Original Article

A clinical assessment of the volume of interproximal papilla after definitive prosthesis around immediate and delayed loading implants placed in the maxillary esthetic zone: An *in vivo* study

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Abstract

Background: The presence of the dental papilla is critical to achieve esthetics in a single tooth implant restoration.

Aim: The purpose of this study was to determine if there were differences in the papilla fill between implant and teeth comparing immediate implant placement and provisionalised single tooth implant restorations with delayed implant placement and provisionalised single tooth implant restorations. The papilla fill in these two groups was evaluated using the Jemt papilla index.

Results: It was seen that there was no statistically significant difference seen in the volume of the papilla between both the groups. There was a statistically significant difference seen in both the groups on the distal and mesial side from the initial stage go the follow up period of 10 days, 3 months and 6 months.

Conclusion: The interpretation of clinical papilla is a difficult task since many different clinical situations can be encountered while studying single tooth implant restorations. The single tooth implant restoration is a specific entity; the distance between the mesial and the distal side of one implant is never the same. Therefore the present study analysed the papilla as a unit and focused on the vertical fill related to the implant and adjacent teeth.

Keywords: Interproximal papilla, Jemt index, immediate implants

INTRODUCTION

The goal of prosthetic dentistry is to restore the patients' dentition to normal contour, function, comfort, esthetics, speech, and oral health. Loss of tooth/teeth results in the loss of structural balance, inefficient oral function, poor esthetics, and positional changes of remaining natural teeth. The anterior region of maxillary jaw is

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frequently termed as the "esthetic zone," due to its high visibility and influence on facial appearance. Different implant protocols have been reassessed and various authors have come up with different loading protocols, one of which is the immediate extraction, placement, and loading.[1,2] Immediate restoration of dental implants may have significant advantages, especially in restorations involving the esthetic zone.

Immediate implant placement and provisional restoration suggests that potential deleterious osseous and mucosal response could result from the following:

a. Diverse anatomy of extraction socket
b. Imposed loading environment of provisional restoration
c. Nature of restoration–mucosa interface
d. Contamination of healing sites by restorative materials and dental cements.[3]

It is known that the level of papilla is highly related to the level of the peri-implant marginal bone. If there is a loss of marginal bone, then this will lead to a concomitant loss of the marginal gingiva, which will affect the final esthetic outcome.[4] Till date, no study has compared papilla volume of immediately placed implants and delayed placement of implants with loading. The purpose of this study is:

1. To assess the volume of interproximal papilla in patients where implants were placed and immediately loaded in fresh extraction sockets
2. To assess the volume of interproximal papilla in patients where implants were placed and immediately loaded in healed single-tooth edentulous sites
3. To compare the volume of interproximal papilla in patients where implants were placed and immediately loaded in fresh extraction sockets and healed single-tooth edentulous sites.

MATERIALS AND METHODS

Patient groups
Twenty patients were selected from patients referred to the Department of Prosthodontics and Crown and Bridge. The sample included male and female patients with age ranging from 18 to 55 years. Patients were provided with a consent form plus a written explanation regarding the nature of treatment, associated procedures, and risks involved with the treatment.

• Group I included ten patients in which extraction of the tooth was indicated, followed by immediate implant placement and loading.

• Group II included ten patients in which implants were placed and were loaded immediately in healed single-tooth edentulous sites.

Inclusion criteria
1. Anterior tooth indicated for extraction should have adequate and similar level of gingival and underlying bony architecture as the contralateral natural tooth
2. Reasons for extractions were root fractures and endodontic failures
3. Adequate bone volume to place an implant with a minimum dimension of 3.5 mm × 11 mm without the necessity of bone grafting
4. Good oral hygiene
5. Immediate loading of implants was performed if implant insertion torque was > 35 N
6. Thick gingival tissue biotypes.

Exclusion criteria
1. Presence of dehiscence or fenestration of the residual bony walls
2. Uncontrolled diabetes, coagulation disorders, or any other systemic disease leading to failure of implants
3. Signs of acute infection around the alveolar bone at the surgical site
4. Smoking >4 cigarettes per day, alcohol or drug abuse, and bruxism
5. Thin gingival tissue biotypes.

The study was approved by the institutional ethical committee under the guidelines of adherence to Helsinki declaration (article 14). A single operator who was blinded performed all the surgical procedures and also conducted the follow-up.

Figure 1: Armamentarium – (a) Surgical apparatus. (b) Implant Prosthetic kit. (c) Cannon EOS 1100D D-SLR camera. (d) Marcrolens with magnification 1:1

Surgical procedure

Pretreatment clinical examination was performed on the selected patients, which included a thorough medical and dental history and current general and oral health status. A papillary bleeding index (Muhlemann, 1977) was recorded to ensure that the gingival tissues in the peri-implant area were not inflamed. Patients were prescribed with prophylactic antibiotic therapy (amoxicillin 500 mg t. i. d) preoperatively and were asked to continue for 6 more days after the surgery. One hour preoperatively, patients were advised to start analgesic therapy (ibuprofen 400 mg and paracetamol 325 mg).

