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COMPARATIVE STUDY OF BONE FORMATION AROUND THE IMPLANT SURFACE FOLLOWING SIMULTANEOUS SINUS MEMBRANE ELEVATION AND IMPLANT PLACEMENT WITH AND WITHOUT PLATELET RICH FIBRIN

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ABSTRACT:

INTRODUCTION: Rehabilitation of edentulous posterior maxilla with short implants or by using bone grafts have always been a challenging task since last two decades in the field of Oral and Maxillofacial Surgery. Recent studies have shown that the lifting of the maxillary sinus membrane in atrophic posterior maxilla and simultaneous implant placement without any grafts have resulted in bone formation in sub antral space. There are studies regarding the use of Choukron's platelet rich fibrin as the sole grafting material below the sinus floor and immediate implant placement leading to bone formation in the peri-implant region.

PURPOSE OF THE STUDY: This study was conducted to show that, direct sinus membrane elevation of the maxillary sinus membrane and simultaneous implant placement without any graft resulted in bone formation in the sinus floor. This study compares and evaluates the bone formation with the help of Cone Beam CT Scan (CBCT) in the sinus floor following direct sinus membrane elevation and simultaneous implant placement without using any graft material and with platelet rich fibrin as the sole graft.

MATERIALS AND METHODS: 48 patients who fulfil the inclusion criteria were divided into 2 groups as Group I- direct sinus membrane elevation and simultaneous implant placement without any graft and evaluated radiographically using CBCT. Group II- direct sinus membrane elevation and simultaneous implant placement along with PRF as sole graft and evaluated radiographically using CBCT.

RESULTS: Unpaired t test was used where we compared p value with the level of significance. On comparing the peri-implant bone density in Hounsefield units, the peri-implant bone density was more in group 2 which was statistically significant ($p<0.05$).

CONCLUSION: PRF has proved to be a valuable autologous augmenting material in direct sinus membrane elevation and simultaneous implant placement in edentulous posterior maxilla.

KEYWORDS: Direct Sinus Membrane Elevation, Atrophic Maxilla, Without Graft, Immediate Placement, Platelet Rich Fibrin, Hounsefield Unit.

INTRODUCTION:

Restoring functional occlusion in edentulous posterior maxilla has always been an onerous challenge in the field of Implant Dentistry. The propinquity of the

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maxillary sinus and the alveolar bone below and its tendency to pneumatise inferiorly reduces the height of the available residual bone. Patients having to part with their molars or premolars at a younger age who never underwent any rehabilitating measures or those groups of aged individuals, who have become completely or partially edentulous in the maxillary alveolar region, also tend to have reduced alveolar bone height. A decrease in residual bone height (RBH) will directly affect the post-operative implant stability. Bone augmentation procedures like grafting bone blocks and sinus lift procedures have made the challenge of attaining acceptable implant stability more facile. Linkow in 1960s reported placement of blade vent implants following maxillary sinus membrane elevation when the RBH 7mm.[1] Sub-antral augmentation with autogenous bone graft is considered to best treatment option when adequate RBH is unavailable, but the requisite for an additional surgery through a harvesting procedure increase risk of post-operative complications. More over recent studies have shown that using grafts for bone augmentation was not always necessary. A mere elevation of sinus membrane and subsequent implant placement without grafting also resulted in bone formation around the implants and below the membrane.[2] Such a possibility is attributed to the osteogenic potential of the maxillary sinus membrane and reparative property of the growth factors emancipated from the blood clot (platelets) that fill up the space between new sinus floor and the bone below. PRF, which is similar to a blood clot in many ways, acts like one too. PRF membrane traps at least 95% of the platelets of the collected blood, allowing for the natural release of several growth factors (GFs) to the surgical area which stimulates the replication of progenitors of fibroblasts and endothelial cells in addition to production of fibronectin.[3,4] It also induces osteoconduction and promotes the production of hyaluronic acid which is an essential component for wound contraction and remodelling. Furthermore the architecture of PRF is quite unique which fosters enough platelets for a long term release of growth factors.[5]

Density of the bone formed during the healing period can be measured in terms of Hounsfield units by measuring the attenuation coefficients on the cone beam computed tomography (CBCT). Norton et.al demonstrated a scale to evaluate the bone density of a region and concluded that and HU of 600 and above implied formation of very dense cortical bone. Values in between 400 and 600 HU signified presence of a lower density bone but with a consistency in between cortical and spongy. HU of 200 and below reveals more of spongy bone formation.[6,7]

In this study we are evaluating and comparing height and maturation of bone achieved in peri-implant region in atrophic posterior maxilla where direct sinus membrane elevation procedure was required with simultaneous implant

placement and use of PRF as the sole graft material in subantral space and in cases without any graft and simultaneous implant placed in sub antral space and evaluating radiographically using CBCT using NNT viewer software with the help of Hounsefield Units.

