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Splinting for traumatic injuries

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Abstract
With advances in the understanding of healing processes of the periodontium, pulp and alveolar bone following various injuries, the role of splinting has become relatively well defined. Different types of splints have been used to stabilize traumatised teeth of them. Composite resin has been used widely over many years due to ease of application but removal of the material is not only time consuming but more seriously accompanied by minor or major iatrogenic damage to enamel.Some others splints have compromised healing of theteeth and associated dental tissues. Dental materials science has continued to provide new splint materials which simplified splinting regimen for traumatized teeth which offers ease of application and removal with minimal or no iatrogenic damage to enamel. This article considers the ideal properties for the splint and most commonly used and recent developments in splinting materials.

Keywords: understanding, Periodontium, traumatized, seriously, splinting materials

Introduction

A splint has been defined as "a rigid or flexible device that maintains in position a displaced or movable part, also used to keep in place and protect an injured part".

In dentistry splinting consists of the connection of two or more teeth to each other to limit increased mobility because of acute periodontal lesions following trauma. From a prognostic standpoint, traumas involving these structures have more unpredictable outcomes and restoration of the periodontal ligament is the crucial prerequisite for complete healing of the lesion.

The splint reduces the load exerted on each tooth by distributing the masticatory and perioral muscle forces on multiple teeth and a broader surface.

Furthermore, the direction of the forces applied to the teeth is favorably modified, converting the lateral loads into vertical ones that are less harmful for the tooth supporting apparatus, which can thus heal more easily by restoring bone integrity and rearranging the periodontal ligament fibers [1,2].

There are essentially two biomechanical factors regarded as the condition for successful
treatment:

1) Mild loads applied to the healing tissues
2) Controlled tooth movement (about 50 lm) within the traumatized socket.

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Indications

- To stabilize moderate to advanced tooth mobility that cannot be treated by any other means.
- To stabilize teeth in secondary occlusal trauma
- To stabilize teeth when increase tooth mobility interferes with normal masticatory function and comfort of the patient.
- To prevent tipping or drifting of teeth.
- To stabilize teeth following orthodontic movement.
- To create adequate occlusal stability when replacing missing teeth.
- To prevent extrusion of unopposed teeth.
- To stabilize teeth following acute trauma [3]

Contraindications

- When there is moderate to severe increased tooth mobility in the presence of periodontal inflammation and or primary occlusal trauma.
- Prior occlusal adjustment has not been done on teeth with occlusal interference and occlusal trauma.
- When there are insufficient numbers of immobile teeth to adequately stabilize the mobile teeth.
- Oral hygiene maintenance is inadequate**.** [3]

Classification

1) According to Ross,Wiesgold and Wright(196810:

- Temporary

-Removable extra coronal splints
-Fixed extra coronal splints
-Intracoronal splint
-Etched metal resin-bonded splints.

- Provisional stabilization

-Acylic splints
-Metal band and acrylic splints

- Long-term stabilization

-Removable splints
-combination

2) According to Grant

- **Temporary**

- External(extracoronal)
  - Ligature splint
  - Enamel bonding material
  - Welded band splints
  - Continous
  - Night guards
- Internal(intracoronal)
  - Acrylic splints
  - Compound splints
  - Acrylic full crown

- **Provisional splinting:** Serves to stabilize a permanently mobile dentition from the time of initial tooth preparation until the time the dentition is periodontally stable enough for permanent restorations.
- **Permanent splints**

-Removable(external)
- Continous clasp devicesSwing lock device
- Over denture

-Fixed
- Full coverage
- ¾ crowns and inlays
- Posts in root canals
- Horizontal pin splints

-Cast metal resin bonded FPD(Maryland splints)
-Combined
- Partial dentures and splinted abutments
- Removable fixed splints
- Full or partial dentures on splinted roots
- Fixed bridges incorporated in partial dentures seated on posts and copings

-Endodontic

Until the 1970s, splinting of traumatized teeth was primarily accomplished using methods employed in the treatment of jaw fractures with cap splints, arch bars and wires. Since the discovery of adhesive techniques in the late 1960s a wide range of splinting devices has been developed. However, most important discovery in recent decades has been that splinting in general can have an adverse effect on healing processes in the periodontium and pulp after trauma. Thus non physiological fixation of displaced tooth can induce periodontal and pulpal healing problems and long term splinting may not only prolong the wound healing process in the periodontal ligament but may also lead to preservation of an otherwise transient ankylosis. Arrest of revascularization of the pulp has also been observed in animal experiments.
The splint should preferably have slightly vertical and horizontal flexibility in order to support healing.
The rigidity of splints will be described as
Flexible: that is more mobility than a non-injured tooth.
Semi-rigid: equal to normal tooth mobility.
Rigid - Less than normal tooth mobility.[4]

