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Comparing Fibre-Reinforced, CAD/CAM and Composite Wire Splints

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KEYWORDS

CAD/CAM, Digital Dentistry, Periodontitis

ABSTRACT:

Aim: To compare the clinical effectiveness of composite wire splints, fibre -reinforced splints and CAD/CAM manufactured splints in stabilizing anterior teeth affected by periodontitis.

Objectives: To evaluate and compare the reduction in tooth mobility, plaque index(P I) and Probing pocket depth (PPD) among three splinting modalities over a three -month period

Methods: **:** Fifteen patients with Grade I or II mobility in mandibular anterior teeth were randomly assigned to one of three groups: Group 1 – Composite Wire Splint, Group 2 – Fibre-Reinforced Splint, and Group 3 – CAD/CAM Splint. Clinical parameters (PI, PPD, and mobility) were assessed at baseline, 15 days and 3 months using standard indices and Periotest-S.

Results: All groups showed significant improvements in tooth mobility, plaque index and probing pocket depth from baseline to 3 months. The most substantial reduction in mobility occurred within the first 15 days. Fibre-reinforced splints demonstrated superior plaque control, while CAD/CAM splints offered improved fit and aesthetics.

Conclusions: Each splinting modality effectively improved periodontal stability. Fibre-reinforced splints were more effective in reducing plaque, while CAD/CAM splints excelled in aesthetics and precision. Selection of splinting type should be individualized based on patient needs, clinical condition and follow-up capacity.

1. Introduction

Periodontitis is an inflammatory disease induced by bacterial biofilms that accumulate in the gingival margin and is characterized by gingival inflammation, loss of connective tissue attachment and alveolar bone.[1] If left untreated, the continuous loss of the supporting tissues during periodontal disease progression may result in increased tooth mobility, ultimately yielding tooth drifting and exfoliation.[2]

In advanced cases of periodontitis, managing tooth mobility is crucial, particularly in the anterior region, where stabilization of the affected teeth is essential to maintain both functional integrity and aesthetic appearance. According to the Glossary of Periodontic Terms, Splint is an appliance designed to stabilize mobile teeth.[3] Numerous types of splints have been described in the literature, such as composite resin based ones used in conjunction with adhesive systems, orthodontic wire, wire-composite or fibre reinforced composite resin, nylon fishing line-composite and polyethylene.

However, splints cause retention areas, facilitating the growth of microorganisms and impairing oral hygiene, reducing the longevity of the teeth and the splint itself. Syme and Fried stressed that excellent prophylaxis during professional follow-ups, frequent periodontal debridement and a comprehensive assessment of periodontal and caries risk are all necessary for the longevity of dental splints. Splinting does have certain disadvantages, too, such as the potential for speech impediment, a higher risk of crown fractures and the chance for mesial tooth shifting over time. [6]

Composite splints reinforced with fibres based on fibreglass or polyethylene are widely used. These splints

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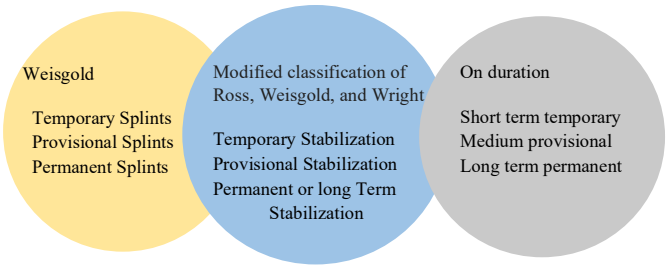
are durable, do not cause discomfort. Currently, Computer Aided Design and Computer Aided Milling (CAD/CAM) technologies are widely used in dentistry, allowing accuracy and at the same time aesthetic designs and reproduction of all planned parameters, such as shape, the thickness of the fixing layer, distance to the edge of the tooth. In addition, using CAD/CAM technology minimizes the human factor that affects the restoration accuracy. CAD/ CAM splints have been introduced in dentistry recently. CAD/CAM splints have been made using various materials (PEEK, PMMA) for periodontal stability in mandibular anterior teeth. They have helped overcome the disadvantages of fibre reinforced splints and composite wire splints.