MATERIALS AND METHODS:

A total of 48 patients who fulfil the inclusion criteria were divided into two groups where Group I consisted of 28 patients (18 male & 10 female) who underwent maxillary sinus elevation and simultaneous implant placement without any graft material and 20 patients in Group II where maxillary sinus elevation and simultaneous implant placement were performed with PRF as the sole grafting material. ***An Informed consent was obtained from all patients who were willing to participate in the study.*** All cases were followed up for 24 months with 6 months interval and CBCTs were advised during each follow-up. Patients that were included in this study were those who were interested for fixed prosthetic rehabilitation in posterior atrophic maxilla with a minimum alveolar bone height of 4 to 6mm. Patients with a RBH of greater than 6mm, medically compromised patients, chronic smokers and patients with sinus pathology contraindicating implant placement were excluded.

A direct sinus approach was carried out through a bony window created in the lateral wall of the maxillary sinus. The size of the window varied according to the number of implants that had to be placed but it was kept as small as possible to protect the osteogenic potential of the sinus cavity. In Group I cases an appropriate size implant was selected and placed in atrophic posterior maxilla and flap was closed without using any graft material. In Group II cases two PRF concentrates were prepared adhering to the standard protocols. One was placed in the sub-antral space created following sinus elevation and appropriate sized implants were selected and placed. The second PRF concentrate was placed around the peri-implant surface in the sub-antral space. A total of 50 implants were placed in group I&II. CBCTs were taken post-operatively at an interval of every 6 months for 2 years (6, 12, 18 and 24 months). The peri-implant bone formation was assessed on the CBCT using NNT viewer software in terms of Hounsfield Units (HU) on Buccal and Lingual side.

RESULTS:

In Group I patients, Mean Hounsfield Units on the Buccal side were measured at 6, 12, 18 and 24 months was found to be -21.14, 117.21, 271 and 384.89 respectively. Mean Hounsfield units on the Lingual side during the same intervals were 20.21, 228.46, 335.29 and 397.89***(Table 1 and 3)***. Similarly in Group II, Hounsfield units were measured to be 146.41, 192.77, 354.68 and 458.77 on the Buccal side and 235.18, 350.27, 452.41 and 625.77 on the Lingual side ***(Table 2 and 4)***. On comparing both the groups, Group II had a significantly higher HU than

Group I *(p<0.05)* suggestive of D3 bone formation in the peri-implant- sub antral region according to Misch.[8]

DISCUSSION:

Ziv Mazor et.al found that, PRF, when placed as the only grafting material after the elevation of the Schneiderian membrane, managed to regenerate naturally, a satisfactory amount of bone around the protruding portion of the implant in the sub-antral space created. This was verified radiographically as the sinus floor was in continuation with the end of the implant.[9] Calcified bone substitutes even though it appears dense radiographically, clinically it was still fragile. This proves that bone formation beginning from the PRF matrix showed a stronger architecture when compared to other calcified bone substitutes. Radiological analyses in such circumstances are useless. Antoine Diss et.al concluded that PRF when used as a grafting material generated quite an amount of bone within a period of 2 to 3 months which could resist a torque of 25 N-cm applied when the abutment is being tightened. Radiologic evidence of bone formation between the implant and the sinus floor led to a predictable implant function.[10] Our study also delineates that within 18 months of post-operative period a considerable amount of bone was seen to form around the implant in the created sub-antral space in both with PRF augmented and non PRF cases, but bone density was found to be more in PRF augmented cases.