It has been observed that teeth stabilized with high flexibility splints are less likely to undergo root resorption and show a better reorganization of the periodontal fibres compared with teeth splinted by means of rigid devices. Many studies have attributed the negative effect of the rigid contention to the periodontal neoangiogenesis, whereas the mechanical stimulus exerted by mild tooth movement would favour there vascularization process, prevent ankylosis and maintain the Hertwig's epithelial root sheath, which is vital in the event of the developing roots.Complete immobilization, on the contrary, thwarts healing by interfering with fibroblast metabolism because of the lack of mechanical stimuli.
These considerations led several authors to conclude that a splint allowing mild tooth movement for a limited period of time is actually more effective.[4,5,6]

Influence of splinting on dental tissues
Influence upon gingival- It has been shown that gingival damage caused by arch bars fastened with steel wire is reversible if the periodontium was healthy before splinting wire loop splints (used in intermaxillary splinting) have been found to lead to gingival changes which are, however, reversible after wire removal.The presence of wires placed in contact with the gingival may lead to invasion of bacteria through rupture or tears in the epithelial attachment.
Influence upon periodontal healing-An early experimental study in 1974 by Andreason demonstrated that optimal periodontal healing(i.e 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 ankylosis sites.
Influence upon pulp healing:- In humans, splinting of autotransplated teeth for only one week(with a suture splint) has been found to improve pulpal healing as compared to rigid splinting for 4weeks. In a monkey model of extracted and replanted teeth,it was shown that splinting could decrease pulp revascularization and increase the extent of pulp necrosis and IRR compared to non-splinting.
Enamel changes after splinting:-The staining of labial enamel after acid etching could present a problem, especially if filled composite resin has been used,where there is no clear distinction between enamel and the splinting material.However animal studies have shown that splinting doesnot cause permanent staining.

An optimal splint should fulfil following requirements
- Direct intra-oral application
- Easy to construct with material available in dental practice
- Doesn't increase periodontal injuries or promote caries.
- Doesnot irritate oral soft tissues.
- Passive,doesnot exert any orthodontic force on teeth.
- Versatile in achieving rigid,semi rigid or flexible splint.
- Easy to remove and causes minimal or no permanent damage to the dentition.
- Allows pulp testing and endodontic treatment.
- Hygienic and esthetic.[7,8]

Various types of splints
Suture splints
The simplest type of splint is a suture placed over the incisal edge from the palatal/lingual gingiva to the buccal gingiva. A suture splint has been used to treat traumatized tooth injuries in pediatric patient.

In a hospital scenario, the first medical aid is usually given by the medical staff. The necessity for lifesaving procedures and the lack of dental instruments in the emergency or operating room may lead the general medical practitioner or surgeon to ignore the dental trauma or postpone the dental treatment to a later stage. The present recommendation for re-implantation and the easy-to-perform fixation can be carried out by the general medical staff. This method is quick and does not delay the general medical treatment needed. Furthermore, the suture splint can be used in multi-injured patients treated under general anesthesia where standard splinting is not possible to perform. This could improve the prognosis of traumatized teeth in the long term.[9]

Arch bar splint

Several decades ago, rigid splinting of luxated teeth was considered necessary, and the types of splints used were either arch bars or cap splints. These splints caused considerable damage to the injured teeth, due to inaccurate re-positioning, which could press the loose tooth against th.e socket wall. Further more, there was risk of bacterial invasion into the perioontal wound due to the proximity of the splints and wires to the gingival margin.

Orthodontic appliances [Bracket splint]

Orthodontic ligature wire bonded with composite or attached to brackets has been advocated. However, orthodontic bracket wires and composite may cause irritation of oral mucosa, impairment of oral hygiene and discomfort, especially at the start of the splinting period. Furthermore, demands for a passive splinting(i.e with the tooth in a neutral position) are endangered if brackets are united by rectangular orthodontic wires. It is therefore recommended that malleable steel wire is used.[9,10]

Composite resin

A splint composed entirely of composite resin is esthetic and easy to construct, but has been found to fracture in the interdental area, as the material is fragile. The splint is rigid and thereby violates the demands for splinting in most cases. Moreover, due to color match and bonding strength to etched enamel, it is difficult to remove without damaging underlying tooth structure. If a splint of this material must be used, it is advisable to splint the luxated tooth to only one adjacent tooth.

Wire-composite splint

Wire-composite splinting was introduced in 1987 and since been reviewed and teste both in vitro and invivo. One of the major benefits is that the splint is constructed of materials that are routinely available in dental o. Wire composite splinting is easily modified into a rigid splint by changing the dimension of the wire or by adding composite along the labial wire up to the interdental space.

Howeever, there is the same problem concerning risk of potential damage to underlying enamel as with a composite splint.

In a recent comparative study of various types of splints in volunteers, a wire composite splint proved to be well accepted, didnot cause major damage to the oral mucosa and allowe the volunteer to maintain good oral hygiene.

In several studies the use of fibre glass instead of wires has been described and is frequently in use. Fiber glass ribbon is soaked in composite resin and no filler material is used. Flexibility can be varied with the numbers of layers and extension of the splint.