Teeth scheduled for immediate replacement in Group I were atraumatically removed following minimal mucoperiosteal flap elevation. Atraumatic extraction was done using periotomes. Osteotomy was done on the palatal wall of the extraction socket to prevent perforation of the labial cortical bone. Immediate implant placement (Ankylos® plus, Dentsply Friadent) [Figure 1 a,b] was performed. Balance abutment of suitable height and angulation was placed and torqued for 15 Ncm which is the recommended torque for implant abutment connection for Ankylos® system [Figure 2].

In Group II, to preserve the papillae of adjacent teeth and to prevent recession of the gingival margins, flap was reflected as minimal as possible. After administering local anesthesia, midcrestal incision was placed using a Bard-Parker blade no. 15 and full-thickness mucoperiosteal flap was reflected. After the preparation of the osteotomy site, implant was placed with the help of physiodispensor (Surgic Pro, NSK, Japan). Balance abutment of suitable height and angulation was placed and torqued at 15 Ncm which is the recommended torque for implant abutment connection for Ankylos® system [Figure 3].

Prosthetic procedure

A putty index (Speedex, Coltene Whaledent) of the diagnostic mock-up of the tooth was made before the surgery which was used in the fabrication of the temporary crown. Temporization was done using bisacryl composite (Protemp 4, 3M ESPE). Nonfunctional loading was done by keeping the temporary crowns out of occlusion both in centric and eccentric relation. Three months after the placement and loading of implant, the temporary crown was removed. An abutment-level impression was made using addition silicone material and the cast was poured using Type IV die stone (Kalrock, Kalabhai dental, Mumbai, Maharashtra, India). Implant crowns were fabricated and cemented. Patients were recalled after 3 months (6 months after implant placement) after the cementation of the crowns and photographs were recorded.

Photographic analysis

High-quality photographs were taken with DSLR camera Canon EOS 1100 D and macro lens (Canon 100 mm, Canon, Japan) [Figure 1 c,d] along with a set magnification (1:1) and illumination by one single investigator. The lens was placed at right angles to the labial surface of the temporary crown and then the image was recorded in RAW format. These photographs were cataloged, labeled, and then digitized at a resolution of 1000 dpi and compressed to JPEG format. All the images were recorded by a single operator proficient with dental photography to avoid the risk of bias. The digital images were stored in files on a computer. Digitized images were evaluated using commercially available software (Adobe Photoshop 8.0 [Adobe Systems Inc., San Jose, CA, USA]). Images were magnified when needed to ensure accurate scoring. Photographs were recorded before

Figure 2: Immediate extraction and implant placement with immediate loading. (a) Preoperative photo. (b) Extracted tooth. (c) Implant placement. (d) Immediate provisionalization
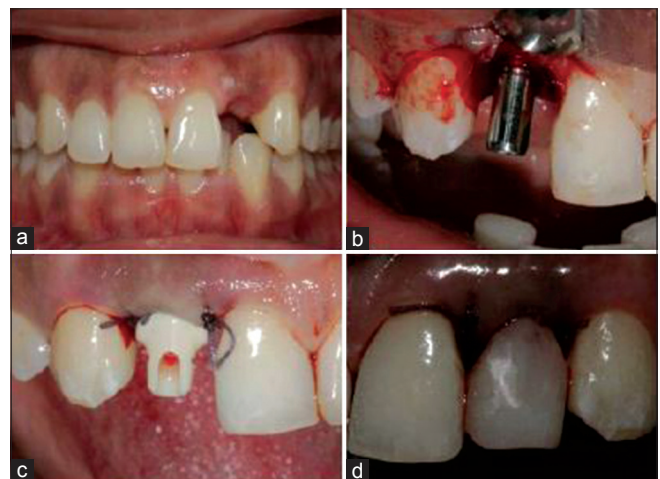

Figure 3: Delayed implant placement and immediate loading. (a) Preoperative photo. (b) Implant placement. (c) Abutment torqued. (d) Immediate provisionalization
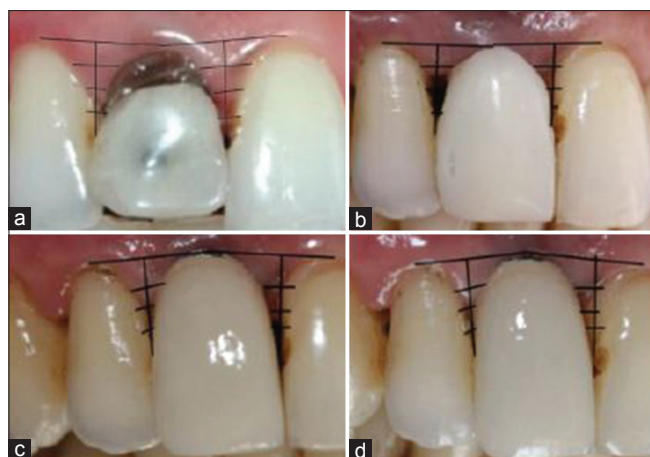
Figure 4: Jemt index for Group 1 (a) on the day of implant placement, (b) 10 days, (c) 3 months, (d) 6 months