Promising results were seen in a systematic review by Sherif Ali on Platelet rich fibrin when used as the only graft material following sinus lift and simultaneous implant placement showed promising results. They also found that though the Schniderian membrane has osteogenic potential of its own, the maturation of the de novo bone formed in the peri-implant region was accelerated when augmented with PRF. Qi Li et.al documented that PRF, apart from being a regenerative scaffold it has progenitor-specific mechanisms that aid in formation of soft and hard tissue. Their studies have shown that PRF improves differentiation of both osteogenic and periodontal progenitors with a higher inclination towards enhancement of the former[12]

G C Rajkumar et al in 2013 conducted a study to evaluate the changes in alveolar bone height after direct elevation of maxillary sinus membrane and simultaneous implant placement in the posterior edentulous maxilla. They concluded that, placement of endosseous implants in the atrophic posterior maxilla in conjunction with sinus elevation without any grafting resulted in a significant amount bone formation around the implants at the sinus floor.[7] In our present study a total of 50 implants were placed in 48 patients and qualitative evaluation of bone formation was assessed using CBCT which revealed peri-implant bone formation. Group 1 patients, in whom no grafts were used showed bone formation in the sub-antral

space with HU measured to be corresponding to D4 quality of bone where as in Group II, the bone formation measured in HU were similar to bone with D3 quality. In one particular case in Group II where sinus membrane thickening was noted, the HU measured during one week post-operative period (282 HU) was subtracted from the HU measured during the 6th and 12th month intervals. But during the 18th month follow up the sinus membrane appeared normal and therefore these reading were recorded as such.

In our study the effects of age and systemic conditions were also visible, where we observed a better quantity and quality of bone in younger population post-operatively while the bone formed in a patient with diabetes was found to be of inferior quality when compared to the other participants.

CONCLUSION:

With the advent of platelet rich fibrin (PRF), the daunting task of rehabilitation of edentulous residual ridges especially the posterior maxilla has become facile. Introduction of PRF has also reduced the chance of donor site morbidity when autologous bone grafts are harvested. PRF is an excellent reservoir of growth factors with almost no complications because of its autologous nature. It also possesses antimicrobial properties which enhance its clinical importance. Though, the preparation of appropriate quality of autologous platelet rich fibrin requires meticulous and standardised procedures, they are easy to adopt, cost effective and can be readily carried out by a trained professional. Implant placement in the posterior maxillary region can be done simultaneously in conjunction with direct sinus membrane elevation technique without using any grafts, but with the use of platelet rich fibrin, a better quality of D3 bone in the peri-implant region within a span of 18-24 months can be achieved without any undue complications when compared to D4 bone formation when no grafts are used for augmentation. It also showed good implant stability fit for permanent prosthetic rehabilitation owing to long-term implant survival.

However, further studies with larger population, longer duration of follow up and other factors like age, sex and systemic status, along with histomorphic assessment of the bone formation in the peri-implant region need to be carried out.

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TABLES:

Group I	6 months		12 months		18 months		24 months	
18 M & 10 F	Buccal	Lingual	Buccal	Lingual	Buccal	Lingual	Buccal	Lingual
Case 1	-11	27	102	237	302	287	357	369
Case 2	-23	26	120	241	214	321	353	367
Case 3	-13	21	117	245	305	312	392	356
Case 4	-16	23	108	223	313	360	421	439
Case 5	-19	27	96	191	319	323	385	371
Case 6	-20	26	113	235	285	361	334	359
Case 7	-25	25	136	225	232	323	391	347
Case 8	-31	27	102	251	323	345	442	368
Case 9	-15	15	126	243	314	345	413	469
Case 10	-19	13	137	225	233	355	432	448
Case 11	-14	18	115	221	303	323	351	363
Case 12	-17	27	125	239	251	334	345	357
Case 13	-13	20	113	211	244	313	414	456
Case 14	-31	24	106	253	293	355	431	467
Case 15	-20	11	98	213	198	344	322	344
Case 16	-12	12	111	232	312	364	353	333
Case 17	-23	22	134	229	243	353	342	360
Case 18	-15	24	112	246	323	323	414	461
Case 19	-16	18	124	233	251	331	435	452
Case 20	-21	17	131	228	254	323	422	464
Case 21	-20	14	112	213	241	314	353	346
Case 22	-12	12	122	228	289	347	341	366
Case 23	-34	23	115	218	314	359	354	370
Case 24	-56	26	132	229	242	327	435	451
Case 25	-21	18	121	253	253	336	353	366
Case 26	-29	17	95	195	182	313	432	475
Case 27	-27	14	127	229	323	354	419	468
Case 28	-19	19	132	211	232	343	341	349

