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Recent Advances In Splinting In Dentistry

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Abstract
Splinting Has Been Advocated After Repositioning Of A Tooth/Teeth To Stabilize The Tooth/Teeth And To Optimize Healing Outcomes For The Pulp And/Or The Periodontal Ligament. A Splint Has Been Defined As 'An Apparatus Used To Support, Protect Or Immobilize Teeth That Have Been Loosened, Replanted, Fractured Or Subjected To Certain Endodontic Surgical Procedures. A Periodontal Splint May Be Permanent Or Temporary. The Aim Of This Is To Improve The Masticatory Function And Comfort Of Teeth And Also To Reduce The Risk Of Inadvertent Extraction Or Unintended Orthodontic Movement During Normal Function. It Must Also Achieve The Long-Term Benefit Of Retaining The Teeth In A Functional, Comfortable, And Cosmetically Acceptable State For Longer Than Would Otherwise Have Been The Case Without The Provision Of The Splint Although This Is Almost Impossible To Prove.

Key Words:*Mobility, Splinting, Stabilization, Composite Resin, Ligature Wire, Fibre Resin*

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I. INTRODUCTION

Treatment of teeth is done in an era now a days when there is patient pressure, not only to retain teeth, but to provide treatment to achieve good cosmetic results, frequently without regard to the long-term effects on the oral health of the individual. By definition, periodontal splinting is only undertaken for those patients who have already experienced extensive periodontal attachment loss. This may be either locally, and limited to a small number of teeth, or involving most or all ofthe remaining dentition. As a result of the attachment loss, the teeth affected may display increased mobility, discomfort in function and a tendency to migration due to occlusal forces. In addition, there is also an increased risk of inadvertent extraction due to functional forces overloading a reduced periodontium. An additional consideration nowadays is the availability of implant treatment and the need to conserve alveolus, if this is a possible future treatment modality for the patient. The retention of teeth, and hence a fixed restoration, is only possible in these cases with complex splint/restorative treatment.

A periodontal splint may be permanent or temporary. A permanent periodontal splint is, by definition, a non- reversible treatment using a dental device to stabilize teeth with significant, but stable, attachment loss. The aim of this is to improve the masticatory function and comfort of teeth and also to reduce the risk of inadvertent extraction or unintended orthodontic movement during normal function. It must also achieve the long-term benefit of retaining the teeth in a functional, comfortable, and cosmetically acceptable state for longer than would otherwise have been the case without the provision of the splint although this is almost impossible to prove. At an absolute minimum it must not worsen the periodontal prognosis for the dentition, even if it achieves the aims of improved function, comfort and cosmetics. A temporary periodontal splint is the one used on unstable teeth to prevent mobility during the healing phase of a regenerative periodontal procedure and may be removed later after healing. In rare cases, it may be necessary to place a permanent splint before definitive periodontal treatment to enable effective debridement of teeth with gross attachment loss. In many cases, there will also be a need to replace missing teeth for cosmeticas well as functional reasons and the demarcation between a purely periodontal splint and a restorative/cosmetic treatment is blurred.

Splinting has been advocated after repositioning of a tooth/teeth to stabilize the tooth/teeth and to optimize healing outcomes for the pulp and/or the periodontal ligament. A splint has been defined as 'an

apparatus used to support, protect or immobilize teeth that have been loosened, replanted, fractured or subjected to certain endodontic surgical procedures'. Historically, splinting of teeth utilized the principles of jaw bone fracture with rigid, long-term immobilization for a few months. A flexible splint allows functional movement in contrast to a rigid splint where the injured teeth are immobilized.

In periodontitis, chewing and bite function as well as phonetics are often impaired by increased tooth mobility. The increased mobility of a periodontally affected tooth can be caused by a shift of the rotation centre of the tooth to apical due to clinical attachment loss (CAL) and alveolar bone loss (ABL) and/or due to secondary occlusal trauma. The new classification of periodontal diseases states that teeth with progressive mobility may require splinting therapy to improve patient comfort.

II. BIOMECHANICS OF SPLINTING

Theoretically, a splint limits the amount of force a single tooth can receive during occlusal loading.
It does this by distributing occlusal forces over a large number of teeth.
Splinting also alters the direction of applied forces.

