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Review Article

Splinting- A Dilemma in Periodontal Therapy

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***ABSTRACT*:**
Splinting appears to be the rational safety procedure to employ when a tooth must withstand forces beyond its individual physiologic limit. By splinting, the pathologic tilting of the individual tooth is transformed into a physiologic bodily movement analogous to the bodily movements of the roots of multirooted teeth.The importance of an adequate diagnosisandproper managementis greatly emphasized to improve the health of tooth, thereby decreasing mobility, otherwise it may become a curse to periodontium.
Key words: Splinting, secondary occlusal trauma, mobility, stabilization.

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Introduction

Splinting is one of the periodontal therapeutic procedures which is miserably understood and decisive to implicate. Proper knowledge regarding its implications will go far in deciding for/ against the use of splints.[1]The value of splinting has been debated for a long time. Most of the benefits splinting have been reported from clinical observations than from scientific evaluations.[2]The need to stabilize periodontally involved mobile teeth has resulted in the development of numerous types of splints, which allow for maximum repair of the periodontium during and after periodontal therapy.[3] But any attempts to perform splinting techniques without adequate diagnostic techniques in oral diagnosis, periodontal analysis or occlusal analysis can often lead to misapplication of these procedures.[1]

Historical perspective

Early evidence of human desire to splint weakened teeth can be seen in archeological findings. A phoenix mandible from 500 B.C. demonstrated, loosened and periodontally compromised anterior teeth bound together by gold wire. Findings from digging of Egyptians show similar gold wiring. The history of splinted dental prosthesis progressed to using silver wire followed later by appliances of gold wire or ribbon to support loose teeth.

Obin & Arvins (1951) advocated the use of self curing internal splint to achieve temporary stabilization. Harrington (1957) modified the splint by incorporating a cemented stainless steel wire. Wellensiek (1958), Shatzkin (1960) &Taatz (1964) presented approaches to the anterior intracoronal splints.

Cross (1954) suggested the use of a continuous amalgam splint for fixation of mobile post teeth. L'yod& Baer (1959) & later on Ward & Weinberg (1961) developed new techniques using a plastic matrix or using wire reinforcement.[1] Splints have therefore gone to a far approach of intracoronal bondable fibre splinting, of the present.

Definition

A splint is an appliance used for immobilization of injured or diseased parts. A periodontal splint is an appliance used for maintaining or stabilizing mobile teeth in their functional position.[2]

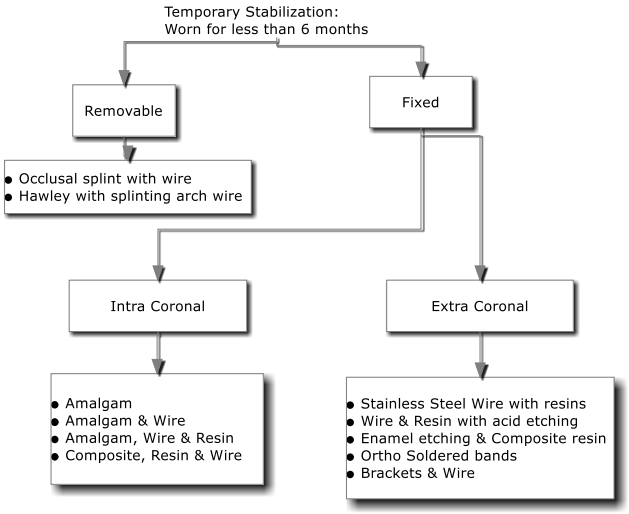
The general biologic benefits of splinting are (1) reduction of periodontal strain and tightening of teeth (2) physiologic reorientation of teeth movements from pathologic tilting to stimulating vertical pressure.[3]

Classification of splinting

The choice of splint should be made after considering factors such as tooth contour, spacing of teeth, location of the teeth in the arch, length of the splinting period, oral physiotherapy, aesthetics and the degree of rigidity desired.[3]

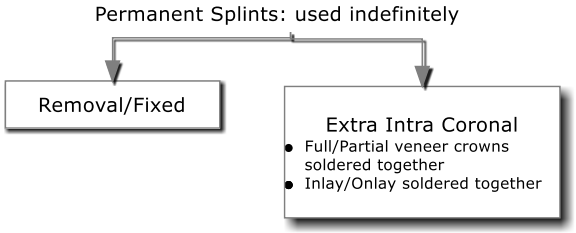
A) According to the period of stabilization:

(a) Temporary stabilization:



