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Research Article

Evaluating The Efficacy of Platelet Rich Fibrin with Hydroxyapatite in The Extraction Socket of Mandibular First Molar – A Prospective Single Blind Randomized Control Study

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Abstract: Tooth extraction is a common dental procedure used to manage issues such as tooth decay, fractures, periodontal disease, infections and orthodontic space creation. After a tooth is extracted, the socket typically takes about 40 days to heal. During this time, there is a natural process of bone resorption that occurs, which can make it difficult to place an implant and achieve an esthetic and functional restoration. To address this issue, a method called Platelet-Rich Fibrin (PRF) has been developed. PRF is a second-generation of autologous growth factors that is believed to accelerate wound healing and promote the formation of new bone. A recent study aimed to evaluate the effectiveness of using PRF gel with HA nanocrystals as an aid in ridge preservation for implant placement following the extraction of a mandibular first molar. Our study was a randomized controlled clinical trial that analyzed the quality of bone healing in the mandibular first molar socket using radiographic imaging at various time intervals. The aims were to evaluate the effectiveness of PRF gel with HA nanocrystals as an aid in ridge preservation for implant placement following extraction of mandibular 1st molar, a randomized controlled clinical study and to analyze the quality of bone healing in the mandibular first molar socket using RVG at various time intervals4th week and 10th week. The mean lamina dura scores at the 4th week in group I & group II 4.333 and 3.636 respectively, 10th week 3.545 and 3.091 respectively. the mean trabecular pattern in 4th week 4.364 ,3.182 respectively in 10th week 3.424 ,3.030 respectively, the mean overall density in 4th week 4.242 ,3.545 respectively in 10th week 3.485 and 2.545 respectively The results showed that the use of PRF gel with HA nanocrystals was effective in promoting bone formation and reducing bone resorption, but it is recommended that further studies are conducted to compare the efficacy of PRF with other materials and techniques. One limitation of the study was the short follow-up period of only 8 weeks. Overall, the study suggests that PRF gel with HA nanocrystals may be useful in promoting bone formation and reducing bone resorption after tooth extraction, but more research is needed to fully understand its effects.

Keywords: Molar Teeth, Extraction, Platelet Rich Fibrin, Hydroxyapatite, Bone Formation

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1. INTRODUCTION

Tooth extraction is a common dental procedure in the management of tooth decay, complicated fractures, periodontal disease, infections and orthodontic space creation. The normal sequence of events of socket healing takes place over a period of approximately 40 days, beginning with clot formation and culminating in a bone- filled socket with a connective tissue and epithelial tissue covering. In the normal sequence of events of socket healing, controlled clinical studies have documented an average of 4.4 mm of horizontal and 1.2 mm of vertical bone resorption 6 months after tooth extraction. [1] The sequence of healing involves a blood clot for the first 3 days, with the clot replaced by a provisional matrix by day 7. The provisional matrix is replaced by woven bone with 80% of the socket filled with mineralized material by day 30. By day 180, 85% of the site is bone marrow[2], with 15% of the volume filled with mineralized bone by volume. The ideal situation is for an extraction site to heal with bone formation completely preserving and recreating the original dimensions of the bone when the tooth was present[3]. Bone resorption is common after tooth extraction- thus the need to intervene with a method to provide ideal bone for implant placement and reconstruction with an esthetic and functional restoration. Replacement of lost teeth is further complicated, especially in case of implant therapy, [4]due to loss of bone volume required for successful implant treatment. In addition, post extraction bone loss necessitates bone-grafting procedures for implant placement to predictably restore function and esthetics. [1]multiple procedures are employed for prevention of post extraction bone loss and predictable implant placements after extraction, including socket preservation with grafts (biomaterials), and immediate or early implant placements. While the clinician has a number of graft materials to choose from, some bone graft materials need longer healing time to achieve even a small amount of new bone incorporation into the graft site [5] In addition, immediate implant placements to avoid subsequent bone resorption often result in buccal bone defects requiring simultaneous grafts, showing lower success rates compared to non graft implant placements. Early implant placement is another possible alternative for avoiding post extraction bone loss, however, at 4 weeks bone formation is slow and bone density is suboptimal.[4] Socket preservation using biomaterials has been proposed and autologous platelet concentrates including platelet rich plasma (PRP) with growth factors and platelet rich fibrin (PRF) are employed. PRF is a second- generation of autologous growth factors, which encourages healing and is proposed to be associated with effective and early organization of bone substance and bone volume percentage. In addition [6] PRF is a platelet concentrate with leukocytes in dense fibrin matrix, which can be conveniently prepared from autogenous non anti- coagulated blood when centrifuged. Reports with regards to the clinical efficacy of using platelet concentrates (like PRF) in the healing of extraction sockets have been controversial. With studies showing significant and comparable outcomes among control and test groups for assessing the effect of platelet concentrates in post extraction socket preservation,[7] it is hypothesized that PRF will accelerate wound healing of socket after tooth extraction, noticed by increased bone fill and reduced bone resorption. It is well established that nano-sized HA can mimic the dimensions of constituent components of calcified tissues such as bone and teeth. Thus, recent development of HA-based biomaterials for biomedical applications will obviously stand to benefit most from nanotechnology,[8] which offers a unique approach to overcome the shortcomings of their conventional forms due to their large surface to volume ratio and unusual chemical/electronic synergistic effects. Nanocrystalline HA is expected to have better bioactivity and dissolution than coarser crystals.[9] Nanostructured biomaterials promote osteoblast adhesion and proliferation, osseointegration, and the deposition of calcium-containing minerals on the surface of these materials. Nanocrystalline HA powder exhibits improved sinterability and enhanced densification due to a greater surface area, which could improve the fracture toughness as well as other mechanical properties. [10] In addition, nanostructured ceramics can be sintered at a lower temperature; thereby problems associated with high temperature-sintering processes can also be eliminated. It is possible to enhance both the mechanical and biological performance of HA by controlling the characteristic features of powders such as surface area, crystallinity, morphology, particle size, particle distribution, and agglomeration.[5] Therefore the aim of this study was to evaluate clinically and radiographically extraction socket healing using autologous platelet rich fibrin (PRF) gel and HA nanocrystals.[11]