A mobile individual tooth is capable of being loaded and moved in several directions: mesio-distally, buccolingually and apically.

When the mobile tooth is splinted, the splint tends to redirect lateral forces into more vertical forces, which the tooth is better able to resist.

In an individual tooth, the mesially directed force produces a center of rotation in the apical third of its root.

The same force directed to the same individual tooth in a four unit,fixed splint produces a center of rotation in the root of the first molar.

This produces a wider fulcrum about which the splint can rotate, thereby redirecting the mesial force into a more vertical one.

III. CLINICAL RATIONALE FOR SPLINTING

- To control parafunctional or bruxing forces.
- Stabilization of mobile teeth during surgical, especially regenerative therapy. Friedman believed that unless splinted, mobile teeth may not respond as well to reattachment procedures.
- Stabilization of a periodontally compromised tooth when more definitive treatment possible,
- Prevention of the supra-eruption of an unopposed tooth to eliminate the potential for the development of periodontal problems .
- Stabilization of loose teeth to restore the patient's psychologic physical well-being.
- Splinting during or following periodontal therapy is useful and beneficial for controlling the effects of secondary trauma from occlusion. Also, it improves the patient's comfort and function.
- The main objective and rationale of splinting and occlusal adjustments are to control the progressive tooth mobility.

IV. OBJECTIVES

(1) Allow periodontal ligament reattachment and prevent the risk of further trauma or swallowing of a loose tooth.
(2) Be easily applied and removed without additional trauma or damage to the teeth and surrounding soft tissues.
(3) Stabilize the injured tooth/teeth in its correct position and maintain adequate stabilization throughout the splinting period.
(4) Allow physiologic tooth mobility to aid in periodontal ligament healing.

V. REQUIREMENTS IDEAL SPLINT

An optimal splint should fulfil most or all of the following requirements:

- Direct intraoral application
- Easy to construct with materials available in dental practice
- Passive ,does not exert any orthodontic force on tooth
- Simple & economical
- Hygienic and aesthetic
- Esthetically acceptable
- Not provoke iatrogenic disease

VI. RIGIDITY OF SPLINTS

Splint should preferably have slightly vertical and horizontal flexibility in order to support healing.
Rigidity of splints will be described as
Flexible – more mobility than a non-injured tooth
Semi rigid – equal to normal tooth mobility
Rigid- less than normal tooth mobility

VII. FACTORS THAT GOVERN THE USE OF PERIODONTAL SPLINTS

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 partsof 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.

VIII. INDICATIONS

- To stabilize moderate to advanced tooth mobility that cannot be reducedby other means that has not responded to occlusal adjustment andperiodontal therapy.
- Stabilize teeth in secondary occlusal trauma.
- Stabilize teeth after orthodontic movement.
- Stabilize teeth with increased tooth mobility, which interfere withnormal masticatory function.

IX. CONTRAINDICATIONS

- Splinting teeth is not recommended if occlusal stability and optimalperiodontal conditions cannot be attained.
- Poor oral hygiene
- Inadequate number of non mobile teeth to adequately stabilize mobile teeth
- Overall poor prognosis

X. PRINCIPLES OF SPLINTING

» Should be simple in design without involving extensive tooth preparation
» Should be stable and efficient, easily repaired
» Should permit good plaque control
» Should not hamper periodontal instrumentation
» Should be non-irritating to the tissues
» Should be esthetically acceptable
» For every mobile tooth, at least two firm teeth should be present.[67]

ADVANTAGES
» Alveolus remodeling of alveolar bone and periodontal ligament for orthodontically moved tooth or teeth.
» Provides healing of supporting structures.
» Fine stability and comfort for patient will be provided.

DISADVANTAGES
» Accumulation of plaque can lead to further periodontal maintenance
» Requires excellent OHI maintenance.
» If one tooth in the splint is in traumatic occlusion, it can injure the periodontium of all other teeth included in the splint.
» Development of caries is an amenable risk

XI. INFLUENCE OF SPLINTING IN DENTAL TISSUES

Influence Upon Gingiva
The presence of wire loop splint on gingiva may lead to invasion of bacteria due to loss of some epithelial attachment
Wire loop splints have been found to lead to gingival changes which are however reversible after wire removal.

