Tooth Splinting : An Update

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Splints may be used to limit tooth movement, prevent the drifting of teeth, and secondary trauma from occlusion. Glickman[1] defines a splint as being an appliance utilized in the stabilization of injured parts[2]. When teeth are seriously loosened by acute trauma or periodontal disturbance, stabilization by splinting can become a valuable adjunct, before, during & after corrective therapy. 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. [5]

Clinical Rationale & Indications for Splinting Teeth

According to Lemmerman (1976)[11] tooth stabilization was indicated

1. In post acute trauma to prevent mobility
2. As part of occlusal therapy
3. To prevent tooth drifting
4. As a replacement for missing teeth (post-orthodontic treatment)
5. As a treatment of secondary trauma from occlusion to provide functional stability

Tarnow and Fletcher[12] summarized the indications and contraindications for splinting of periodontally involved teeth. The three primary rationales for controlling tooth mobility with periodontal splinting are:

1. Primary occlusal trauma.
2. Secondary occlusal trauma.
3. Progressive mobility, migration, and pain on function.

Objectives of Splinting[5,6]

1. **To Provide Rest.**
2. **For Redirection of Forces:** The forces of occlusion are redirected in a more axial direction over all the teeth included in the splint. The centre of rotation of each tooth is so altered so as to afford greater resistance to mesiodistal forces. Resistance to facio-lingual thrust results, if the splint extends around the arch.
3. **For Redistribution of Forces:** The redistribution of forces ensures that forces do not exceed the adaptive capacity.
4. **To Preserve Arch Integrity**
5. **Restoration of Functional Stability**
6. **Psychological Wellbeing** of the patient
7. **Stability:** To stabilize mobile teeth during surgical, especially regenerative therapy and stabilization of dislocated and fractured teeth and alveolar bone fragments. The aim of splinting is fixation of teeth and fragments in their original anatomical position and prevention of accidental ingestion or inhalation as well as protection of the impaired teeth and surrounding tissues from traumatic forces during the vulnerable healing period.

Trauma involving periodontal ligament, after dislocation injuries, requires flexible splinting to allow the transmission of functional forces and improved outcome. Hard tissue injuries such as alveolar process fractures or horizontal intra-alveolar root fractures should be splinted more rigidly[18].

8. **Prevention of Eruption of Unopposed Teeth.**

Classification of Splinting

I. Weisgold[18] classified splints as temporary, provisional or permanent[3].

Temporary Splints: This is used on a short term basis, usually less than 6 months, to stabilize teeth during periodontal treatment. It may or may not lead to other types of splinting. The materials used in stabilization will periodically need replacement, repair or both.[3,10].

Provisional Splint/Semi-permanent Splint[15]: This type of splinting is used for a few months to as long as several years. It is used for diagnostic purposes and allows the clinician to see how teeth will respond to treatment and how missing teeth may be replaced. It usually leads to more permanent forms of stabilization[5,9].

Permanent Splints: This is one which is to be worn indefinitely. It may be either fixed or removable.

II. Modified classification of Ross, Weisgold, and Wright

A. Temporary Stabilization

1. Extra-coronal Splints Not Requiring Cavity Preparation

a. Removable-
i. Acrylic bite guards
ii. Cast continuous clasp appliances
b. Fixed-
i. Wire-and-acrylic splints
ii. Wire-mesh-and-acrylic splints
iii. Orthodontic bands soldered in series.

2. Intra-coronal Splints Requiring Cavity Preparation

a. Wire-and-acrylic splints
b. Wire-and-amalgam splints
c. Combination amalgam, wire, and acrylic splints.
d. Inter-proximal splints of acrylic or amalgam with friction or threaded pins.

