Original Article

Innovative Method to Increase the Stability of Mini-Implant

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Abstract

Aims: Mini-implants are routinely used as an absolute anchorage device. The failure rate of mini-implants varies from 6.6 to 16.1%. Many methods are innovated to gain the stability of implants. Out of the various methods, platelet concentrations are gaining popularity. Platelet rich fibrin (PRF) is new generation platelet concentrate. Various studies have shown its role in enhancing the stability of dental implants. Although in orthodontic implants, osseointegration is not required but to avoid the chance of failure of implant, this study was undertaken. **Materials and Methods:** The study comprised of 9 subjects (18 years and above). The split mouth technique was used; Group A (where implants were coated before insertion) and group B (implant were normally inserted). The stability of the implant was measured using resonance frequency analysis. The readings were recorded at insertion (T0), 24 h (T1), 2 weeks (T2), 4 weeks (T3), 6 weeks and 8 weeks after insertion. **Results:** Statistically significant findings were found when group A was compared to group B using ANOVA test ($P < 0.05$). The stability of implant of group A at each time interval was greater than group B. The implant stability was high at T0 and reduces at T2 and increasing through T3 to T5. The stability was highest at T5. **Conclusion:** The stability of implants was found to be increased when they were coated with PRF than the normally inserted implants. Hence, the stability of mini-implants can be increased by chairside with minimally invasive procedure.

Keywords: PRF, Orthodontic miniimplants, Implant stability.

Introduction

Anchorage is one of the most challenging aspects of Orthodontics.[1] It is based on Newton's third law and is a prerequisite for successful orthodontic treatment of malocclusions.[2] The quest for search of an absolute anchorage has led to the use of implants.

These were first introduced by Gainsforth and Higley in 1945 and main stayed since then.[3] Mini-implants are routinely used as an absolute anchorage device.

Long-term microsatellite instability (MSI) stability depends on both primary and secondary stability, two closely related phenomena. Immediately after the MSI has been inserted, its retention is entirely mechanical, due primarily to the characteristics and amount of the bone contacting the MSI, particularly the cortical bone.[4,5] This mechanical type of MSI retention is called primary stability. For orthodontists, primary stability is important because it allows MSIs to be immediately loaded. More importantly, primary stability is critical for the development of secondary stability. The endosseous literature has shown that primary stability is essential for the long-term success of implants

Optimal primary stability depends on bone quantity (cortical bone thickness, cancellous bone density, amount of available bone), mini-implant design (length, diameter, tapering, thread length, and pitch) and placement conditions (predrilling, insertion angle and penetration depth).[6,7]

MSI placement generates stresses and strains along the length of the screw that damage the surrounding bone. Too much damage can lead to micromotion of the implant and early loss due to a lack of osseointegration.[6]

The reported failure rate of mini-implants varies from 6.6% to 16.1%.[8]

Out of the various methods of gaining stability, platelet concentrations are gaining popularity for various reasons. Platelet concentrations include PRP and platelet rich fibrin (PRF). Out of the two, PRF is new generation platelet concentrate.[9]

PRF is minimally invasive method and there are various studies that have shown its role in enhancing the stability of general implants.[10-12]

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Although in orthodontic implants, osseointegration is not required but to avoid the chance of failure of implant; this study was undertaken.

The aim of the study was to evaluate and assess the efficacy of PRF on the stability of orthodontic implant.

Materials and Methods

Prospective single group split mouth experimental study was performed to compare the primary stability of orthodontic micro-implants without loading, at various time intervals using resonance frequency analysis.

Patients who already had their strap-up done, and whose treatment plan included mini-implant placement in the interradicular bone between the maxillary 1st molar and the 2nd premolar were approached. Patients were selected by simple random single blind sampling technique who visited to the Department of Orthodontics and Dentofacial Orthopaedics, Chhatrapati Shahu Maharaj Sikshan Sanstha dental College, Aurangabad. The patients were explained about the study and those who agreed to participate were included in the study. Case history was recorded for each patient to rule out any conflicting medical conditions (disease affecting bone metabolism) or drug use (such as steroids and bisphosphonates). Subjects with a healthy periodontium and good oral hygiene were included in the study as these might affect the stability of the micro-implants. The age group of patients above 18 years irrespective of gender was considered. A written consent form was procured from the selected subjects.

In this manner, the first 9 patients that agreed to comply were selected. The selected patients (18 sites) were randomly divided into two groups:

- Group A (experimental group): 9 Implants coated with PRF before insertion
- Group B (control group): 9 Implants not coated with PRF before insertion.