Influence Upon Periodontal Healing

Experimental studies demonstrated that optimal periodontal healing (ie. With minimal ankylosis) after extraction and replantation of teeth in animals was obtained in a non splinted situation compared to rigid splinting.

It is assumed that slight mobility in the initial healing period activates resorption of initially formed ankyloses sites.

Influence On Pulp Healing

Splinting could decrease pulp revascularization and increase the extent of pulp necrosis and inflammatory root resorption compared to non-splinting.

* in humans, splinting of auto transplanted teeth for only one week (with a suture splint) has been found to improve pulpal healing as compared to rigid splinting for four weeks.

Enamel Changes After Splinting

The staining of the labial enamel takes place because of acid etching and can be easily removed by careful polishing**.**

CLASSIFICATION

The choice of splint should be made after consideringfactors such as

- Tooth contour
- Spacing of teeth
- Location of the teeth in the arch
- Length of the splinting period
- Aesthetics
- The degree of rigidity desired

» A) According To The Period Of Stabilization:

(A) Temporary Stabilization

Ib) Provisional Stabilization: To Be Used For Months Up ToSeveral 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

» C) According To The Location On The Tooth

Ross, Weisgold and Wright Classification

(1) Temporary stabilization

Removable extra coronal splints

Fixed extra coronal splints

Intra-coronal splints

Etched metal resin-bonded splints

(2) Provisional stabilization

Acrylic splints

Metal-band-and-acrylic splints

(3) Long term stabilization

Removable splints

Fixed splints

Combination removable and fixed splints

Titanium Trauma Splints

The titanium trauma splint developed by Von Arx is a flexible splint made of titanium, 0.2 mm thick and 2.8 mm wide. It has a rhomboid mesh structure which is secured to the tooth with flowable composite resin. A disadvantage of this splint type is its relatively high cost. In this application composite resin was used instead of flowable resin (e.g. Filtek supreme plus flowable restorative; 3m espe, st paul, mn, usa). The patient initially presented with an arch bar splint which was replaced with a titanium trauma splint because of gross irritation to the gingival tissues.

Composite and wire splints

Composite and wire splints are perhaps the most commonly used in clinical practice and are flexible splints when the wire has a diameter of no greater than 0.3– 0.4 mm.. An aesthetic splint was provided. Composite and fishing line splints an alternative to wire is where fishing line replaces wire and the line is secured with composite resin. An interesting alternative at st vincent's hospital, sydney, utilizes whipper snipper nylon purchased from a hardware store attached to the teeth with coloured composite resin (ultradent; flowable purple).The coloured composite provides a guide for the removal of the splint to minimize damage to enamel.

Orthodontic Wire And Bracket Splints

This splint, which is extensively employed by paedodontists in Australia, involves orthodontic brackets bonded to the teeth with a resin-based orthodontic cement and connected with a light 0.014 niti flexible wire. .orthodontic bracket splints allow teeth that have been intruded or not repositioned correctly to have the occlusal relationships modified at a later date. However, care must be taken that orthodontic forces do not develop stress that disturbs the healing phase of an injured tooth. While this type of splint was found to be irritating to the lips when compared to composite and wire splints and titanium trauma splints, this is generally not considered to be a clinical problem as any lip irritation can be avoided with the application of wax.

Resin Splint(Protemp &Luxetemp)

- Protemp and luxatemp are multi-phase resin materials used in temporary prosthetic restorations and for lining prefabricated crowns.
- Protemp is chemically cured; whereas luxatemp is dual cured (i.e. Chemical
- And light cured).
- It is possible to apply the material in stages, an advantage with multiple displaced and repositioned teeth . These materials do not exert forces on teeth during application and are esthetically and hygienically acceptable.

Arch Bar Splints

Arch bar splints were initially adopted for maxillary and mandibular fractures in the 1870s and adapted for dentoalveolar trauma. A metal bar is bent into the shape of the arch and fixed with ligature wires. Disadvantages of this technique are that this type of splint is rigid and arch bars may loosen and cause irritation. There may also be physical damage from the ligature wires to the gingival tissues and the integrity of the cemento-enamel junction. Wire ligature splints wire ligature splints are sometimes used by oral surgeons in clinics where dental splinting materials may not be available. These splint types are generally rigid and impinge on the gingival tissues with resulting inflammation.