This study aims in evaluating the stability of resin-bonded splint using CAD/CAM technology compared to composite wire splint and Fibre-reinforced splint in mandibular anterior teeth, using periotest for assessment.

Figure1, Depicts classification of types of splints



Classification of splints[4,5]

2. Methods

The present study was an experimental type of study that involved a total of 15 patients that underwent splinting procedures. These included all treatment modalities of splinting. The study was performed in Department of Peridontology, Rural Dental College, Loni Ahmednagar. The ethical approval for the collection of data was obtained from the Institutional Ethics Board.

The inclusion criteria were as follows:

1. The patients must give an informed consent for the study.
2. Age group: 26-55 years of either sex.
3. Patients with no systemic disease.
4. The patients should have an ability to maintain good oral hygiene.
5. Grade I or grade II mobility with lower anterior teeth.
6. Patient ready to come for follow up.

Patients were randomly distributed into three groups, depending on the type of splint:

Group 1-Composite Wire Splint

Group 2-Fibre Reinforced Splint

Group 3-CAD/CAM Splint

Working algorithm was conducted in several stages, as follows:

1. Clinical evaluation

In the first stage, clinical examination was performed for each patient. Following the initial clinical periodontal evaluation, the parameters were quantified: plaque index Silness and Löe (PI), periodontal pocket depth (PPD), clinical attachment loss (CAL) and mobility were recorded at baseline,15 days and at 3 months.

2. Etiological treatment

Complete Scaling and Root planing was done**.** A prophylactic cup was used to clean the teeth's lingual and facial surfaces with pumice paste. Patient was educated about the oral hygiene maintenance.

3. After complete resolution of gingival inflammation patients were randomly allocated into 3 groups .

4. For composite wire splints orthodontic ligature wire was intertwined, thickness of it was 0.33mm and cut to the desired length, adapted to the contour of teeth with the help of cement carrier, was washed, dried and prepared for use with composite material. Splint extended from canine to canine. Then the teeth were isolated. In all of the cases splinting was done on the lingual aspect, the lingual surface of teeth were selectively etched (in middle third of teeth) and bonding agent was applied. Packable composite was applied on the middle third of bonded lingual surface as a button and the adapted wire was immersed in composite and cured for specified time then the composites buttons were polished.

5. For fibre-reinforced splint the method involves preparing and engraving the anterior teeth to achieve stiff stabilization. The bonding technique used to stabilize mobile teeth involved reinforcing them with fibres and securing them with Ribbond®-Ribbon. The enamel of lingual surface of selected teeth were etched and bonded. Fibres were measured and cut to the desired dimension. A thin layer of composite (fusion flow resin) was applied

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on the enamel surfaces by using a microbrush and left uncured. The cut ribbons were carefully adapted on the lingual surfaces of anterior teeth into the uncured composite, pushed into the embrasures and a new thin layer of flowable resin were applied. The excess of composite resin was removed before light curing. Each segment of splints was light-cured for 20 seconds. A new layer of flowable resin was applied on splints and each segment was light-cured for 30 s, to be certain that the light penetrated in the ribbon and the composite resin is completely cured. The occlusion was checked and adjusted if it was necessary and the surface of composite resin was finished with burs for composites. The polishing was realised with hand-piece at 3000 rpm, with polishing paste, in order to not expose the fibres of ribbons.

6. For CAD/CAM splints, following scaling and root planing digital impression of mandibular anterior and posterior teeth was recorded (TRIOS; 3SHAPE 4). To choose the milling method, use the "inlay/veneer" module of the CAD software (exoCAD;exo Elefsina) and choose PMMA from the material menu. Describe the splint's extension. In order to facilitate interdental brushing, the splint should
be 1 to 1.5 mm thick and extend to atleast one non mobile tooth on each side of the mobile teeth. The STL file of the splint design was transferred to the milling machine and fabricated using PMMA disc.

