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THE USE OF FIBER REINFORCED COMPOSITE SPLINT TO DEAL WITH TOOTH MOBILITY IN PATIENTS WITH PERIODONTALLY COMPROMISED TEETH: A LITERATURE REVIEW

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ABSTRACT Splinting is a treatment to stabilize mobile teeth. Wire composite and composite are common materials used for splinting. But these materials have some limitations, wire composite tends to fracture while composite is less durable. Based on the limitations, fiber reinforced composite can be used as an alternative. The aim of this study is to review the effectivity of fiber reinforced composite splint to deal with tooth mobility in patients due to periodontally compromised teeth. Study was conducted using literature based study method through searching the articles from PubMed and Scopus. Ten articles were obtained after selection. Overall, the articles stated that fiber reinforced composite splint is effective to treat mobile teeth in patients due to periodontally compromised teeth. Based on the level of evidence, more clinical research with a high level of validity is needed to strengthen the conclusion.

KEYWORDS : splinting, fiber reinforced composite, tooth mobility, periodontally compromised teeth

Tooth mobility is a symptom of periodontal disease (Newman, Takei, Klokkevold, & Carranza, 2015). Increased tooth mobility will effects the convenience during function. Even in more severe conditions can cause tooth loss. These problems can be overcome by stabilizing and fixing teeth through splinting. There are many splinting materials have been used, including composite splint, wire-composite splint, orthodontic bands welded together acrylic splints, and other extracoronal and intracoronal splints. However, these splinting materials tend to not last long because it is easily cracked and detached from the tooth surface so that the splint fails (Karabekiroğlu, Öncü, Yıldız, & Ünlü, 2017; Mittal and Jain, 2013). Wire on the composite splint can only be mechanically lock, so that there is a potential for stress to accumulate on the wire and the stress of the wire can cause fractures in the composite (Sekhar, Koganti, Shankar, & Gopinath, 2011).

Alternative splinting materials that can be used are fiber reinforced composite (FRC) splint. This splinting material combines the adhesive properties of composite resins with the strength of fiber, resulting in good fracture resistance while maintaining tooth structure (Bechir, Pacurar, Hantoiu, & Bechir, 2016). The study was conducted to review and analyze the literature on the effectiveness of using fiber reinforced composite splint to deal with tooth mobility in patients with periodontally compromised teeth.

Method

The research procedure was carried out using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses). The author uses PubMed and Scopus as database. The search strategy is done by using the keywords "Splinting" AND "Fiber" OR "Fiber composite" AND "Tooth mobility".

Inclusion criteria for articles included:

(1) Articles concerning fiber reinforced composite splint in patients who experience tooth mobility due to periodontally compromised teeth;
(2) Articles published in 2008-2018; and
(3) English-based articles. Articles are not available in full-text form and only done in animal is excluded.

RESULT

STUDY SELECTION

A total of 122 articles were obtained in both database. 65 articles excluded due to publication year. Four articles were further excluded because of duplication. From 53 articles remained, 40 articles excluded after screening title and abstract as they were considered irrelevant to the focus question. 13 articles selected for full-text reading and five were excluded. After the final stage of selection, 10 articles were selected to be review. The selection process based on PRISMA guideline are shown in figure 1.

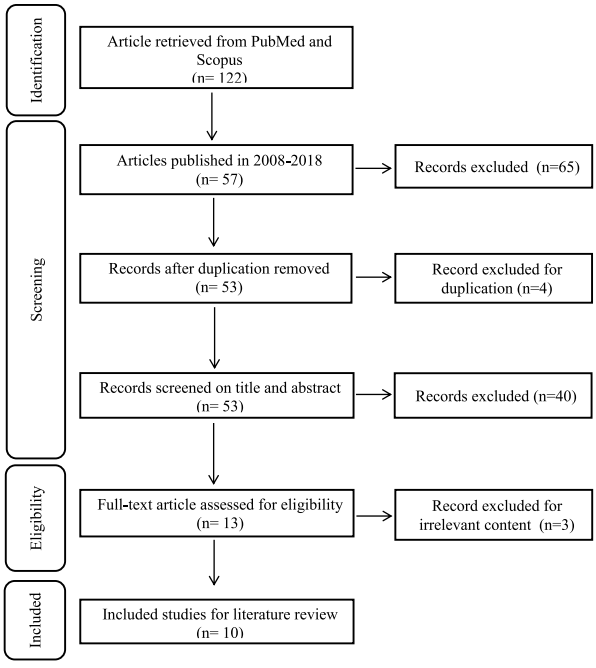

Figure 1 PRISMA diagram for selection of studies through the search process and article selection