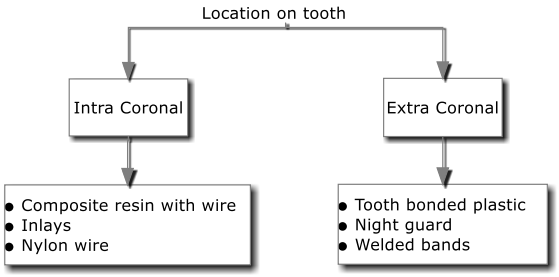
(b) Provisional stabilization: to be used for months up to several years.- e.g. Acrylic splints, metal band

(c) Permanent splint:



B) According to the type of Material:
-Bonded composite resin button splint
- Braided wire splint
- A splints

C) According to the location on the tooth



Biomechanics of splinting

Resistance to mesiodistal tilting forces: the effect of a splint is achieved through the use of any appliance which ties several teeth together rigidly. A mesiodistal force applied to a splint or stationary bridge will act like force M. (fig 1) It will tend to rotate the entire unit of teeth and appliance about an axis m running between the teeth (at right angles to the force initiating the movement). The individual roots cannot tilt as separate units but must move vertically and bodily. This utilizes the maximum stabilization available through splinting in resisting forces that tend to tilt teeth mesiodistally.

Distal abutments: The distal tilting force of a free end saddle partial denture may be periodontally pathogenic for an abutment to which it is clasped. That force might be oriented physiologically if the abutment were splinted to the adjacent mesial tooth.

Cantilevered bridge: Vertical occlusal pressure falling outside the long axis of the tooth induces tilting similar to that resulting from horizontal strain. To prevent this splinting can be utilized to support some cantilevered bridges.

Resistance to buccolingual tilting forces: Abuccolingual force, force B in fig.1 tends to tilt the splint in a buccolingual direction about an axis of rotation (dotted line b) that runs mesiodistally through both teeth. The splinting effect is least in its resistance to buccolingual loads.

Buccolingual diameter of teeth: In order to enhance the reduction of occlusal trauma of the splint in buccolingual direction, the splint restoration should be narrow buccolingually so as to reduce the torque resulting from occlusal forces which fall outside the long axis of the tooth.

Splinting around the arch: Carrying the splint around the curve of the dental arch approaches the idea of multidirectional splinting, of having the occlusal stresses applied in the direction of the splint rather than at right angles to it. In fig 2labiolingual force P falls on the central incisor and tends to rotate the splint labially around an axis2 running labiolingually. Since the central incisor and cuspid are not in one labiolingual line, the axis 2 cannot run through both teeth but is located between them. Simple individual tooth tilting therefore is impossible, and bodily movement of the root results. The same analysis can be applied to labiolingual force L which produces bodily movement by rotating the splint around the dotted line 1 as the fulcrum. Thus, splinting around the arch has a distinct advantage over splinting teeth in a straight line.

Resistance to rotation about the long axis of the tooth: After the teeth are repositioned in the dental arch, they may

require stabilization because of the diminished periodontal support.

Distance and the splinting effect: When the teeth are farther apart, the arch of movement increases and induces a more nearly vertical resistance, which is desirable. The farther apart the teeth are, however, the weaker is the buccolingual splinting effect, because a slight tilt in one tooth will permit a large movement in the other, as if one tooth were rotating about the other as a distant fulcum.The unifying or splinting action diminishes as a wider latitude of independent tooth movement is permitted by distant abutments. Therefore, when three or more missing posterior teeth are replaced, the splinting effect must be increased by including at least three abutments when opposed by the natural dentition or a stationary bridge.[3]

Several factors govern the use of periodontal splints:[2,4,5]

1. All periodontal disease must be eliminated before they are constructed. Inflammation of the periodontal structures can produce mobility in the presence of normal occlusal forces and normal periodontal support.
2. Include a sufficient number of firm teeth in the splint.
3. The splint should not impinge upon gingival, irritate the other parts of oral mucous membrane or create a functional disharmony.
4. The splint should not interfere with oral hygiene.
5. The splint should be simple and esthetically acceptable.
6. Their construction should entail a minimum loss of tooth structure.
7. Meticulous care by patient should be emphasized.
8. Coronoplasty may be performed to relieve traumatic occlusion. Excessive occlusal contacts from parafunction or deflective tooth contacts are frequent causes of excessive mobility. Whenever occlusion is the cause, occlusal therapy is always performed first. The mobility is then evaluated over time to determine if it resolves before splinting is considered.