7. Assess the splint's fit intraorally before cementation. 35% phosphoric acid was used to etch the teeth's lingual surface for 15 seconds. Wash the teeth with running water spray for 10 seconds. Apply 2 successive layers of adhesive. After applying resin cement to the teeth's lingual surfaces and then cement the splint. After removal of extra cement photopolymerization was done.

8. The patient was recalled periodically for supportive periodontal treatment and to examine the splint and tooth mobility using Periotest-S.

Figure 2, Depicts Composite Wire Splint

Figure 3, depicts Fibre reinforced Splints

Figure 4 , depicts CAD/CAM Splints

3. Results

The results of the study showed that there were significant changes in clinical parameters in all three groups, namely Composite wire splint (Group 1), Fibre-reinforced splint (Group 2) and CAD/CAM splint (Group 3) from baseline to 3 months. As far as the tooth mobility is concerned, a significant reduction was found from

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Baseline to 15 days and from Baseline to 3 months in all the groups, indicating rapid initial stabilization followed by sustained long-term effects. However, no significant difference was observed between 15 days and 3 months; therefore, it can be assumed that the main stabilization effect occurs within the first 15 days after splinting, with little change thereafter.

By applying Student's Paired 't' test there is a significant difference between mean values of mobility from Baseline to 15 days and baseline to 3 months in Group 1 (Composite wire splint), in Group 2 (Fibre reinforced splint) and in Group 3 (CAD/CAM splint). While no significant difference seen from 15 days to 3 months in Group 1 (Composite wire splint), in Group 2 (Fibre reinforced splint) and in Group 3 (CAD/CAM splint).

The mean Plaque Index showed a statistically significant reduction from baseline to 1 month in all groups, thereby indicating better plaque control due to the splinting modalities. By applying Student's Paired 't' test there is a significant difference between mean values of plaque index from baseline to 1 month in Group 1 (Composite wire splint), in Group 2 (Fibre reinforced splint) and in Group 3 (CAD/CAM splint). The CAD/CAM splint compared to Group 1 (Composite wire splint) and Group 2 (Fibre-reinforced splint), showed relatively smaller reductions in mean plaque index values, suggesting that, although effective, its performance in plaque control was not as marked as with the fibre-reinforced splint (Group 2), showing the largest reduction.
Similarly, a significant decline in mean probing pocket depth was recorded from baseline to 3 months in all the groups that indicated periodontal healing and reduced inflammation. By applying Student's Paired 't' test there is a significant difference between mean values of probing pocket depth from baseline to 3 months in Group 1 (Composite wire splint), in Group 2 (Fibre reinforced splint) and in Group 3 (CAD/CAM splint).

By applying One way ANOVA test there is a significant difference in the mean values of PI, PPD and mobility at baseline, 15 days, 1 month and 3 months in Group 1, 2 and 3 compared together. (p=0.0001)

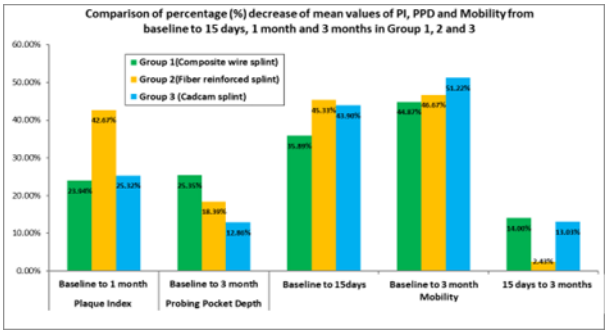

Figure 5, represents Comparison of mean values of Plaque Index in Group 1 (Composite wire splint), in Group 2 (Fibre reinforced splint) and in Group 3 (CAD/CAM splint) at Baseline to 1 month.