The fresh PRF was made for each patient by following the given procedure:

Around 2 ml of whole venous blood was drawn from cubital vein after tourniquet application in upper arm (Figure 1). A 5 ml syringe with 26-gauge needle was used for blood extraction and blood was collected in each of the two sterile vacutainer tubes (test tube) of 5 ml capacity without anticoagulant. Following blood collection, the vacutainer tubes were then placed in a centrifugal machine (Figure 2) at 3000 revolutions per minute for 10 min. The resultant product (Figure 3) consisted of following layers:

1. Top layer consists of straw-colored cellular plasma
2. Middle layer consists of PRF
3. Bottom layer consists of red blood cell (RBC).

PRF and red corpuscle base was extracted using a sterile forceps from straw colored cellular plasma and then with help of a sterile scissor PRF was cut-off from RBC and transferred onto a sterile dappen dish.

9 implants were coated with PRF using zero size brush (Figure 4).

All the 18 titanium- Grade 5(Ti-6AI-4V) implants (1.5 × 6 mm) were then inserted 8 mm from the alveolar crest between the upper first molar and premolar with a self-drilling method at 90°.

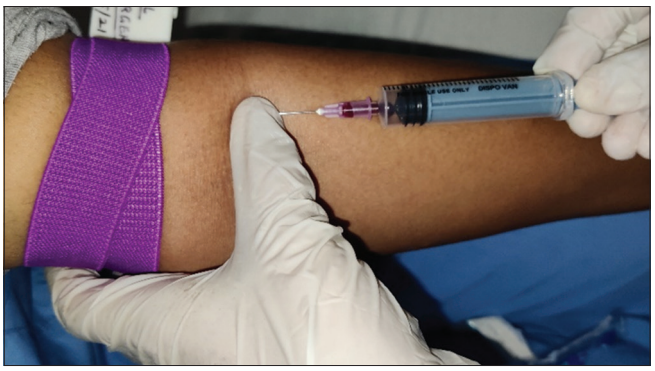


Figure 1: Blood withdrawal using 5 ml syringe

Figure 2: Centrifugal machine

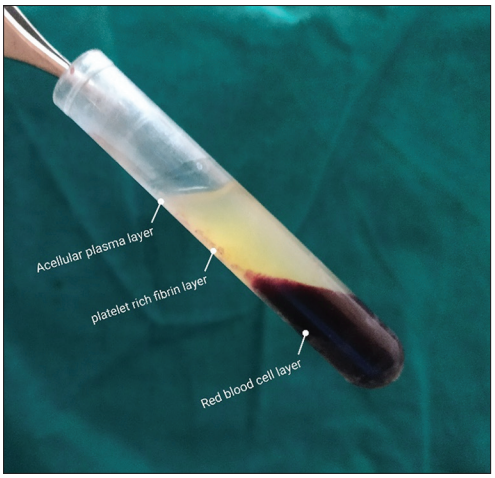


Figure 3: Resultant product after centrifuging blood at 3000 revolutions per minute for 10 min

The ISQ was measured using resonance frequency analyzer at 6 different time intervals – at time of insertion (T0), 24 h (T1), 2 weeks (T2), 4 weeks (T3), 6 weeks (T4) and 8 weeks (T5) after insertion in two directions, that is, mesiodistal direction (D1) and occlusogingival direction (D2) (Figures 5 and 6).

Results

Statistical analysis

The observations obtained in the study were subjected to statistical analysis, so as to get their interpretation. Data were coded, transferred and analyzed on SPSS version 19. ANOVA test was used to compare the two groups. Level of significance was set at $P < 0.05$.

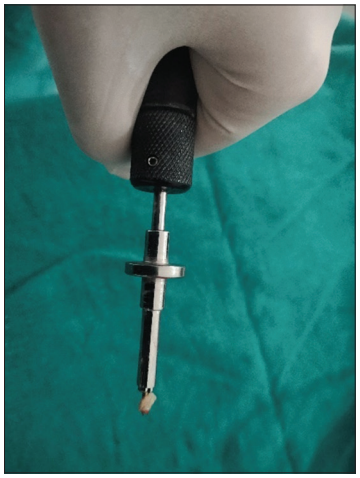


Figure 4: Microimplant coated with platelet rich fibrin

Figure 5: Reading in mesiodistal direction (D1)

Figure 6: Reading in occlusogingival direction (D2)

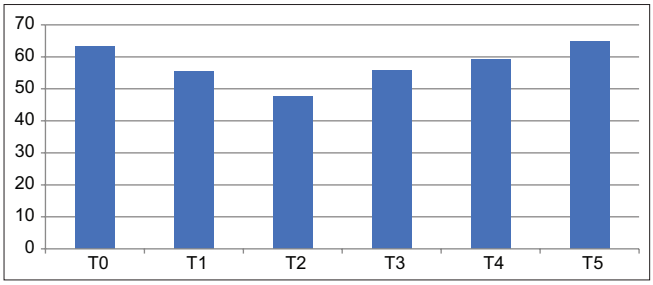
Statistically significant findings were found when group A was compared to group B using ANOVA test ($P < 0.05$). The stability of implant of group A at each time interval was greater than group B. The implant stability was high at T0 and reduces at T2 and increasing through T3 to T5. The stability was highest at T5 (Tables 1 and 2) and (Graphs 1-3).