Indications[1]:

1. To stabilize moderate to advanced tooth mobility that cannot be reduced by other means that has not responded to occlusal adjustment and periodontal therapy.
2. Stabilize teeth in secondary occlusal trauma. If most of the teeth have moderate to severe bone loss, generalized secondary occlusal trauma is the diagnosis. Where possible, GTR should be employed with temporary or provisional splitting before permanent splinting is employed. If a smaller amount of support has been lost, splinting may be a sufficient treatment with maintenance of surgery[6]
3. Stabilize teeth with increased tooth mobility which interfere with normal masticatory function.
4. Facilitate scaling and surgical procedures.
5. Stabilize teeth after orthodontic movement.
6. Stabilize teeth after acute dental trauma i.e. Subluxation, avulsion.
7. Prevent tipping and drifting of teeth.
8. Prevent extrusion of unopposed teeth.

Contraindications[1]:

1. Moderate to severe tooth mobility in the presence of periodontal inflammation and/or primary occlusal trauma.
2. Insufficient number of firm/ sufficiently firm teeth to stabilize mobile teeth.
3. Prior occlusal adjustment has not been done on teeth with occlusal trauma or occlusal interferences.
4. Patient not maintaining oral hygiene.
5. When the sole objective of splinting is to decrease tooth mobility following the removal of the splint.

In common clinical practice, splinting is usually done for anterior/posterior segments.

A) Splinting for anterior teeth:

1. **Direct bonding system:** It uses an acid technique and a light cured resin in interproximal areas to splint the teeth. Unfilled resins may also be used as it shows high resistance to fracture. Adequate compressive strength and minimal marginal leakage.
2. **Intracoronal wire &acrylic wire resin splint:** It uses preparation of a slot on the lingual aspect of the tooth and stabilizing teeth using a stainless steel wire placed in the slot. Slot prepared midway between cingulum&incisal edge about 1.5mm deep. It is then half filled with resin and stainless steel wire is adapted into the slot. The resin is then placed over the wire to seal the slot.
   Variation of the A splint: A 1mm deep mesial/distal box is prepared parallel to the long axis of tooth.SnF/Ca(OH)2 varnish is applied & thread pin is then placed. Stainless steel is adapted around the pin whilst it passes through the slot.[1]

B) Splinting for posterior teeth:

1. **Intracoronal amalgam wire splint:**It uses resin restoration in proximal amalgam restored areas of tooth re-inforcedwih wire to stabilize posterior teeth. A similar procedure A splint is utilized with slot preparation 1.5mm deep and 2-3mm wide. A braided stainless steel wire is used & covered with resin, before finishing & polishing.

2. **Bite /night guard:** Ideal occlusal may require occlusal adjustment, orthodontics &restotative dentistry to eliminate occlusal habits. The occlusal splint may be rigid or soft, made of acrylic or composite. It is often diagnostic as well as therapeutic.[1]

Extra-coronal splinting

The simplest way to connect teeth to each other is the classic bonding method. The enamel surface of the tooth is etched, most commonly with 37% phosphoric acid. Composite resin can then be bonded to the etched surface and used to rigidly connect the teeth to each other. The composite resin splint can be strengthened by adding fibers to the splint or by using a fiber meshwork, e.g., Ribbond (Ribbond Inc., Seattle, WA, USA)(Fig. 3) to reinforce the material. Extracoronal resin-bonded retainers, which can be fabricated in a dental laboratory, serve to strengthen the overall bonded situation. The splints are usually cast from metals, usually non-noble alloys that can be electrolytically or chemically etched. Recent innovations in materials allow these frameworks to be air abraded and then cemented in place with adhesive resin cement (Barzilay, 2000).[7] There are various materials used for extra-coronal splinting such as stainless steel wires (most commonly used), fiber reinforced composite,composite alone, and cast splints.

Adjoining crowns, bridges, adjoining onlay preparations, and veneers without involving any internal line angles are part of extra-coronal splints.(Table 1) These adjoining prostheses can be laboratory fabricated, solder joined or precision attached. Extra-coronal splinting methods that attract more plaque, complicate oral hygiene and further compromise esthetics are obsolete and are to be avoided.[8]

Table 1: Types, trade name and material composition with the advantages and disadvantages of different types of splints.[9-15]

