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A COMPARATIVE EVALUATION OF IMPLANTS STABILITY IN FRESHLY EXTRACTED SOCKETS VERSUS HEALED ALVEOLAR BONE: AN IN-VIVO STUDY

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ABSTRACT

Aim: To evaluate and compare the clinical outcome of single or multiple implant(s) which underwent placement in fresh sockets versus in the healed alveolar bone pertaining to the clinical site at different time intervals. **Materials and method**: The prospective study was conducted in Department of Prosthodontics & Crown and Bridge among 30 clinical cases requiring a single or multiple implants irrespective of gender. These patients were then, divided into two groups i.e. Group 1 and Group 2. In Group 1, 15 implants were placed in fresh sockets following standard two-stage procedure of implant placement. In Group 2, 15 implants were placed at healed alveolar bone following the same standard protocol. Evaluation and comparison of the implant stabilty was done using Insertion torque value (ITV) at baseline during placement. The effect on implant stability from baseline to 90 days and 180 days was done using Implant Stability Quotient (ISQ) by means of Resonance Frequency Analysis (RFA). The statistical tests used to compare for intergroup comparison was One-way ANOVA test and unpaired t-test while for intragroup comparison was Paired t-test. **Results**: One way Anova (F) test shows a statistically significant difference for Group 1 and 2 at different time intervals when compared for the RFA stability scores ($p<0.05$). A significant difference was present in RFA scores at different time intervals as well as in Insertion Torque Values (ITV) between fresh socket & healed alveolar bone. **Conclusion**: This study showed that Bioline Dental Implants could be effectively used for most of the patient situations encountered clinically ie. single or multiple tooth replacement in fresh sockets as well as healed alveolar bone.

KEYWORDS: Implant, Alveolar bone, RFA, Tooth replacement.

INTRODUCTION

Implant Dentistry is the second oldest discipline in dentistry, Exodontia being the first. It has emerged as "a fully accepted discipline" in dentistry.[1] The procedure of placement of an implant in a fresh extraction socket simplifies the treatment by performing a single surgical procedure, decreasing treatment time, minimizing shrinkage of hard tissue, minimizing soft tissue recession and taking advantage of the healing socket a success ranging from 92.7% to 98.0% (Pe-narrocha et al. 2004). Whereas, a healed socket provides a defect-less bone without any pathology or soft tissue interference thus, contributing to the success of the implant.[2]

Implant stability is mandatory for osseo-integration and implant success, an objective surrogate measure of primary stability is the specification of the applied torque (Ncm) during the progress of implant insertion. Reports in the scientific literature show that torque levels which are too low or too high can be associated with implant failure.[3] Resonance frequency analysis (RFA) offers a clinical, noninvasive measure of stability and presumed osseointegration of implants (Meredith et al. 1997a,b; Meredith 1998; Barewal et al. 2003) and is a useful tool to establish timing for implant loading (Uribe et al. 2005).[4]

Therefore, it is important to evaluate whether predictable results can also be obtained when loading dental implants in fresh as well as healed sockets in more critical situations. Hence, this study was undertaken to compare the stability of implants placed in fresh sockets and healed alveolar bone sites. The aim of the present study was to evaluate and compare the clinical outcome of single or multiple implant(s) which underwent placement in fresh sockets versus in the healed alveolar bone pertaining to the clinical site at different time intervals.

MATERIALS AND METHODOLOGY

The prospective study was conducted in Department of Prosthodontics & Crown and Bridge, Subharti Dental College, Meerut, Uttar Pradesh. Ethical clearance was obtained from the Ethical Committee of Swami Vivekanand Subharti University. A total of 30 clinical cases in patients requiring a single or multiple implants irrespective of gender were selected from the OPD of department according to the following inclusion and exclusion criteria i.e.

Inclusion criteria: The age of the patients must be between 18-60 years, patients having single or multiple tooth missing with adjacent and opposing teeth present, adjacent teeth intact; restored with functionally & aesthetically good restorations; restored with prosthesis precluding the addition of the missing tooth and patients with good periodontal and general health.