B. Provisional Stabilization:

1. Acrylic splints
2. Gold-band-and-acrylic splint

C. Permanent or Long-Term Stabilization

1. Removable splints
2. Fixed splints
3. Combination removable and fixed splint

III. Periodontal Splinting Can Also be Classified As-

Non-Prosthetic Appliances

- Historical-wire splints, wire layered with composites
- Wire and amalgam splints
- Stand alone composite splints.
- Fiber reinforced composite splints

Prosthetic Appliances

- Conventional cemented fixed partial prosthesis
- Metal bonded Maryland splints
- Metal free bonded fixed partial prosthesis

Duration Classification

- Short term temporary splint
- Medium provisional splint
- Long term permanent splint

Numerous splints have been described in the past including wire and composite splints, titanium trauma splints, titanium ring button bracket, orthodontic bands welded together, wire and mesh acrylic splints, removable continuous cast appliances, wire ligation, wire and acrylic splints, grooves with wires, pins or bars fixed with amalgam and various other extracoronal and intracoronal splints. However these splints have now been replaced by new reinforced materials which are easy to use and more esthetically pleasing.

Fibre Reinforced Splints

- Composites are not durable enough to join two teeth together & hence break.
- When stainless steel wire rods were embedded into composites, they fractured at the metal-resin interface. [10]

Functionality of Fiber Reinforced Material [4,16]

Fibres Can Enhance the Efficacy of a Composite Splint By:

1. Acting as a stress bearing component, which increases the load enhancing effect of the brittle matrix composite material.
2. By its crack-stopping or a crack deflecting mechanism, which also increases the toughness of the material (Gordon JE: The New Science of Strong Materials. Princeton, NJ 1988).

When loaded in longitudinal tension, a fiber reinforced composite structure is subject to diverse micro mechanisms ultimately leading to failure. These mechanisms are:

- Crack propagation
- Fiber pull out
- Composite matrix microcracking
- Longitudinal matrix failure
- Fiber debonding
- Fiber fracture

All the above failure mechanisms depend on the direction in which loads are applied to the splint. The smallest of cracks in a strategic position can lead to stress propagation and ultimate failure of the splint structure. If the fiber bundles are so positioned that the forces travel around the crack and are absorbed by the fibers, the crack will not propagate. The process of crack propagation can be easily seen in some composite materials since the area usually turns white.

Commercially Available Fibers - Structural Forms [4,16]

1. Ribbond: Leno Woven Polyethylene Ribbon

This material has been developed by Dr. David Rudo. Ribbond is a fiber that is woven using Spectra polyethylene fibers in a leno

weave configuration. This is in contrast to other kinds of open weaves. This fiber is lock-stitched and cross linked. This pattern makes the fiber more resistant to shifting and sliding under loads.

Ribbond has an ultrahigh tensile strength of 435,000 Ib/in2. The basic material is converted from hydrophobic to a hydrophilic material by being subjected to a cold gas plasma treatment. This facilitates the creation of a chemical bond between the fiber and the resin.

THM Ribbond (Thinner Higher Modulus) is thinner than regular Ribbond, being only 0.18 mm thick despite a higher thread count. The flexural strength is higher than regular Ribbond and its thinness allows the operator to adapt it more closely to the teeth. The finish of splints with the material is smoother and more aesthetic. The original Ribblond, however, still has better breaking resistance than THM Ribbond.

2. Unidirectional Pre-impregnated Glass Fibers [4,16]

Freshly drawn glass fibers have higher values which degrade on exposure to moisture & humidity. High strengths are maintained by coating them with resin & hence they are called pre-impregnated. Two important considerations are, whether these values are maintained when the fibers are subjected to degradation by microcracking and exposure to saliva, and whether these values remain the same since loads & fibers become multi-directional and complex.

3. Open weave Glass Fibers [4,16]

Even though unidirectional glass fibers exhibit excellent strength figures in the lab, they may not be translated clinically due to the multidirectional forces that a splint is subjected to. The open weave pattern has an inherent ability to dissipate stresses and prevent crack propagation.