Group I Direct sinus lift without any Bone Graft or PRF - Table 1

Group II	6 months		12 months		18 months		24 months	
13 M & 9 F	Buccal	Lingual	Buccal	Lingual	Buccal	Lingual	Buccal	Lingual
Case 1	132*	255*	259*	343*	393	454	479	629
Case 2	122	218	212	317	350	412	413	625
Case 3	143	242	220	341	326	432	487	612
Case 4	156	239	201	335	355	429	446	603
Case 5	143	243	191	293	401	417	465	626
Case 6	152	211	198	319	397	455	498	656
Case 7	167	224	185	311	338	444	457	618
Case 8	158	233	179	323	389	410	489	650
Case 9	144	253	186	334	329	498	467	600
Case 10	155	246	179	326	377	478	481	586
Case 11	171	259	184	352	368	454	457	607
Case 12	112	189	172	339	389	451	449	711
Case 13	135	252	209	349	330	401	445	678
Case 14	126	199	178	319	319	489	497	621
Case 15	135	226	180	345	312	445	465	601
Case 16	165	211	196	415	373	486	412	641
Case 17	151	222	179	399	389	432	464	584
Case 18	159	271	164	309	314	463	467	678
Case 19	144	256	193	413	316	451	471	610
Case 20	161	242	205	424	328	499	423	623
Case 21	141	259	178	387	317	494	415	597
Case 22	122	227	193	416	393	459	446	611

* Actual HU were subtracted from HU observed due to sinus thickening during 1 week post op which was calculated to be 282 HU. During 18 month post op, the sinus membrane appeared normal hence the HU calculated during 18 and 24 months were recorded as such.

Group II Direct Sinus lift with PRF as sole Graft Material - Table 2

Comparison of mean Hounsfield units of buccal side between groups - Table 3

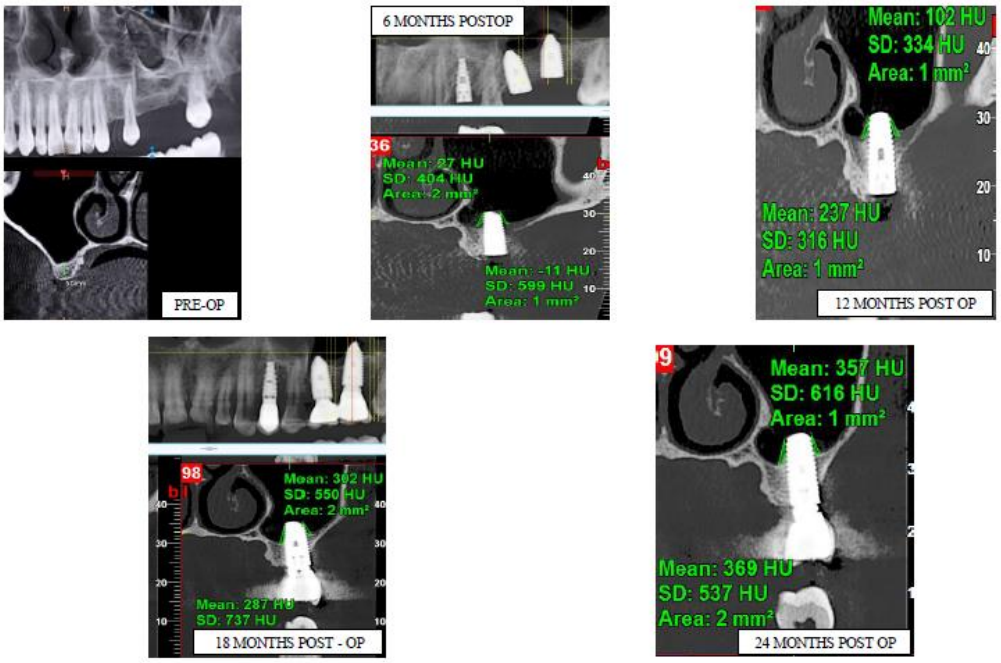
Group	6 months	12 months	18 months	24 months
Group I	-21.14	117.21	271	384.89
Group II	146.41	192.77	354.68	458.77
t-value	-45.66	-16.28	-7.71	-7.58
p-value	p <0.05	p <0.05	p <0.05	p <0.05