2. MATERIALS AND METHODS

2.1 Sample area

A total of 66 subjects who required tooth extraction and future implant therapy were included in the study. Patients were selected from the department of oral and maxillo facial surgery, Indira Gandhi Institute of Dental Science Pillayarkuppam for treatment of extraction of mandibular first molar under local anesthesia.[11]

2.2 Ethical issues

The protocol for investigation was approved and registered by the institutional review board. (IGIDSIEC2016NDP04PGBSOMS)All participants have been informed about the procedure and informed consents in English and Tamil were obtained. [18, 11, 25]

2.3 Sampling and statistics

The sample size calculation is an important step in any study to ensure that the study has sufficient power to detect any differences or effects that may exist between the groups being compared. The sample size calculation for this study likely involved determining the minimum number of subjects needed in each group to detect a significant difference in the outcomes of interest, based on the means and standard deviations from previous studies. Alpha power of 80 % and a beta value of 0.05%. The sample size of a total of 56 was found out. The drop outs were calculated to have 66 in both group. The patients were then randomly allocated into two groups using computer generated randomization, which helps to ensure that the groups are similar in terms of baseline characteristics and reduces the risk of bias. To analyze the data, the chi square test was used, which is a statistical test that is commonly used to compare proportions between groups. This test can help to determine

whether any differences in the proportions of patients with a certain outcome in the two groups are statistically significant.

2.4 Inclusion and Exclusion Criteria

The inclusion criteria were patients willing to participate in this study, willing for implant, patients free from systemic illness, includes age group between 19 to 45, surgical site free of active infection, patient not willing for RCT[7],Dental caries with apical periodontitis and indication for extraction [23,11,17] and the exclusion criteria are Medically compromised patient, Patients with periodontically compromised, root stump, smokers and those with regular postoperative follow up. [20,11,15] .The 66 subjects were divided into two groups among which group I includes Extraction sockets left for normal healing (blood clot) and group II includes Extraction sockets which received platelet rich fibrin gel and hydroxyapatite nanocrystals.

