occlusal adjustment. A new restoration or an existing restoration that is not in accordance with occlusal pattern of mouth e.g. a "high filling" or the insertion of a prosthetic replacement jeopardize the opposing teeth, the entire dentition and the restored tooth or abutment.

III. Special restorative considerations

Crowns for root-resected teeth

Even after the modest amount of tooth preparation, structural challenges are created in restoring root resected teeth because of the amount of tooth structure lost in the resection process. A post and core will add strength to the resected teeth which may be considered. Crowns must be prepared such a way that patient has access for oral hygiene measures. The preparation should eliminate residual ledges, roots, furcation lips or horizontal components or the furcation. From the margin the contours should be straight line or slight convexity facially and lingually whereas proximally areas the embrasures should be fluted to the convexities of root allowing access for oral hygiene measures.

Splinting

Mobility of teeth and the need of multiple abutments' compel clinician to perform splinting, either bonded external appliances, intracoronal appliances, or indirect cast restorations to connect multiple teeth. Before splinting is advocated etiology should be elucidated and necessary occlusal therapy should be done and the patient should be re-evaluated. The splinting is done with composite and stainless steel wire, fibre splint and amalgam etc. Also, adequate space must exist between the connector and the papilla for access with dental floss anteriorly and with an interproximal brush on posterior teeth.

IV. Conclusion

Periodontal health depends on the continued integrity of the restoration. Predictability and success in restorative dentistry largely depends on the health and stability of the periodontal tissues. There is definite correlation between restoration and periodontal health. Research proves that periodontal apparatus of teeth are very sensitive to minor changes of their environment and require extreme care and immense scrutinization to maintain periodontal health and prevent inadvertent destruction.

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