Main Outcome

All studies show that fiber reinforced composite splint is effective in dealing with tooth mobility in periodontally compromised teeth. Three out of the ten studies assessed the degree of tooth mobility after splinting and showed that the use of fiber reinforced composite splint succeeded in reducing the degree of tooth mobility (Bechir et al., 2016; Novelli, 2015; Sekhar et al., 2011) .Two studies assessed that the occlusal load distribution is good enough, even though not as good as wire composite (Kurgan, Terzioglu, & Yilmaz, 2014; Soares, Neto, Magalhaes, Versluis, & Soares, 2011). Two studies which discussed tooth loss rate after splinting application showed a low rate of tooth loss (Kumbuloglu, Saracoglu, & Ozcan, 2011; Sonnenschein, Betzler, Rütters, Krisam, Saure, Kim, 2017). Eight studies that assessed the survival rate showed that FRC splint have better fracture resistance than wire composite and composite material (Agrawal and Chitko, 2011; Bechir et al., 2016; Karabekiroğlu et al., 2017; Kumbuloglu et al., 2011; Sekhar et al., 2011; Soares et al., 2011; Sonnenschein et al., 2017; Strassler & Serio, 2007). In fact, two studies with a cohort study

design showed a survival rate of 94.7% and 74.4% (Kumbuloglu et al., 2011; Sonnenschein et al., 2017).

Oral hygiene assessed by two studies showed that oral hygiene was maintained (Sekhar et al., 2011; Sonnenschein et al., 2017). Periodontal stability was assessed by four studies. Two cohort studies showed a reduction in the value of clinical attachment loss (CAL), periodontal pocket depth (PPD), and rate bone loss (RBL) (Kumbuloglu et al., 2011; Sonnenschein et al., 2017). Two other studies with the design of case report studies showed a good result of periodontal stability after splinting (Novelli, 2015; Strassler, 2011). Four studies that carried out aesthetic assessments and increased conveniences stated that the use of FRC splint had a satisfying aesthetic value and succeeded in increasing patient's comfort (Bechir et al., 2016; Kumbuloglu et al., 2011; Novelli, 2015; Sekhar et al., 2011). Two studies observed on biocompatibility and showed good results (Bechir et al., 2016; Sekhar et al., 2011).

Table 1 Summary of fiber reinforced composite splint study

Author	Study Design	Total Sample	Splinting Material	Assessment	Result	Conclusion
Sekhar et al., 2011	RCT	30 patients: 1. 10 control (without splinting) 2. 20 experimental - 10 group A (wire composite) - 10 group B (FRC)	FRC and wire composite	1. Tooth mobility index 2. Plaque index 3. Subjective and objective criteria for splint – Resistance to fracture – Aesthetic – Biocompatibility – Patient comfort	1. More reduction of tooth mobility in wire group (36,11%) rather than fiber group (35,42%) 2. Fiber controls plaque better than wire 3. Splint assessment - 9 Partial fracture in wire and 2 in fiber - 14 Reversible discoloration in wire group and 13 in fiber group - Same level of comfort in wire and fiber group - Good compatibility in wire and fiber group	FRC and wire composite splint show good clinical result in tooth stabilization, durable in function, and well-tolerated by the patients. However, FRC was an excellent material for splinting with respect to patient comfort, durability, resistance to fracture, biocompatibility and aesthetic acceptability. Overall patient acceptance of FRC is better than wire
Kumbuloglu et al., 2011	Cohort: prospective	19 patient	FRC	1. Technical failure – Chipping – Debonding – Fracture 2. Biological failure – Caries 3. Periodontal aspect – PPD – CAL	1. 1 partial debonding 2. No caries in splinting tooth 3. No teeth had to be extracted 4. Good vitality 5. High patients compliance and satisfaction 6. The mean for PPD decrease from 8.9 ± 1.8 mm to 5.2 ± 1.2 mm. The mean for CAL decreased from 7.2-1.6 mm to 4.6-1 mm at the end point	Splinting using fiber reinforced composite material performed successfully with an overall survival rate of 94.8% up to 4.5 years. Periodontal status of the splinted teeth also showed decreased PPD and CAL
Sonnenschein et al., 2017	Cohort: retrospective	39 patients: - 9 FRC splint - 30 composite splint	Composite and FRC	1. Tooth loss rate 2. Periodontal stability – CAL – RBL 3. Splint stability 4. Oral hygiene index – Gingival-Bleeding-Index (GBI) – Plaque Control Record (PCR)	1. No splinted tooth was loss within the first 3 years, 1 splinted tooth loss after 7 years, and 1 after 12 years 2. CAL decreased from 5.61(1.66) mm to 5.09(1.67) mm after 3 years. RBL decreased from 72(14)% to 63(17)% after 10 years. Increase of RBL only detected in 3 individuals 3. Three years after splinting, splint survival rate was 74,4%. After 10 years, splint survival rate was 67,3% 4. The mean of GBI decreased from 12,8(23,5)% to 6,1(12,2)% after splinting. PCR was 35,9(31,3)% before and 41,9(29,7)% after	Splinting with fiber reinforced composite or composite material may be an adequate option to maintain severely periodontally compromised tooth
Agrawal et al., 2011	Case reports	3 patient	FRC	Strength and fracture resistance	Strength and fracture resistance of FRC splint is satisfying. Of the 3 patients, non has exhibit debonding or caries over 1-year period	Splinting with FRC material has the most fracture resistance compared to other splinting materials
Bechir et al., 2016	Case series	62 patients: 1. 20 control (without splinting) - 141 teeth 2. 42 experimental (*splint* FRC) - 143 teeth interlig - 152 teeth Ribbon	FRC (interlig and ribbon)	1. Failure of splint 2. Tooth mobility degree 3. Aesthetic	1. 25 interlig splint failure 25 of 143 teeth. Ribbon 23 of 152 teeth 2. The degree of mobility has decreased 95,93% after 6 month splinting 3. Aesthetic between 8-10 points 4. All patients in experimental group reported improvement of masticatory comfort 5. No adverse reaction	FRC splint have presented good clinical effectiveness. The material have beneficial in reducing the degree of tooth mobility and have excellent aesthetics. Based on the splint failure, there was no significant difference between the 2 type of FRC