Discussion

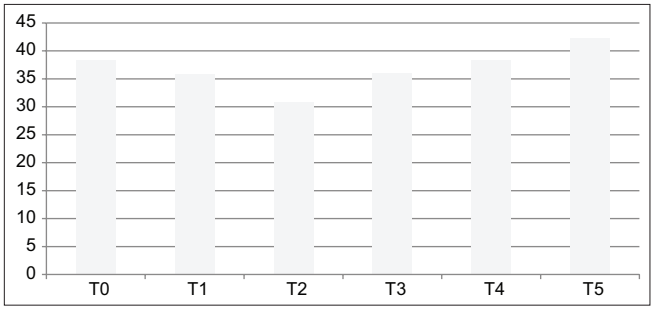
In this study, statistically significant findings were found when group A was compared to group B using ANOVA test ($P < 0.05$).

Table 1: Mean of Group A and Group B

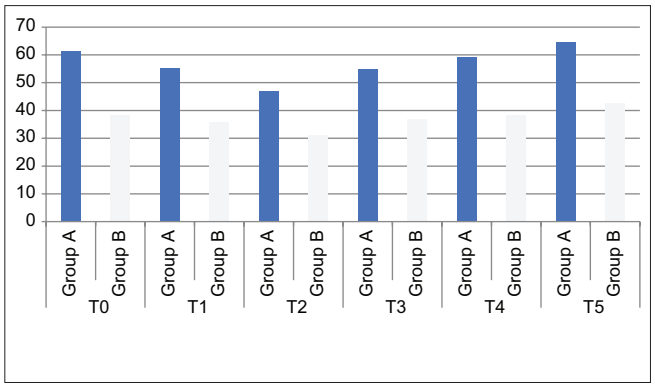
Time intervals	Mean
T0	
Group A	61.24
Group B	38.33
T1	
Group A	55.39
Group B	35.94
T2	
Group A	46.87
Group B	31.00
T3	
Group A	54.78
Group B	36.78
T4	
Group A	59.15
Group B	38.39
T5	
Group A	64.44
Group B	42.57



Graph 1: Comparison of ISQ in Group A



Graph 2: Comparison of ISQ in Group B



Graph 3: Comparison of ISQ between Group A and B

Table 2: Comparison of ISQ of Group A and Group B using ANOVA test

ANOVA

Time interval	Sum of squares	df	Mean square	F	Sig.
T0					
Between Groups	8337.796	1	8337.796	193.300	0.000
Within Groups	2242.963	52	43.134		
Total	10580.759	53			
T1					
Between Groups	5104.167	1	5104.167	400.528	0.000
Within Groups	662.667	52	12.744		
Total	5766.833	53			
T2					
Between Groups	3733.352	1	3733.352	217.296	0.000
Within Groups	893.407	52	17.181		
Total	4626.759	53			
T3					
Between Groups	5260.907	1	5260.907	717.675	0.000
Within Groups	381.185	52	7.330		
Total	5642.093	53			
T4					
Between Groups	5932.519	1	5932.519	845.610	0.000
Within Groups	364.815	52	7.016		
Total	6297.333	53			
T5					
Between Groups	6913.352	1	6913.352	1216.639	0.000
Within Groups	295.481	52	5.682		
Total	7208.833	53			

*P<0.005 significant corelation

The stability of implant of group A at each time interval was greater than group B. The implant stability was high at T0 and reduces at T2 and increasing through T3 to T5. The stability was highest at T5.

PRF is second generation platelet concentrate. It consists of an autologous leukocyte-platelet-rich fibrin matrix[13] composed of a tetra molecular structure, with cytokines, platelets, and stem cells within it, which acts as a biodegradable scaffold that favors the angiogenesis and is able to guide epithelial cell migration to its surface.[14-17] The mechanism which was followed here was that, fibrinogen which was initially concentrated in the high part of the tube, combined with the circulating thrombin due to centrifugation, to form fibrin. A fibrin clot was then obtained in the middle of the tube, just between the red corpuscles at the bottom and acellular plasma at top. Platelets were trapped massively in the fibrin meshes.[9]

Conclusion

Anchorage is most important for successful orthodontic treatment. Anchorage preservation has always been a concern for orthodontist. The quest for search of an absolute anchorage has led to the use of implants. In this study, PRF coating has shown a promising result in terms of increase in stability of implants. Hence, with the use of PRF, the stability of mini-implants can be increased by chairside with minimally invasive procedure. Therefore, this warrants further studies in this aspect.

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