Type	Trade name	Material details
Fiber reinforced composite splint	Splint-It®-Pentron	Fiber splints are available in three unique designs for a variety of stabilization and reinforcement procedures The high strength glass and polyethylene fibers are pre-impregnated with a special resin ensuring complete saturation within each strand and eliminating the need to apply bonding agent The resin-treated fibers provide versatility, in addition to substantial strength and ease of placement **Unidirectional fiber strip:** The 3 mm wide unidirectional glass fiber strip is ideal [redacted] for stabilizing mobile teeth, repairing dentures, and reinforcing temporary bridges **Woven fiber strip:** The 2 mm wide woven glass fiber strip easily tucks into interproximal contacts [redacted], adapts effortlessly to malaligned teeth, and stays in place due to its lack of memory **Braided rope strip:** The 1 mm wide braided polyethylene rope is ideal for use [redacted] when lingual space is limited, and may also be used as a post
	Open weave glass fiber ribbon	Have been adapted to compensate for the unique structural design of periodontal splints Has an inherent ability to dissipate stresses and prevent crack propagation, which is not seen with the unidirectional glass fibers (Giordano, 2000; Vallittu, 1998)
	Ribbond (Eminkahyagil, 2006; Clinical Research Associates, 1997)	Advantages of this material include ease of manipulation and adaptation to dental contours during the bonding process, as it is a relatively easy and fast technique (no laboratory work is needed) In the case of fracture, the appliance can be easily repaired Now also available as thinner higher modulus (THM) Ribbond. This material is thinner than the regular Ribbond and has higher flexural strength. Its thinness allows the operator to adapt it more closely to the teeth. Developed by Dr. David Rudo Woven using spectra polyethylene fibers in a leno weave configuration It is lock stitched and cross-linked

Unidirectional pre-impegrated glass fibers	E.g., Prepreg (Giordano, 2000; Vallittu, 1998)	Unidirectional fibers oriented in multiaxial plane (e.g., 0°, +45°, -45°) stitched together Glass fiber reinforcing materials are available as resin-impregnated (pre-preg), fiber-reinforced glass fibers, in contrast with polyethylene fibers, and have to be protected from environmental damage These materials are esthetic and have translucency similar to castable glass-ceramics such as OPC and Empress The glass fibers can pose a health risk. They are small enough to be inhaled and deposited in the lungs, resulting in a silicosis-type problem.
Open weave glass fibers	(Giordano, 2000; Vallittu, 1998)	Can be used with both polyester and epoxy resins Open weave glass fiber design has been adapted to compensate for the unique structural design of periodontal splints Has an inherent ability to dissipate stresses and prevent crack propagation, which is not seen with unidirectional glass fibers
Provisional fixed partial prosthetic splint	Heat processed acrylic resin splint (Renggli and Schweizer, 1994; Pollack, 1999)	In certain situations occlusal rehabilitation is complex in nature. In such situations, provisional prosthetic splints play greater role Allows patient and periodontist to evaluate restorative treatment planning Material of choice to fabricate a provisional splint is heat processed acrylic resin
Definitive fixed partial prosthetic splint	Crown and bridge prosthesis (Renggi, 1984; Seigel, 1999)	Serve additional purpose of splinting the abutment and other supporting teeth Conventional crown and bridge prostheses fulfill this requirement very well if adequate abutment teeth are included Optional resin-bonded splint can be designed if anatomy and situation of the teeth are not conducive to slender cement retained prosthesis

Figure. 1. (M) indicates mesiodistal force, dotted line (m) indicates axis between teeth, (B) indicates buccolingual force, dotted line (b) indicates an axis which runs through both teeth.