Kurgan et al., 2014	Case control: in vitro	24 teeth - 6 without splinting - 6 composite - 6 wire composite - 6 fiber	Composite, wire composite, and FRC	Occlusal stress distribution	1. Stress distribution in wire composite splint better then composite and FRC 2. Stress distribution on the composite and fiber is equally good	Metal is stiffer so that it can transfer loads better than composite and fiber materials.
Strassler, 2011	Case report	1 patient	FRC	Periodontal prognosis	1. 3 years after treatment, periodontal health was excellent with minimal periodontal pocket 2. 3,5 years after treatment, splint repaired 2 times 3. 6,5 years after treatment, periodontal prognosis was good and splint removed	The use of FRC splint in maxillary arch has an outstanding result in changing periodontal prognosis from "guarded" to "good"
Karabekiroğlu et al., 2017	RCT	in vivo 37 patient 1. Control (composite) 2. Experimental - FRC - MFL in vitro 1. 160 human teeth 2. 40 sheep mandible	FRC, Multifilament Fishing Line (MFL), and composite	1. Shear bond strength 2. Type of splint failure	1. shear bond strength mean value in FRC group higher than control group 2. Type 4 fracture (splint did not debond, but the overlying composite detached) dominant in FRC group. Type 1 (complete adhesive debonding) and 2 (partial adhesive debonding) fracture dominant in control group	- Composite splint without fiber reinforcement was insufficient for periodontal splinting - MFL and FRC materials are quite economical and resistant to failure
Novelli, 2015	Case report	1 patient	FRC	Aesthetic	6 month after splinting, patient reported good aesthetic, firm teeth, no marginal discoloration, no fracture, marginal adaptation, good periodontal response, and no postoperative sensitivity	Combination of FRC and composite veneer produce minimally invasive periodontal treatment, more conservative, simple, and economic
Soares et al., 2011	Case control: in vitro	80 mandibular human teeth, divided into 7 group: 1. Control (no bone loss and no splinting) 2. Bone loss but no splinting 3. Composite 4. Wire 5. Wire composite 6. Extracoronal FRC 7. Intracoronal FRC	Composite resin, wire, wire-composite, FRC	Biomechanical response to bone loss and different types of periodontal splint by measuring strain	1. Strain value in 50 N load level were not significantly different 2. Strain value in 100 N and 150 N load level shows that all splint materials used reduce strain significantly except wire	Periodontal splints with adhesive systems were more effective in reducing stress, especially in higher occlusal loads condition. Splint that only use wire was the most inadequate splint type for restoring strain values, especially in conditions of high occlusal loads.