2.5 Prf Preparation

Immediately after surgical procedure, 10 ml of blood was drawn from each patient in test group without adding anticoagulant. Following blood collection each sample was centrifuged at 3000 rpm (approximately 400 g) for 10 min using compact centrifuge (Hermle labortechnik, Germany). These results in a fibrin clot formation, containing platelets located in the middle of the tube, just between the red blood cell layer at the bottom and acellular plasma at the top. This clot is removed from the tube using sterilized tweezers. [14, 17, 26]

2.6 Sybograf Synthetic Nanocrystalline Hydroxyapatite (Eucare Pharmaceuticals Private Limited)

2.7 Clinical Procedure

All patients were given inferior alveolar nerve block and long buccal nerve block using 2%lignocaine with epinephrine 1:200000. The teeth were extracted with minimal trauma by a single surgeon with mucoperiosteal flap elevation. The final tooth delivery was performed with molar forceps. [20] The surgical procedure was performed by the same experienced oral and maxillofacial surgeon in all groups. The standard technique for extracting mandibular first molars was used under local anaesthesia. A triangular flap was raised using a ward-I or ward-II incision or an envelope flap. A tungsten carbide bur and a micromotor handpiece were used for buccal guttering and ditching. After the tooth was extracted and hemostasis was achieved, the socket was thoroughly irrigated with 40 ml of normal saline.The they are divided into groups In group I patients, the control group following tooth extraction, buccal releasing incision will be placed and post extraction socket will be sutured using 3-0 silk.[16] (Fig 1,1A,1B) In group II patients, following tooth extraction, buccal releasing incision will be placed and the post extraction socket will be treated immediately by placement of PRF gel and HA nanocrystals and using 3-0 silk simple interrupted sutures will be placed.[17,11](Fig 2,2A,2B,2c).Postoperative instructions included prevention of wound disturbance Avoid excessive rinsing and spitting for 48 hours tongue and fingers should not used to apply pressure at wound site no smoking and pulling or lifting of lip and bone morphology was assessed with the help of RVG, regular intervals on 4th week and 10th week. (22, 15, 18)

2.8 Radiographic Analysis (Blind Investigator)

Bone healing of the first molar socket was assessed radiographically using a RVG. The criteria for bone healing and the scoring system are based on a modification of the method used by Kelley et al. Three radiographic parameters, namely, lamina dura, overall density, and trabecular pattern, were used for assessment of bone healing. It was agreed in advance that baseline radiography will be the reference radiograph and will receive a score of 0. A score of -2 to 2 represented gross variance from baseline radiographic score and a score of -1 to 1 represented significant variation from normal.[20] The descriptions of the different scores for each radiographic parameter are listed,

2.9 Lamina Dura

-2 Lamina dura essentially absent, may be present in isolated areas
-1 Lamina dura substantially thinned, missing in some areas
0 Within normal limits
1 Portions of lamina dura thickened, milder degrees
2 Entire lamina dura substantially thickened

2.10 Overall Density

-2 severe increases in radiographic density
-1 mild to moderate increase in radiographic density
0 Within normal limits
1 Mild to moderate decrease in radiographic density
2 severe decreases in radiographic density

2.11 Trabecular Pattern

-2 All trabeculae substantially coarser
-1 some coarser trabeculae; milder degrees
0 Within normal limits
1 Delicate finely meshed trabeculations
2 Granular, nearly homogenous patterns; individual Trabeculations essentially absent [13]

2.12 Graft Material And Its Use

Platelet-rich plasma (PRP) and hydroxyapatite crystals can be used in combination during a molar extraction to promote healing and regenerative processes in the jawbone. PRP contains growth factors that stimulate healing and reduce inflammation, while hydroxyapatite crystals are a form of synthetic bone replacement that can be used to fill any defects created by the extraction. The use of these materials helps to maintain the integrity of the jawbone and prevent bone resorption after the extraction. However, the specific use of PRP and hydroxyapatite crystals depends on the individual case