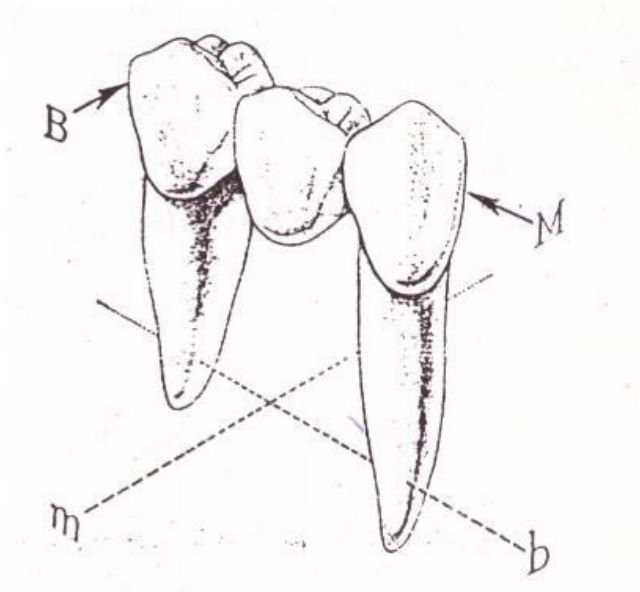


Figure 2. (P) and (L) are labiolingual forces: (1) and (2) indicate axis

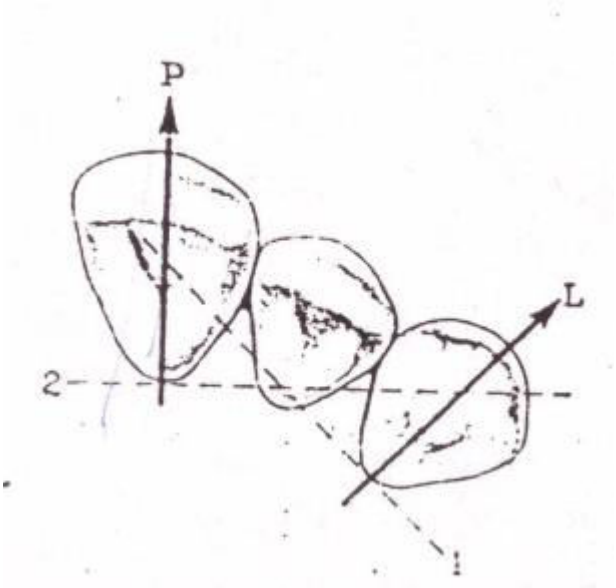


Figure 3. Ribbond splinting

Removable and fixed prostheses

When one or two teeth are missing or have to be removed because they have a poor prognosis, a decision has to be made about the question of replacement of the missing teeth as well as stabilizing the remaining teeth. There have been controversies about the use of periodontally com-promised teeth as abutment teeth. Several studies accepted such teeth as abutments if favorable crown:root ratios were available or generated by addition of another abutment tooth.[16,17] If the crown:root ratio of a periodontally compromised tooth is not favorable, a decision can be made to extract that tooth. The extracted tooth can then be used as a natural tooth pontic after extra-oral root canal and splinting with the adjacent teeth.[18]

Effect of splinting on periodontium:

Splinting of the teeth will not prevent or retard apical downgrowth of plaque (in fact, it will increase) and associated attachment loss.[8]Attachment levels and bone levels were similar in splinted and non-splinted teeth following osseous surgery.[19]In a study on rhesus monkeys to determine the effect of splinting on hyperocclusion, it was observed that forces applied to one tooth in a splint are distributed over the entire unit, that is, all the teeth included in that splint, thus reducing the occlusal load on a periodontally compromised tooth and facilitating the distribution of occlusal forces over a larger periodontal surface. Thus, it was concluded that splinting of tooth helps in redistributing the occlusal forces over a larger area. It was also observed that the areas of root bifurcation and trifurcation are more susceptible to excess occlusalforces.[20]

In another study of 2 weeks in vervet monkeys to determine the effect of rigid splinting on anterior teeth following extrusion of teeth by 3 mm and their replacement back into the socket, the investigators did not observe any signifi cant difference between the splinted and non-splinted teeth in terms of periodontal ligament width or stress or strain values. Results of the study showed that rigid splinting of luxated teeth did not improve the mechanical properties of the periodontal ligament during healing [21].

In a study to determine the effect of initial preparation and occlusal adjustment on tooth mobility, it was observed that for teeth with initial mobility of greater than 0.2 mm there was a decrease in tooth mobility upto 20% .[22]

Thus, splinting mobile teeth acts as an adjunct to periodontal treatment and maintenance and hence is recommended. However, selecting the right splint for the right procedure is done based on the discretion of the advantages and disadvantages of each. A splint should be designed in such a way that it attracts the least plaque and calculus, is able to be retained for the specified time, is able to carry out its designated function, and does not interfere with healing and esthetics.[8]

Conclusion

Loss of tooth-supporting structures results in tooth mobility. Increased tooth mobility adversely affects function, aesthetics, and the patient's comfort. Splints are used to overcome all these problems. When faced with the dilemma of how to manage periodontally compromised teeth, splinting of mobile teeth to stronger adjacent teeth is a viable option. This prolongs the life expectancy of loose teeth, gives stability for the periodontium to reattach, and improves comfort, function and aesthetics. Although splinting has been used since ancient times, it has been a topic of controversy because of its ill effects on oral health, including poor oral hygiene and adverse effects on supporting teeth. There have been considerable advancements in the materials used for splinting, resulting in fewer ill effects.

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