Exclusion criteria: Patients with history of smoking, active infection in site intended for implant placement, patients with psychoses or dental history of bruxism & parafunctional habits, systemic disease that compromise osseo-integration like uncontrolled diabetes, pregnancy lactating mother, patients on intravenous bisphosphonates and history of recent Radiotherapy.

These patients were then, divided into two groups i.e. Group 1 and Group 2. In Group 1, 15 implants were placed in fresh sockets following standard two-stage procedure of implant placement. In Group 2, 15 implants were placed at healed alveolar bone following the same standard protocol. Written consent was taken from the patient participating in the study.

As primary implant stability is mandatory for osseo-integration and implant success, an objective surrogate measure of primary stability was performed (as is the specification of the applied torque (Ncm) during the progress of implant insertion) in all 15 cases of Group 1 and Group 2 respectively. Thus, evaluation and comparison of the implant stabilty in fresh sockets and healed alveolar bone of single or multiple implant(s) was done using Insertion torque value (ITV) at baseline during placement. Also, the effect on implant stability in fresh sockets and healed alveolar bone of single or multiple implant(s) from baseline to 90 days and 180 days using Implant Stability Quotient (ISQ) by means of Resonance Frequency Analysis (RFA) was evaluated and compared as per standard protocol.

Diagnosis and Examination: It includes diagnostic instruments (API, India), OPG (PaX-400 C, Vatech Global, Korea), Cone Beam Computed Tomography (Galileos-Sirona, CS 9300 Scanner), Resonance Frequency Analyser (Osstell ISQ), impression trays (S.S. White Dental Mfg. Co., U.S.A.), Irreversible Hydrocolloid Impression Material (Plastalgin, Septodont, France), Dental Stone (Type III, Kalabhai, India), Dental Stone (Type IV, Ultrarock, Kalabhai), Transparent Autopolymerising Acrylic Resin Powder and Liquid (DPI, India) and Cold Mould Seal (DPI, India).

Surgical equipments: required were implants of various sizes (Bioline Spiral Connie Implant®, Germany), physiodispenser (Surgic Pro NSK), Bard Parker Handle with Blade no. 12/15 (API, India), Local Anaesthetic Agent (Lignox, Indoco remedies Ltd., India), Periosteal Elevator (Hu-Friedy, U.S.A.), Surgical Drills (Bioline Spiral Connie Implant®, Germany), Resonance Frequency Analyser (Osstell ISQ), Definitive Abutment Hexed (Bioline Spiral Connie Implant®, Germany), Needle Holder (GDC, India) and Vicryl Sutures (3-0, 4-0, Ethicon, Johnson & Johnson Ltd.).

Assessment of Implant Site: Pre-operative analysis of surgical site was done clinically and by using an OPG. Pre-operative radiographical assessment included Intra-Oral Periapical Radiographs (using iopa's or rvg's) and Cone Beam Computed Tomography (CBCT) Scans together with clinical inspections were used to determine bone volumes and anatomic landmarks.

Diagnostic impressions were made of maxillary and mandibular arch using irreversible hydrocolloid material (Plastalgin, Septodont, France) and casts were made using dental stone (Type III). The following parameters were assessed from the diagnostic models:

1. Length of Edentulous Span (Mesiodistal and Buccolingual Width).
2. Interocclusal Distance.

Pre-Surgical Care: The patient was put on antibiotic therapy i.e. 500mg amoxicillin+125mg clavulanate potassium (Augmentin 625 mg Duo, GalaxoSmithKline) 24 hours prior to surgery which were to be continued 5 days post-surgery.

Surgical Procedure: The surgical site was prepared following surgical protocol and was anesthetized using 2% lignocaine hydrochloride with epinephrine (1:200,000). For Group 1, the tooth is extracted and the implant is placed in the bone. For Group 2, a full thickness mucoperiosteal flap was raised at the site of implant placement. Following elevation of flap, surgical stent was placed at the site of implant placement and optimal implant location was then marked using a surgical round bur with the guidance of surgical

template. The implant was placed into the osteotomy site 0.5mm-1mm subcrestally as the implant collar is not polished. The site was sutured using (4-0 Vicryl Ethicon, Johnson & Johnson).

Prosthetic Phase for Definitive Prosthesis
In GROUP 1: The 2nd stage surgery was performed after 180 days of implant placement.
In GROUP 2: The 2nd stage surgery was performed after 150-180 days of implant placement.