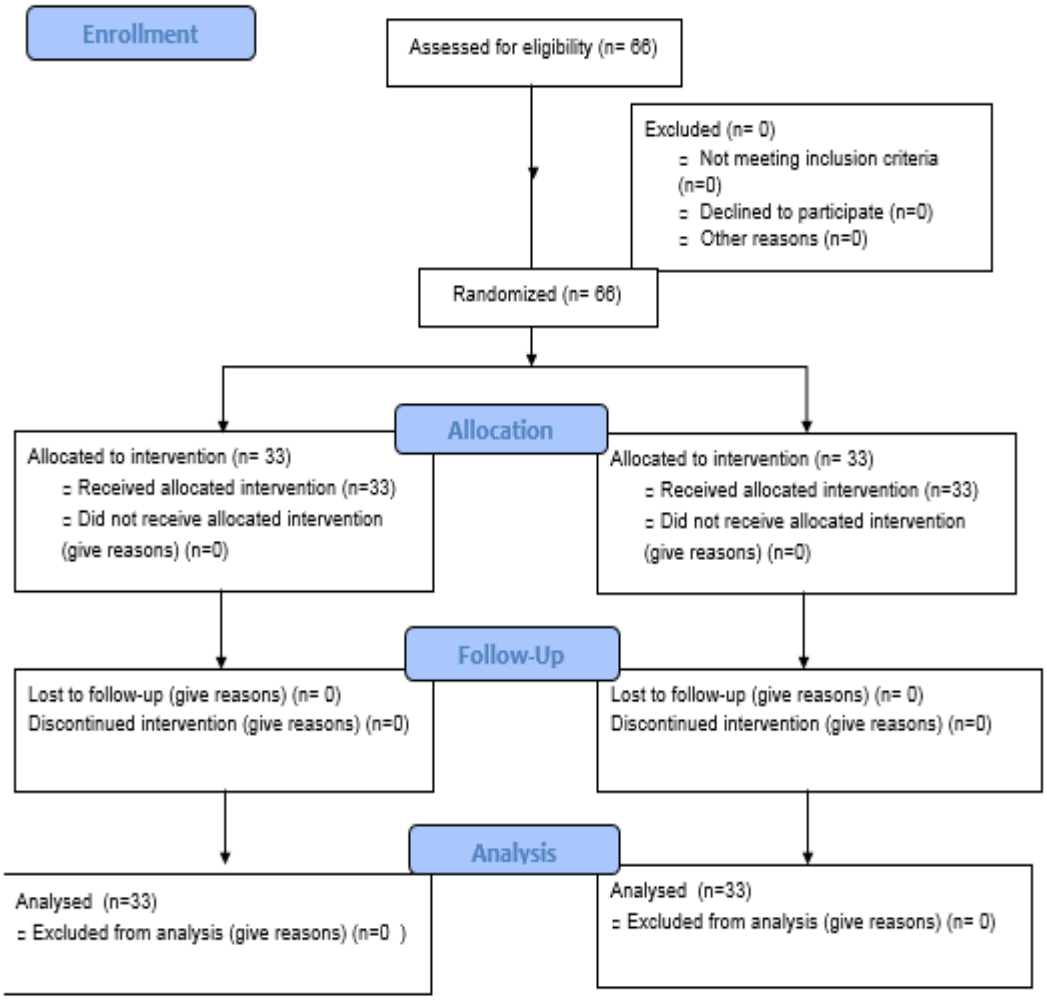

Fig 1 CONSORT 2010 Flow Diagram

3. RESULTS

Sixty six patients aged 19 to 45 (mean 37.8) years; including 40 females and 26 males completed the study. Each patient had single tooth extraction. The mean lamina dura scores at the 4th week in group I & group II 4.333 and 3.636 respectively (table 1),

Table 1: Comparison Of Lamina Dura Formation At 4th Week Between Groups

LAMINA DURA	SCORE	GROUP I	GROUP II	TOTAL
IN 4TH WEEK	+ 2	0	0	0
	+ 1	0	0	0
	0	0	0	0
	-1	11	9	20
	-2	12	6	18
	$X^2 = 4.486$	df=2	p=0.002	

Table 1 compares the lamina dura formation at the fourth week between the groups and its showing a p value of 0.02 which is statistically significant

10th week 3.545 and 3.091 (table 2) respectively. the mean trabecular pattern in 4th week 4.364 ,3.182 (table 3) respectively in 10th week 3.424 ,3.030 respectively (table 4) ,the mean overall density in 4th week 4.242, 3.545 (table 5) respectively in 10th week 3.485 and 2.545 (table 6) respectively:The age wise distribution is tabled below(Table 7)

Table 2: Comparison Of Lamina Dura Formation At 10th Week Between Groups				
LAMINA DURA	SCORE	GROUP I	GROUP II	TOTAL
IN 10TH WEEK	+ 2	4	8	12
	+ 1	0	0	0
	0	11	15	26
	-1	14	9	23
	-2	4	1	5
X^2 = 4.836 df=3 p=0.031				

Table 3: Comparison Of Trabecular Pattern Appearance At 4th Week Between Groups				
TRABECULAR PATTERN	SCORE	GROUP I	GROUP II	TOTAL
4TH WEEK	+ 2	0	6	6
	+ 1	0	0	0
	0	3	15	18
	-1	15	12	27
	-2	15	0	15
X^2 = 29.333 df=3 p=0.000				

The mean trabecular pattern in 4th week 4.364 ,3.182 (table 3)