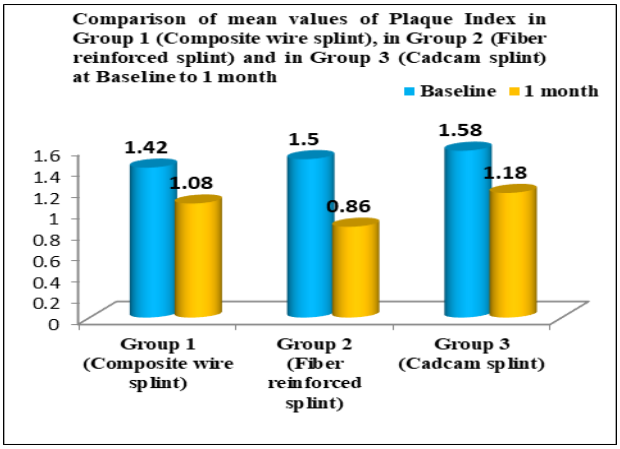

Figure 6, represents Comparison of mean values of Probing Pocket Depth in Group 1 (Composite wire splint), in Group 2 (Fibre reinforced splint) and in Group 3 (CAD/CAM splint) at Baseline to 3 months.

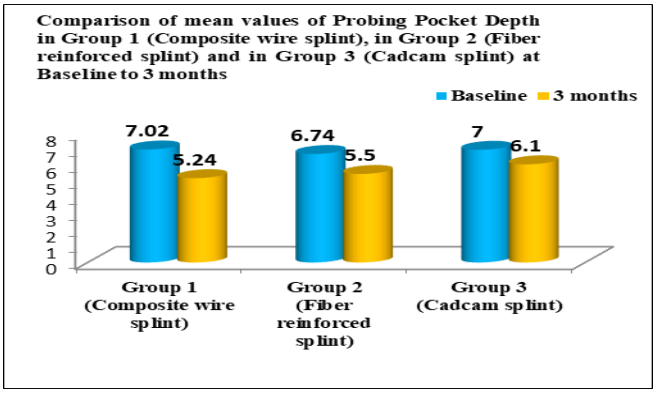

Figure 7, represents Comparison of mean values of Mobility in Group 1 (Composite wire splint), in Group 2

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(Fibre reinforced splint) and in Group 3 (CAD/CAM splint) at Baseline, 15 days to 3 month.

ANOVA TEST One Way Analysis of Variance (ANOVA) Test:

For Group 1,2 and 3: (PI, PPD and Mobility) compared together from baseline, 15 days, 1 month and 3 months together)

Table 1, Depicts Anova test .

Source of variation	d.f.	Sum of squares	Mean square
Treatment (between columns)	**20**	**2245.7**	**112.28**
Residuals (within columns)	**83**	**425.04**	**5.121**
Total	**103**	**2670.7**	

Value of F =21.927, p=0.0001, significant

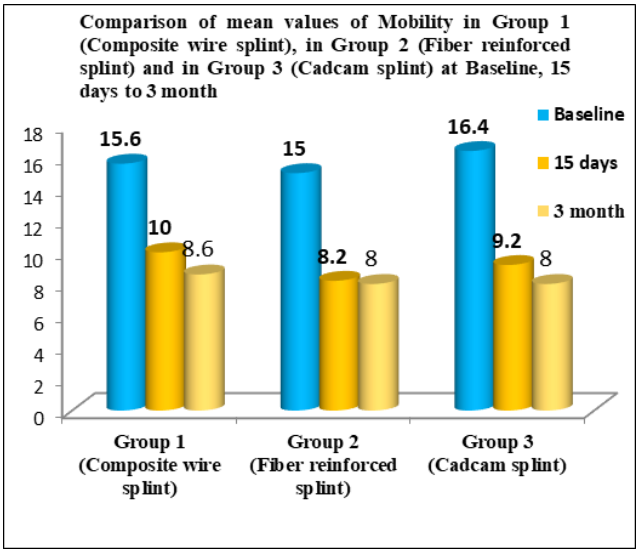

Figure 8, Represents comparison of percentage decrease pf mean values of PI, PPD and Mobility from baseline to 15 days, 1 month and 3 months in Group 1,2 and 3

4. Discussion

Tooth mobility is an important clinical parameter and its presence is one of the risk factors for the progression of periodontal disease. Tooth stabilization with the help of splinting has been recommended for the periodontally compromised dentition to improve patient's comfort and the masticatory function.