Then these same steps were done in both the groups. The cover screw was removed and a healing abutment was placed for a period of 4-5 days for the appropriate gingival contouring. For final impression the healing abutment was removed and the impression coping was tightened over the implant. Following this an implant level impression was made using Vinyl Polysiloxane Addition silicone-Putty & Light body (3M ESPE). The transfer coping was removed and implant analog was attached to it. Healing abutment was placed back in the patient's mouth. Abutments were also removed 3 more times: at the time of metal framework and bisque try-in and at the delivery of the final restoration. The prosthesis was cemented using Zinc Phosphate cement as it is most bio-compatible with the adjoining soft tissues. Hence, there was total 6 times abutment dis/reconnection for delivery of the final restoration by the standard protocol.

Evaluation and Assessment of Implant Stability: The implant stability evaluation was done in group 1 and 2 using standard protocol measures as mentioned in the literature by means of clinical parameters based on :-
(a) Insertion Torque Value (ITV) at Baseline during Placement ie. T1.
(b) Implant Stability Quotient (ISQ) by means of Resonance Frequency Analysis (RFA) i.e. T1, T2 and T3 (Figure 1, 2 and 3).

Statistical analysis
Statistical analysis was carried out using SPSS (statistical package for social sciences) software version 21.0. The data regarding the radiographic and clinical parameters i.e. stability of implants in freshly extracted sockets and healed alveolar site were recorded at baseline, 90 days and 180 days was tabulated and subjected to statistical analyses.

All the values were expressed in the form of mean and standard deviation. The statistical tests used to compare for intergroup comparison was One-way ANOVA test and unpaired t-test while for intragroup comparison was Paired t-test.

RESULTS
Insertion torque value (ITV) is higher in group 2 (52.67) as compared to Group 1 (45.67). The mean difference of ITV between Group 1 and Group 2 was found to be 7.00 (table 1).

Table 2, graph 1 represents the average scores of RFA in Group 1 (fresh socket) at base line, at 90 days & at 180 days respectively. It is evident that average RFA score is maximum at 180 days (76.73) followed by 90 days (72.60) & at base line (60.07) respectively. Also the difference in RFA score was maximum between base line and 180 days (16.67) followed by baseline and at 90 days (12.53).

Table 3, graph 1 represents the average scores of RFA in Group 2 (healed socket) at base line, at 90 days & at 180 days respectively. It is evident that average RFA score is maximum at 180 days (86.47) followed by 90 days (77.87) & at base line (68.33) respectively. Also the difference in RFA score was maximum between base line and 180 days (18.13) followed by baseline and at 90 days (9.53).

Table 4 shows the intragroup comparison of RFA scores between different time intervals in fresh socket & healed alveolar bone (by Paired "t" test). It is evident that RFA scores differed significantly between base line - 90 days and between baseline to 180 days in both groups ($p<0.05$). However, no significant difference was present between 90 days - 180 days for fresh socket as $p>0.05$. One way Anova (F) test shows a statistically significant difference for Group 1 and 2 at different time intervals when compared for the RFA stability scores ($p<0.05$).

Table 5 represents the intergroup comparison in RFA scores between fresh socket & healed alveolar bone (Unpaired "t" test). It shows that a significant difference was present in RFA scores at different time intervals as well as in Insertion Torque Values (ITV) between fresh socket & healed alveolar bone.

Table 1: Mean ITV scores and their differences at baseline of group 1 and 2.

S.NO.	Insertion Torque Value (ITV)		Difference B/W
	Group 1	Group 2	Group 1 - Group 2
1	40	50	10
2	40	55	15
3	45	55	10
4	50	55	5
5	45	45	0
6	40	50	10
7	45	55	10
8	45	55	10
9	55	50	-5
10	50	55	5
11	50	60	10
12	45	60	15
13	50	50	0
14	40	45	5
15	45	50	5
Mean	**45.67**	**52.67**	**7.00**
S.D.	**4.58**	**4.58**	**5.61**
Max.	**55**	**60**	**15**
Min.	**40**	**45**	**-5**

Table 2: Mean RFA scores and their differences at different time intervals for fresh sockets.