Table 4: Comparison Of Trabecular Pattern Appearance At 10th Week Between Groups				
TRABECULAR PATTERN	SCORE	GROUP I	GROUP II	TOTAL
10TH WEEK	+ 2	0	7	7
	+ 1	0	0	0
	0	19	18	37
	-1	14	8	22
	-2	0	0	0
X^2 = 8.663 df=2 p=0.010				

Table 5: Comparison Of Bone Density At 4th Week Between Groups				
OVERALL DENSITY	SCORE	GROUP I	GROUP II	TOTAL
4TH WEEK	+ 2	0	0	0
	+ 1	0	0	0
	0	3	16	19
	-1	19	16	35
	-2	11	1	12
X^2 = 17.485 df=2 p=0.000				

The table 5 is showing the bone density between the groups at the fourth week and the difference is significant (p value of 0.000

Table 6: Comparison Of Bone Density At 10th Week Between Groups				
OVERALL DENSITY	SCORE	GROUP I	GROUP II	TOTAL
10TH WEEK	+ 2	0	16	16
	+ 1	0	0	0
	0	17	16	33
	-1	16	1	17
	-2	0	0	0
X^2 = 29.266 df=2 p=0.000				

The table 6 is showing the bone density between the groups at the tenth week and the difference is significant (p value of 0.000

TABLE 7: AGE DISTRIBUTION		
SEX	GROUP I	GROUP II
MALE	31	30
FEMALE	2	3

Fig 2 showing the response of PRP in first molar extraction

however, the difference was statistically significant that summarizes the mean bone scores for lamina dura, overall density and trabecular pattern at different periods in both groups, showing slightly lower scores in the group II. Which denotes bone formation was good in group II. Based on the information provided in tables above , the study is comparing the effects of a treatment (PRF gel with HA nanocrystals) on lamina dura formation, trabecular pattern, and overall density in two groups (group I and group II) at different time points (4th week and 10th week). The results show that the treatment is effective in promoting bone formation and reducing bone resorption, as evidenced by higher mean scores for lamina dura, trabecular pattern, and overall density in group I (the group that received the treatment) compared to group II at both the 4th and 10th weeks. Facial swelling after a first molar extraction can occur due to various reasons such as trauma to the soft tissue, bleeding, or infection. The use of platelet-rich plasma (PRP) injection before the extraction procedure may aid in reducing swelling and improving the healing of the soft tissues. PRP contains growth factors that promote tissue healing and reduce inflammation. However, it is important to follow proper post-operative care instructions given by the dentist to minimize swelling and ensure proper healing.

4. DISCUSSION

The aim of the study was to evaluate extraction socket healing using autologous platelet rich fibrin (PRF with HA) both clinically and radiographically. The hypothesis that PRF will accelerate socket wound healing after tooth extraction, appreciated by increased bone fill and reduced bone resorption was accepted. [18, 13, 27] The scores for lamina dura, trabecular pattern, and bone density were better among patients in the group II, this difference was statistically Significant.[9,6,28] Sammartino et al established that PRF with HA induced increased bone formation in extraction sockets as evidenced by improved clinical attachment level. Similarly, Choi et al showed in an earlier study a concentration-dependent increase in viability and proliferation of alveolar bone cells in a canine model.[9, 25, 3] It is noteworthy that higher lamina dura scores were observed at the fourth week in the PRF&HA group II compared with the non-PRF&HA group I and this continued throughout the evaluation period, suggesting faster and enhanced bone healing in the PRP group. However, this finding should be interpreted with caution because the difference was not statistically significant. It is instructive that difference was shown in mean overall lamina dura, bone density and trabecular pattern at the 4th and 10th weeks for both groups. [4, 17] In addition, comparison between the proportions of the ridge width among the test and control groups showed that there was a statistically significant difference from tooth extraction to 4 weeks and 10 weeks among the two groups, again signifying the impact of using PRF [16, 7, 21]. It is suggested that incorporation of PRF increases the efficiency of cell proliferation. In addition, platelets in the PRF undergo degranulation (He and Lin, 2009) (6)providing a sustained release of growth factors [platelet derived growth factors (PDGF), vascular endothelial growth factor(VEGF), epidermal growth factor (EGF), thrombospondin (TSP-1), transforming growth factor-beta (TGF-b)] influencing angiogenesis, epithelialization, stem cell trapping and immune control (Boyapati and Wang, 2006; Mazor and Horowitz, 2009; Gurbuzer and Pikdoken, 2010)[22]. This provides major elements for accelerated bone healing in the presence of PRF.Traditionally, different alveolar ridge preservation techniques have been used, most of which include the placement of graft material into extraction sockets (Froum and Cho, 2002; Vance and Greenwell, 2004)[30]. Use of grafts for socket preservation increases the treatment cost as well as the risk of disease transmission. In addition, the graft is not totally incorporated into the newly formed bone and when compared to sites without graft, they show less vital bone formation (Norton and Wilson, 2002) [29]. In addition, in the present study socket occlusion with a PRF membrane was utilized in a flap- less manner for ridge preservation. According to Kotsakis and Chrepa (2014) [23], flap advancement for primary closure in ridge