Resin splint

Protemp and Luxatemp are multiphase resin materials use in temporary prosthetic restorations and for lining prefabricated crowns. Protemp is chemically cured, whereas luxatemp is dual cured. It is possible to apply the material in stages.These materials donot exert forces on teeth using application and are esthetically and hygienically acceptable. Furthermore, they have been shown to allow semi-rigid splinting.

In case of missing teeth or in mixed dentition, where neighbouring teeth or in a mixed dentition, where neighbouring teeth are not fully erupted, it is necessary to span the edentulous area. Ain these cases, reinforcement is necessary This can be accomplished with metal bars, orthodontic wires, nylon lines, glass fibres or synthetic fibres or tapes which are present on the market and which can fuse with resin. If these are not available, even paperclips can be straightened out for the purpose. The material allows some flexibility and the splint is applied directly to the etched crown surfaces.[9,10]

Pre- fabricated metal splinting materials

Pre-fabricated splints commercially available mae of titanium have been reported by Von Arx and co-authors. The pre-fabricated titanium trauma splint (TTS) is only 0.2mm thick and can be easily bent with fingers and adapted to the dental arch. Because of the rhomboid design of the splint, it can also be adapted in length. TTS is bonded to enamel with a light cured composite resin and remove by peeling it off the tooth surface. The splints have been found to be well tolerated and cause only slight patient discomfort.

Removable Splint

Recently a new type of splint has been descibed where a removable splint made of polycarboxylate and polyacrylic was made after impression taking.

These splints were used in cases where intial reposition and splinting was not considered optimal, resulting in occlusal trauma. The indications for this splints appear quetionable.[1]

Emergency splints

A temporary splint can be made using Al foil and Blu-tac(equivalent)

Use the patient mouthguard or orthodontic retainer

Stomahesive wafer cut to size.[9,10]

Polyethylene fibre-reinforced splint

The use of fiber-reinforced composite (FRC) resin provides a marked increase in flexural strength to the entire structure. Different fiber types have been added to resin materials to improve their physical and mechanical properties.Glass fi bers consisting of glass interlaced fi laments, improve the impact strength of composite materials. Polyethylene fi bers improve the impact strength, modulus elasticity, and fl exural strength of composite materials. Ribbond (Ribbond Inc., Seattle, Wash) is a reinforced ribbon made of ultrahigh molecular weight polyethylene fi ber that has an ultrahigh modulus. The special

fiber network of this material allows effi cient transfer of forces. It is virtually pliable and thus, adapts easily to tooth morphology and dental arch contours. Its translucency makes it an esthetic material and it can be cured with light-cured composites. Splinting teeth for periodontal, orthodontic or posttraumatic reasons is a common procedure. In the past, direct stabilization and splinting of teeth using an adhesivetechnique required the use of wires, pins or mesh grids. These materials could only mechanically lock around the resin restorative. Due to this, there was the potential of creating shear planes and stress concentrations that would lead to fracture of the composite and hence, premature failure. When the splint failed, the clinical problems that occurred included traumatic occlusion, progression of periodontal disease, and recurrent caries. With the introduction of bondable, polyethylene woven ribbons, many of the problems with older types of reinforcement were solved and splinting teeth with reinforcement fi bers that can be embedded in composites, has gained popularity. Procedures can often be completed in a single appointment. It also has acceptable strength because of good integration of fi bers with the composite resin; this leads to clinical longevity. Due to the use of a thinner composite resin, the volume of the retention appliance can be minimized. In addition, the appliance can easily be repaired in case of fracture due to wear-and-tear. There is no need for removal of any signifi cant tooth structure, making the technique reversible and conservative. Moreover, it meets patientsí esthetic expectations.[11,12]

Conclusion

While the type of splint and the splinting duration have not been generally shown to affect healing out-.comes, the IADT guidelines support the use of flexible splints whenever possible. This has often been achieved with the use of composite resin or orthodon- tic brackets and light wire. Both of these techniques have been shown to cause iatrogenic damage to the enamel. A new protocol using a resin activated glass- ionomer cement has been proposed that offers ease of application and removal with minimal or no iatro- genic damage to enamel While the type of splint and the splinting duration have not been generally shown to affect healing out- comes, the IADT guidelines support the use of flexible splints whenever possible. This has often been achieved with the use of composite resin or orthodon- tic brackets and light wire. Both of these techniques have been shown to cause iatrogenic damage to the enamel. A new protocol using a resin activated glass- ionomer cement has been proposed that offers ease of application and removal with minimal or no iatro-
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From the patient’s perspective, it is important that these splints

are comfortable anddo not interfere with oral hygiene, speaking and eating. Any mechanical or inflammatory irritation of the healing soft tissues must be avoided.
Maintenance of oral hygiene is essential for healing following dental trauma. To summarize
Resin splint is difficult to clean and therefore leads to greater irritation of the gingival margin bracket splint is rather voluminous and irritates mechanically, and therefore leads to clearly higher sensitiveness of lips and impairment of speech.
However, titanium splints were much less irritating and were well tolerated and characterized by shorter application and removal times.

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