DISCUSSION

The results of several studies stated that the use of fiber reinforced composite splint is effective in reducing tooth mobility (Bechir et al., 2016; Sekhar et al., 2011). However, Sekhar et al. (2011) states that wire reduces tooth mobility more effectively than fiber, even though the difference is not significant. This is supported by Berthold's et al (2011) in their research, the more flexible splint only slightly reduced tooth mobility compared to the rigid splint. Wire is more rigid than fiber so it can reduce tooth mobility more effectively than fiber (Kurgan et al., 2014).

Kurgan et al. (2014) in their study stated that metal material with higher rigidity can transfer load better. This is because the material rigidity is proportional to the material's ability to transfer loads. However, Kuroki and Pereira et al. (2016) stated a different opinion. According to their research the wire composite and composite material does not show good stability because those materials cannot act as a single unit so it is difficult to distribute occlusal loads. The use of wire that has high rigidity in the long term can cause fractures in time being because the stress is concentrated in the splint. In contrast to fiber reinforced composite material which has a modulus of elasticity similar to dentine, which then forms a monoblock system and the stress can be distributed thoroughly (Kuroki and Pereira, 2016; Mohan, Mahesh, Ldr, & Shashidhar, 2012).

The study showed that the use of fiber reinforced composite splint results the low tooth loss rates. This is because splinting allows regeneration of periodontal tissue that reduced and maintained the tooth mobility (Akcali, Gümüş, & Özcan, 2014; Kathariya, Devanoorka, Golani, Bansal, Vallakatla, Bhat., 2016).

In terms of survival rate, the use of fiber reinforced composite splint shows a good survival rate. The fracture and debonding resistance of fiber reinforced composite materials is caused by chemical bonds that occur between fiber and composite resin material showed better integrity between the two materials (Kathariya et al., 2016). Paddmanabhan, Chandrasekaran, & Ramya (2012) state that fiber material will improve the mechanical and physical properties of composite materials if those material combined. This statement is also proven by Mittal & Jain (2013) that fiber material has a role to act as a stress bearing for composite materials and has a crack-stopping or crack deflecting mechanism.

The results of several studies have identified the value of oral hygiene is maintained after the application of fiber reinforced composite splint (Sekhar et al., 2011; Sonnenschein et al., 2017). According to Kakar (2009), a good splint application can improve patient comfort and patients will be more motivated and obedient when it comes to their oral hygiene because they do not have to worry about losing teeth when brushing their teeth. In addition, the advantages of fiber reinforced composite materials that can be made in thin shape without reducing their strength simplify the maintenance of oral hygiene compared to wire composite materials (Kathariya et al., 2016; Strassler, 2008).

The results of studies from the articles identified showed that the

patient's periodontal health improved after the installation of fiber reinforced composite splints which can be seen from a decrease of CAL, PPD, and RBL (Kumbuloglu et al., 2011; Sonnenschein et al., 2017; Strassler, 2011). This is because the splint can distribute the masticatory and occlusal force equally to all the teeth involved so that it can protect the tooth mobility and allow for periodontal tissue repair (Azodo & Erhabor, 2016).

In terms of aesthetics, fiber reinforced composite splint has a good result. Research by Bechir et al. (2016) gave a score 8 out of 10 based on its aesthetics. Kini, Patil, & Jagtap (2011) stated that a good aesthetic value of this material was obtained because the minimum thickness produced by fiber reinforced composite material. In addition, fiber also has a neutral and translucent color that can be disguised under composite material that has a same color as a tooth. In the case of teeth that have drifting and diastema, the use of fiber reinforced composite splint can be extended to cover the gap and produce aesthetic results as well (Kerr, 2013; Sujeetha, Rajaram, & Mahendra, 2018).

Level of Evidence

The level of evidence are assessed by following the strength of recommendation taxonomy (SORT) guidelines (Levels Of Evidence — Grading System, 2018). Of the 10 articles that have been reviewed, 1 article is at level 1, 6 articles at level 2, and 3 articles are at level 3. Although the majority of articles are at level 2, there are several articles with level 3. Therefore, more articles with good quality design study are needed to increase the validity of the results.

CONCLUSION

Based on the results obtained, it can be concluded that fiber reinforced composite splint is effective in dealing with tooth mobility. All of the 10 articles reviewed show the effectiveness of fiber reinforced composite splint in dealing with tooth mobility in patients with periodontally compromised teeth, in terms of decreased tooth mobility, distribution of occlusal loads, tooth loss rates, splinting success rates, oral hygiene, periodontal stability, aesthetics and convenience, and biocompatibility. Higher level of evidence with minimum RCT design study is needed to draw stronger conclusions about the effectiveness of fiber reinforced composite splint in dealing with tooth mobility in patients with periodontally compromised teeth.

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