Comparison of mean Hounsfield units of lingual side between groups – Table 4

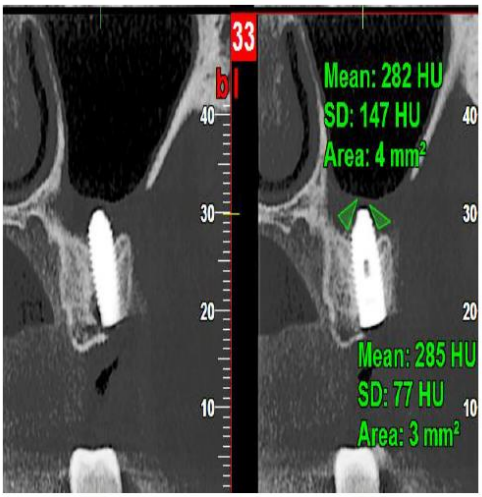
Group	6 months	12 months	18 months	24 months
Group I	20.21	228.46	335.29	397.89
Group II	235.18	350.27	452.41	625.77
t-value	-51.89	-14.79	-17.01	-18.22
p-value	p <0.05	p <0.05	p <0.05	p <0.05

FIGURES:

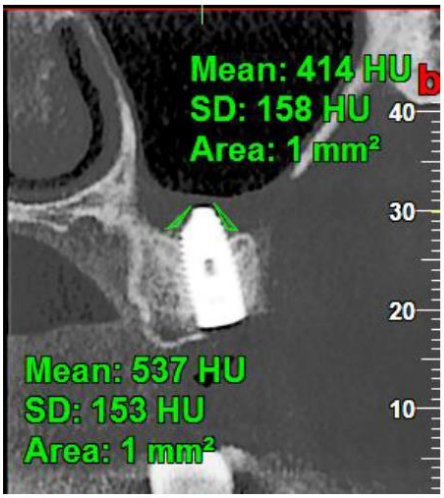
Group 1



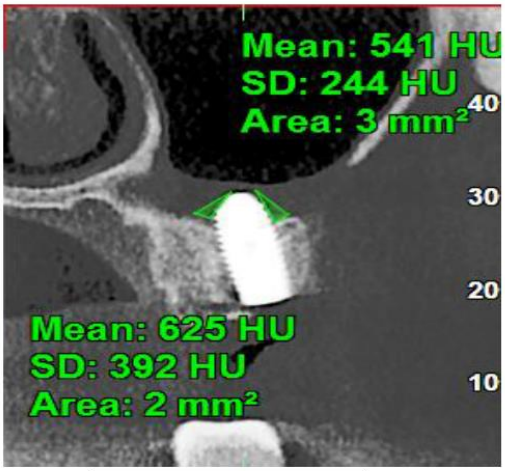
Group 2:



SINUS THICKENING



6 MONTHS POST OP



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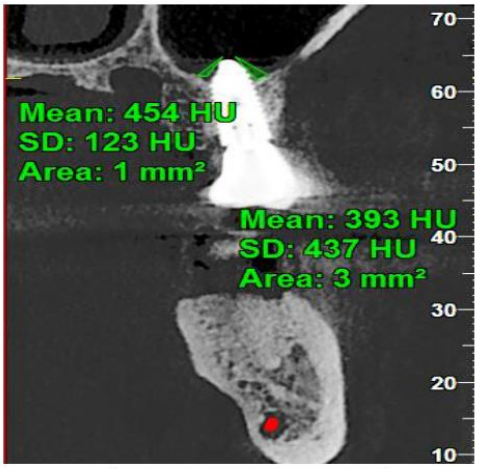
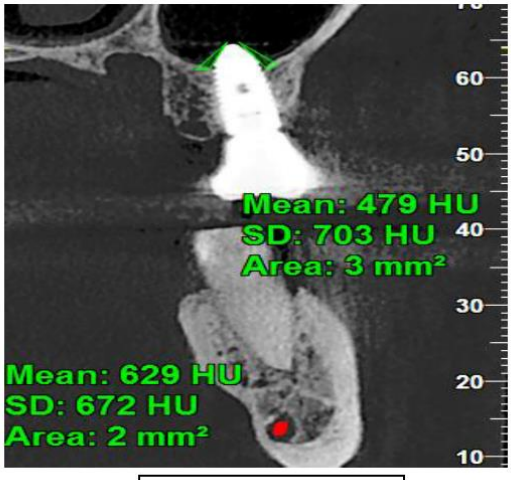


18 MONTHS POST OP



24 MONTHS POST OP