Teeth splinting may be recommended for individual mobile teeth when other treatment choices, such as dental extraction and implant therapy or removable partial denture therapy, are not practical because of patient- and site-related difficulties. It's standard practice to splint mobile teeth, particularly lower incisors, in order to maintain the patient's natural dentition for as long as possible.[7] **Graetz's** results showed that splints in the lower anterior teeth needed fewer repairs compared to the upper anterior teeth and posterior teeth.[8]

Sekhar et al. conducted a comparison of splinted and non-splinted teeth, observing a greater reduction in mobility in the splinted group than in the non-splinted group. The experimental group exhibited a more significant decrease in tooth mobility compared to the control group.[9]

In a clinical study**, Akcali et al.** evaluated the success and clinical survival of two different splint materials-wire composite splint (WCS) or fibre reinforced composite splint (FCS) bonded on periodontally treated mobile teeth. The authors showed that FCS tend to show increased mechanical limitations compared to WCS. [10]

Periodontal splints of different designs and with different materials have drawbacks, including plaque accumulation, fracture in case of composite resin, complex prosthodontic fabrication procedures for partial dentures, or difficulty in adjusting or modifying metal splints intraorally.

An ideal dental splint should include enough stable teeth—typically at least two for every mobile tooth—to minimize load on compromised units. It must provide rigid stabilization without causing torsional stress, extend around the arch to resist antero-posterior and facio-lingual forces, and avoid interfering with occlusion, with major disharmonies corrected beforehand. The splint should be aesthetically acceptable, non-irritating to the pulp and soft tissues and allow for easy cleaning and periodontal maintenance.[11]

These splints offer exceptional strength, durability, and superior aesthetics, making them ideal for long-term periodontal stabilization and full-arch prosthetic splints. The CAD/CAM technology ensures high accuracy, reducing the risk of fabrication errors and providing a customized fit for each patient. Additionally, CAD/CAM

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splints exhibit high wear resistance and require minimal maintenance, making them a reliable long-term solution. However, the primary drawbacks include higher costs and the requirement for specialized digital equipment, which may not be available in all clinical settings.

CAD/CAM splints are fabricated using high-performance materials such as PEEK, PMMA or Trilor, which are digitally designed and milled for optimal precision and fit.

Thus, splinting mobile teeth serves as a valuable adjunct to periodontal therapy and ongoing maintenance, and is therefore recommended in appropriate cases. However, the selection of a suitable splint depends on a careful evaluation of the advantages and limitations of each type. An effective splint should be designed to minimize plaque and calculus accumulation, remain securely in place for the intended duration, fulfil its stabilizing function, and support both the healing process and aesthetic outcomes.

5. Conclusion

The study emphasizes the effectiveness of periodontal splinting in stabilizing mobile teeth and improving clinical parameters such as tooth mobility, plaque index, and probing pocket depth. All three splinting modalities—composite wire splints, fibre-reinforced splints, and CAD/CAM splints—demonstrated significant improvements from baseline to 3 months, with rapid stabilization occurring within the first 15 days. While fibre-reinforced splints showed superior plaque control, CAD/CAM splints provided aesthetic advantages and precise fit, reducing the human factor in fabrication.

Despite these achievements, the selection of splint type should remain individualized depending on the patients' needs - degree of mobility, esthetic preferences, oral hygiene practices - and proper management and follow-up care for their periodontium to ensure prolonged splint wear and periodontal stability. Future research with large sample sizes and longer follow-up periods is highly recommended to examine the long-term outcomes and patients' satisfaction using newer splinting technologies like CAD/CAM systems.

With the strengths of each splinting method and incorporating emerging technologies, clinicians can optimize treatment outcomes to improve functionality and patient comfort in managing periodontally compromised teeth.

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