S.No.	RFA Scores (Fresh Socket)			Differences		
	At Baseline (T1)	**At 90 days (T2)**	**At 180 days (T3)**	**Baseline- 90 Days**	**90 Days-180 Days**	**Baseline-180 Days**
1	59	71	79	12	8	20
2	55	65	74	10	9	19
3	56	85	94	29	9	38
4	65	71	79	6	8	14
5	59	71	74	12	3	15
6	49	85	71	36	-14	22
7	62	71	79	9	8	17
8	62	71	79	9	8	17
9	74	75	85	1	10	11
10	62	71	79	9	8	17
11	59	71	75	12	4	16
12	47	65	47	18	-18	0
13	62	72	79	10	7	17
14	59	65	72	6	7	13
15	71	80	85	9	5	14
Mean	**60.07**	**72.60**	**76.73**	**12.53**	**4.13**	**16.67**
S.D.	**7.04**	**6.32**	**10.08**	**9.00**	**8.43**	**7.75**
Max.	**74**	**85**	**94**	**36**	**10**	**38**
Min.	**47**	**65**	**47**	**1**	**-18**	**0**

Table 3: Mean RFA scores and their differences at different time intervals for healed sockets.

S.No.	RFA Scores (Healed Socket)			Differences		
	At Baseline (T1)	At 90 days (T2)	At 180 Days (T3)	Baseline- 90 Days	90 Days- 180 Days	Baseline- 180 Days
1	59	68	74	9	6	15
2	68	74	94	6	20	26
3	66	71	74	5	3	8
4	75	76	79	1	3	4
5	60	75	94	15	19	34
6	60	74	79	14	5	19
7	71	79	94	8	15	23
8	74	79	85	5	6	11
9	59	74	75	15	1	16
10	71	79	85	8	6	14
11	75	85	94	10	9	19
12	79	85	95	6	10	16
13	59	79	85	20	6	26
14	75	85	95	10	10	20
15	74	85	95	11	10	21
Mean	**68.33**	**77.87**	**86.47**	**9.53**	**8.60**	**18.13**
S.D.	**7.23**	**5.41**	**8.48**	**4.90**	**5.64**	**7.57**
Max.	**79**	**85**	**95**	**20**	**20**	**34**
Min.	**59**	**68**	**74**	**1**	**1**	**4**

Table 4: Comparison of RFA scores at different time intervals in fresh & healed socket.

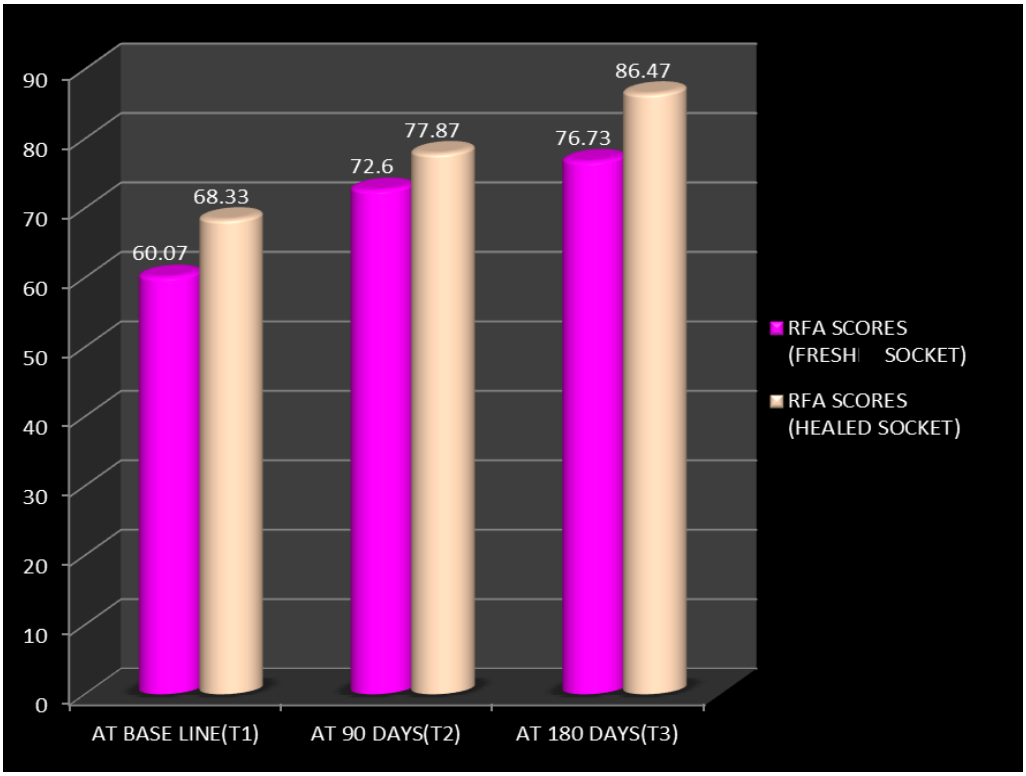
S.No.	Pair Of Time Intervals	Probable Values Of Paired "T" Test In RFA Scores	
		For Fresh Socket	For Healed Socket
1	Baseline-90 Days	.0004*	<0.01*
2	90 Days-180 Days	.0732	<0.01*
3	Base Line-180 Days	<0.01*	.0002*
	Anova test	17.74	24.15
	p value	<0.01*	<0.01*