preservation interventions may lead to repositioning of the mucogingival junction, displacement of the keratinized mucosa, and ridge resorption. Fickl and Zuhr (2008)[13] studied tissue alterations after tooth extraction with and without surgical trauma on beagle dogs at 4 months. The authors (Fickland Zuhr, 2008) [27] reported that leaving the periosteum in place decreases the resorption rate of the extraction sockets. More- over, in a similar study, (Yelamali and Saikrishna, 2015) [5,16]mean values of bone density for PRF groups were significantly higher as compared to PRP groups at four months follow up. The present study showed the efficacy of autologous PRF in the healing of extraction sockets. These results are consistent with study by Hauser and Gaydarov (2013) [12] who reported (0.48%) of alveolar bone loss in extraction sockets with PRF without flap elevation compared with (3.68%) in control group at 8 weeks follow up. The authors also reported that microcomputed tomographic analysis showed significantly improved microarchitecture and significantly higher bone quality in the PRF group. Similarly in the present study, radiographic data showed statistically significant difference between test and control groups at one, four and eight weeks respectively, with a significant advantage in the test (PRF) group. Interestingly in the present study, significant differences were observed in alveolar ridge width proportions among test and control groups for observations between baseline to 4 and 8 weeks respectively. Similar findings were reported in the study by Simon et al., (Simon and Gupta, 2011) [23, 9, 11] showing a mean width socket resorption of 0.57 mm (7.38%) with PRF after4 months and confirmed a significant advantage in the preservation of post extraction alveolar ridge dimensions with the use of PRF. Choukroun and Diss (2006) [11] indicated that when a PRF membrane is used, new blood vessels are generated and epithelialization is promoted. Consequently, this facilitates more rapid wound coverage. Also, after a cystic lesion is removed and filled with PRF, the time it takes to be replaced naturally with new bone was after 2.5 months. Similarly, in a study by Simon and Von Hagen (2000) [12]during morphometric tissue experiment in which they planned a socket preservation surgery showed new bone generated in only 3 weeks when the preservation procedure was conducted by using PRF only. Recently, studies have compared the efficacy of multiple graft materials along with bioabsorbable membranes on alveolar bone healing (Iasella and Greenwell, 2003) [19]. A study using freeze-dried bone allografts and collagen membrane showed a mean net loss of 1.2 mm (13.04%) of preoperative alveolar width at 4 months follow up (Iasella and Greenwell, 2003) [30,12]. Similarly Lekovic and Camargo (1998)[21]reported 1.31 mm (17.79%) mean net loss of alveolar width after 4 months of healing when polygalactide/polylactide membrane was used for ridge preservation. These findings are comparable to the present study findings; however the use of available bioabsorbable membranes is associated with a high rate of (upto 25%) membrane exposure, impacting the amount of bone infill within the socket.

5. CONCLUSION

The effectiveness of PRF gel with HA nanocrystals as an aid in ridge preservation for implant placement following extraction of mandiblular 1st molar was significant. But it is recommended that further studies with improved materials and techniques comparing the efficacy of PRF and bioabsorbable membranes are undertaken to assess their comparative clinical efficacy in extraction socket preservations. In addition, a possible limitation of the study was the short follow-up of the socket healing, which was only 8 weeks. Therefore, further long-term studies with improved patients follow up are warranted. From a clinical perspective, the use of autologous PRF in the healing sockets (extraction sites) and surgical sites is recommended to improve bone healing and minimize resorption.

6. AUTHOR CONTRIBUTION STATEMENT

Concept .design and supervision done by Bharathi.S, Sathyanarayanan, Manuscript and communication done by Venugopalan.V, Data collection and analyses done by RaghuK, Saileshkumar.R, Raja Sethupathy cheeman

7. CONFLICT OF INTEREST

Conflict of interest declared none.

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