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Composite Splints

Resin composite applied to the surfaces of teeth is a rigid splint and accordingly is not recommended in the IADT guidelines .composite splints that are bonded interproximally to adjacent teeth are also reported to be prone to fracture. Furthermore, composite splints resulted in greater gingival irritation when compared with wire and composite, an orthodontic bracket splint or the titanium trauma splint. The potential for iatrogenic damage for all splints that utilize composite resin as the adherent cannot be understated and is discussed further in the section below on 'splint removal'.

XII. NEWER ADVANCES

Fibre Reinforced Materials

Fibre splints use a polyethylene or kevlar fibre mesh and are attached either with an unfilled resin such as optibondtm fl (kerr, usa) and/or with composite resin. Materials such as fiber-splint (polydentia sa mezzovico-vira, switzerland), ribbondtm (ribbond inc., seattle, usa) or everstick (stick tech ltd, turku, finland), which is a silinated e-type glass fibre, are commercially available. In a study of 400 root-fractured teeth by andreasen et al., fibre splints were associated with the highest frequency of favourable healing outcomes.

Commercially Available Fibres

Leno weave polyethylene fibres-ribbondUni directional pre impregnated glass fibres splintOpen weave glass fibres-interlig

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.

B) SPLINTING FOR POSTERIOR TEETH

1. Intracoronal Amalgam Wire Splint:

It uses resin restoration in proximal amalgam restored areas of tooth re-inforced with wire to stabilize posterior teeth. 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.

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 to reinforce the materials.

XIII. PROCEDURE/STEPS IN SPLINTING

Step 1 : Application Of A Wire Composite Splint
Step 2: Etching enamel and application of composite
Step 2: Etching enamel and application of composite
Step 3: Composite Application And Polymerization
Step 4: Finished splint

XIV. FIXATION PERIOD AFTER VARIOUS DENTAL INJURIES

SPLINT REMOVAL

Removal of rigid arch bar splints or interdental wiring is often a difficult process involving unwiring and cutting of wires close to the gingival margins with potential damage to soft tissues. Removing a splint in which composite resin has been used is not only time consuming, but iatrogenic injury to the enamel is an inevitable outcome.[98] Techniques of composite removal may involve debonding pliers, handscalers, ultrasonic scalers, tungsten carbide burs, diamond burs, soflex disks (3m espe, st paul, mn, usa), rubber wheels and cups. It has been shown experimentally that debonding pliers generate shearing forces that result in irreversible damage to the enamel. Additionally, the forces exerted may disturb the periodontal healing of the injured tooth. Both hand and ultrasonic scalers caused distinctive patterns of enamel detachment and therefore it was concluded that they should not be used for composite removal. A similar recommendation applied to the use of diamond burs. The same study found that tungsten carbide burs and soflex discs resulted in the least damage to the enamel. The use of magnification was also recommended to best identify the enamel-resin interface.

SPLINTING IN PRIMARY DENTITION

* In most cases, splinting of luxated primary teeth is not possible due to lack of patient cooperation.
* In the case of alveolar or mandibular fractures, a resin or a cap splint is indicated.
* The cap splint should be cemented only on non-traumatized teeth, leaving the injured teeth free within the splint in order not to damage them when the splint is removed.

IADT GUIDELINES

Table: Current IADT recommendations for splinting time and type for various types of injuries.

Type of injury	Splinting time	Splinting type
Subluxation	2 weeks	Flexible splint
Extrusive	2 weeks	Flexible splint
Lateral luxation	4 weeks	Flexible splint
Intrusive Luxation	4 weeks	Flexible splint
Root fracture	4 weeks	Flexible splint
Root fracture(cervical 1/3)	4 months	Flexible splint
Avulsion	2 weeks	Flexible splint
Avulsion dry time>60 minutes	4 weeks	Flexible splint
Alveolar fracture	4 weeks	No recommendation

XV. CONCLUSION

Splints are becoming an integral part of periodontal therapy and maintenance. Tooth mobility is a common sequel to periodontitis and trauma from occlusion . Mobility, bone loss and attachment loss associated with trauma from occlusion can be reduced by eliminating trauma. Periodontally compromised teeth with poor prognosis can also be retained for a longer time by using splints, until a more definative treatment is planned for the patient.

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