*: statistically significant

Table 5: Comparison of RFA and ITV scores between fresh & healed sockets at different time intervals.

S.No.	Variables	Probable values of unpaired "t" test in RFA scores between groups		
		At base line	At 90 days	At 180 days
1	RFA Scores	.004*	.02*	.008*
2	Insertion Torque Value (ITV)	.0003*		

*: statistically significant



Graph 1: RFA scores in fresh socket & healed alveolar bone group.

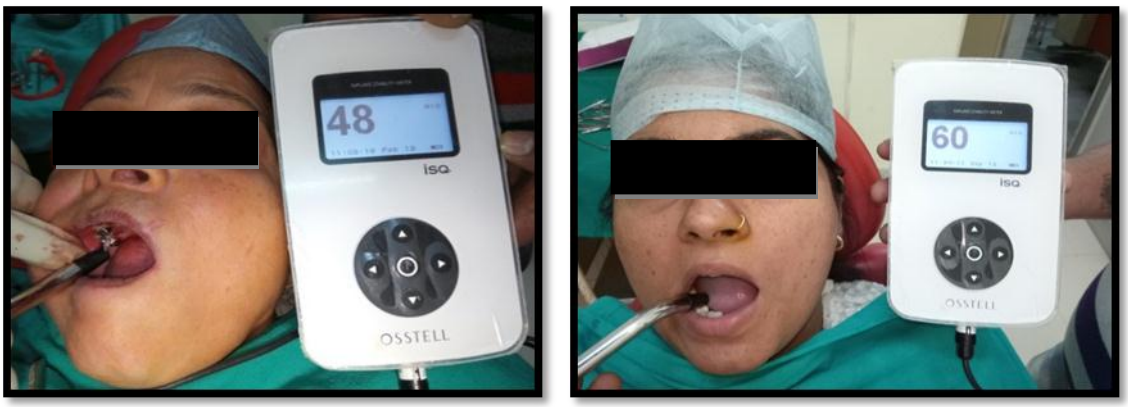


Fig. 1: RFA score at Baseline (T1) in Group 1 and Group 2.

Fig. 2: RFA score at 90 days (T2) in Group 1 and Group 2.

Fig. 3: RFA score at 180 days (T3) in Group 1 and Group 2.

DISCUSSION

Success with dental implant procedures largely depends on osseo-integration. Implant stability plays a critical role in successful osseo-integration. Bioline Implants Systems has a Spiral Connie Implant TM where the design of the upper part of the implant is formed mainly for aesthetic reasons. The implant is built strong and stable body with durable blades that collect at the corners convene the soft bone and compressing it during implantation to ensure the uniform and high-quality platform for connecting the bone graft.[5] Since there have been various studies which have compared the difference between fresh socket and healed socket using different implant system, no study so far has been done on the aforesaid implant system based on standard protocols using the same clinical parameters. Hence, the following study was undertaken to find out its clinical outcomes and success criterions.