Various Consideration While Splinting Teeth[4]

- Unpolymerized fiber areas should be well protected from light source.
- Good isolation should be achieved.
- In maxillary teeth, the groove should be placed in the incisal third of the tooth surface.
- In mandibular teeth, the groove is slightly more apical and it helps to utilize the starting bulge of the cingulum which may act as a seat for placement of the fiber.
- The beveling of the margins of the groove should be a 30 to 40 degree. The bevel should extend to a width of about 1 to 1.5 mm from the main groove on the tooth surface.
- The fiber has to be partially wrapped around the proximal surfaces.
- In case a material like Ribbond is being used for the splint, the fiber has to be soaked in unfilled resin prior to application.
- The groove is generally placed occlusally in posterior teeth with one abutment tooth on each side.
- The splint is finally polished with finishing burs.

A suggested sequence of burs is to use 8 fluted, then 16 fluted and then 32 fluted flame shaped carbide burs. This is to be followed by a silicone tip of an appropriate shape to finish off the splint.

An Innovative Pre-impregnated Glass Fiber For Reinforcing Composites [4]

Strips of reinforcing fiber bundles that already have been impregnated with resin are referred to as being pre-impregnated. These products are available in varying widths, with either unidirectional or woven glass fiber architectures. The flexural properties are higher because of the higher fiber content and fiber volume fractions of more than 40% and flexural strengths of 1-mm thick samples can approach 1000 M Pa.

The current commercially available FRCs are light-cured bis-GMA systems. They are easy to handle and exhibit high mechanical properties, having up to seven times the strength and much greater rigidity than particulate composites. Direct tooth splinting with unidirectional E glass FRC material performed successfully with an overall survival rate of 94.8% upto 4.5 years[19]

Silane Coated Industrial Grade Glass Fiber been suggested as opposed to the current fiber reinforcement materials which are in fixed width and have high costs. This silane coated fiber can be bundled in the form of ribbon according to the required thickness and length. This provides the dentist with splints that are more economical, fracture resistant and durable than most splinting materials of the past[20].

Maintaining Oral Health of Splinted Teeth

- ◈ Effective plaque control and professional caries risk assessment is crucial to the longevity of the splint.
- ◈ A splint should have the following for adequate oral hygiene maintenance: [4,16]
  - Open gingival embrasures
  - No overhanging restorations.
  - Proper polishing to have a smooth finish.
- ◈ The patients should be guided well for:
  - Selection of proper interdental aid for clearing interproximal area
  - Oral irrigation
  - Regular brushing
- ◈ Professional debridement and periodic evaluation should be carried out to ensure total plaque control.
- ◈ Air polishers and abrasives should be avoided near splinted teeth.
- ◈ Ultrasonic scalers should be used with great caution near the resin/tooth interface, as they may lead to inadvertent damage to the splint.

Caries Prevention in Splinted Teeth

The roughness of the composite resin surfaces attracts plaque and debris, however, and can increase the caries risk to the surrounding supportive splinted structures. Composite resin restorations and composite resin splints require close examination at maintenance visits because of the potential for breakdown and marginal leakage through radiographic and clinical examinations[4,16].

Conclusion

By combining the chemical adhesive & esthetic characteristics of composite resin with strength enhancement of reinforcing ribbon, dentists can provide patients with restorations and splints that resist the load bearing forces of occlusion & mastication. The new reinforced materials with either woven or polyethylene fibers (Connect, Kerr, Romulus, MI or Ribbon Reinforcement Ribbon, Ribbond, Seattle, WA) are fast replacing the materials of the past.

The newest composite brands provide shorter working time & are stronger[7]. These fracture-resistant restorations are more durable than most adhesive composite resin alternative splinting materials of the past.[8] The provider's role in fabrication, placement, and oral hygiene instructions cannot be overemphasized.

Professional follow-up concerning periodontal and caries risk assessment, periodontal debridement, and needed preventive intervention are critical to splint longevity.

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