In the present study implant stability at the time of implant placement, followed by consecutive evaluation 90 days and 180 days before loading was measured and compared among Group 1 (fresh socket) and 2 (healed socket). Several authors[6-10] have observed that implants inserted in fresh extraction sockets experience similar survival rates when compared to implants inserted in healed sites. Stephen T[11] et al in his study concluded that short term survival rates and clinical outcomes of immediate and delayed implants were similar and were comparable to those of implants placed in healed alveolar ridges.

A study attempted to investigate the effect of self-tapping design on initial stability of tapered implants in polyurethane bone blocks. The findings indicate that tapered implants with self-tapping blades have higher initial stability than implants without self-tapping blades.[12] In accordance with the above study, tapered implants with self-tapping are used in our study. The surface characteristics of an implant are important in determining the pattern of healing under loading, especially in particularly demanding situations such as immediate loading.

Torque is a measure of the turning force on an object such as a bolt. The force used to insert a dental implant is called insertion torque. It depends on bone and implants parameters such as bone density, site preparation/drill protocol, implant diameter and implant design. Reports in the scientific literature show that torque levels which are too low or too high can be associated with implant failure.

Mean Insertion Torque Value (ITV) in Group 1 was 45.67. All implants showed ITV more than the clinically acceptable limit that meant all implants at the time of placement were having good primary stability as per the documented studies by Jensen T Ole.[10] Minimum Insertion Torque Value (ITV) in Group 2 was 45.67. All implants showed ITV more than the clinically acceptable limit.[13] This result was in accordance with study the done by Neugebauer J et al.[14] Implants of group 2 i.e implants in healed socket showed more ITV than group 1. This result was in accordance with the study done by Raes et al[15] who observed that a trend towards bone gain was found following insertion in fresh extraction sockets, which may be explained by the fact that the gap between the original bone and implant diminishes during healing, and the bone-to-implant contact increases in coronal direction during the healing phase. To achieve these conditions, a minimum of 4-5 mm of alveolar crest width and a residual bone length no less than 10 mm are recommended. Simultaneous bone regeneration may be required to achieve secondary stability.[16]

Meredith et al[17] reported the use of RFA to evaluate implant stability and proved in early in vitro the ability of the device in evaluating the stiffness change of the surface. Resonance frequency analysis uses the principle of a vibrating fork that is, when a frequency of audibility range is repeatedly vibrated onto an implant, depending on the bone implant interface, resonance occurs.

Mean RFA at baseline (T1) for group 1 was 60.07. All implants showed RFA more than the clinically acceptable limit at baseline.[18] This statistical result was in accordance with the study carried out by Lopez B A et al[19], Shokri M et al.[18] The average RFA at 90 days (T2) for group 1 was 73.60. All implants showed RFA

more than the clinically acceptable limit at 90 days in accordance to studies by Lietchi G K et al[20] and Valderrama P et al.[21]

Mean RFA at baseline (T1) group 2 was 68.33. All implants showed RFA more than the clinically acceptable limit at baseline. The average RFA at 90 and 180 days (T2) for group 2 was 77.87 and 86.47 respectively. All implants showed RFA more than the clinically acceptable limit at 90 days and 180 days.

Daraeighadikolaei[22] checked the primary and secondary stability of dental implants by resonance frequency analysis. He concluded that mean ISQ obtained with the magnetic device was 77.2; it decreased to 75.6 at 12 weeks. Changes indicated a pattern of decreased mean stability from 1 to 5 weeks postplacement, and significantly increased mean stability from 5 to 12 weeks which is in accordance with the present study.

Within the limitations of the study, the results are conclusive of the fact that the placement of aforesaid dental implants during stage I surgery by standard two-stage procedure from implant placement to pre-loading time intervals till 180 days exhibited normal range of values for implant stability in terms of both ITV and ISQ values for good clinical prognosis and acceptable outcomes for implant success. These values obtained and compared via data analysis were found to be in lieu with the results obtained in previously done studies. No statistical significant difference was seen between the two groups from placement to pre-loading at 180 days.

CONCLUSION

This short-term study showed that Bioline Dental Implants, Germany could be effectively used for most of the patient situations encountered clinically i.e. single or multiple tooth replacement in fresh sockets as well as healed alveolar bone.

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