Figure 5: Jemt index for Group 2 (a) on the day of implant placement, (b) 10 days, (c) 3 months, (d) 6 months

the implant placement, after implant placement at 10 days', 3 months' and 6 months' interval time. The papillary fill in the image was measured by joining the zeniths of the adjacent teeth and then drawing a line perpendicular to it till the contact point in Adobe Photoshop software version 8. The line was divided into four equal parts. The papillary volume fill was measured using papilla index (Jemt, 1997). The lower value of the index was considered as the final reading [Figures 4 and 5].

The data were analyzed and subjected to repeated measures ANOVA followed by Bonferroni's correction for *post hoc* pair-wise analysis with time.

RESULTS

Twenty patients were scheduled for immediate loading and delayed loading out of which 14 were men and 6 were women (with age range from 18 to 55 years). The papillary fill was measured by joining the zeniths of the adjacent teeth and then drawing a line perpendicular to it till the contact point in Adobe Photoshop software version 8. The data obtained, that is, the papilla-level changes on mesial and distal sides of the implant were tabulated in Microsoft Excel sheets and the statistical analysis was performed using SPSS ver.15 ,IBM, USA, 15 software.

In Group I, six patients were treated for central incisors, two patients for lateral incisors, and two patients for canines, which were fractured after the endodontic treatment or periodontal reasons. In Group II, seven patients were treated for missing central incisors and three patients for lateral incisors, which were extracted due to trauma or failed endodontic treatment. Bone graft was not used in any of the cases to fill the implant–tooth socket
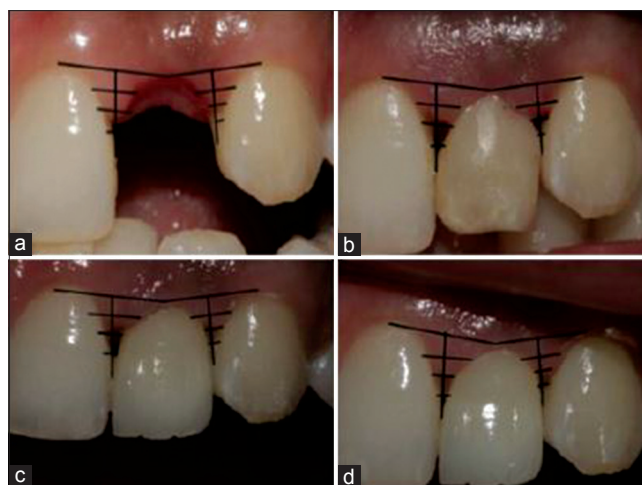
Table 1: Mean, standard deviation, and total number of patients (*n*) for both the groups

Patient	Group	Mean	SD	*n*
Descriptive statistics				
Distal				
Preoperative (T0)	Immediate	0.60	0.843	10
	Delayed	0.89	0.601	9
	Total	0.74	0.733	19
10 days (T1)	Immediate	0.90	0.568	10
	Delayed	0.89	0.601	9
	Total	0.89	0.567	19
3 months (T2)	Immediate	1.10	0.568	10
	Delayed	1.33	0.866	9
	Total	1.21	0.713	19
6 months (T3)	Immediate	1.30	0.483	10
	Delayed	1.89	1.269	9
	Total	1.58	0.961	19
Mesial				
Preoperative (T0)	Immediate	0.30	0.675	10
	Delayed	0.89	0.782	9
	Total	0.58	0.769	19
10 days (T1)	Immediate	0.90	0.568	10
	Delayed	0.89	0.782	9
	Total	0.89	0.658	19
3 months (T2)	Immediate	1.00	0.471	10
	Delayed	1.33	0.866	9
	Total	1.16	0.688	19
6 months (T3)	Immediate	1.20	0.632	10
	Delayed	1.78	1.202	9
	Total	1.47	0.964	19

SD: Standard deviation

gap during the surgery. One implant failed in Group I in the central incisor region after 3 months. After a mean follow-up of 6 months, the other 19 implants were stable with a 95% survival rate.

Table 1 shows the mean and standard deviation between the two groups' immediate loading and delayed loading on the distal and mesial sides. The amount of papilla fill on the distal side which occurred during the follow-up period of 10 days (T1) was a mean of 0.90 in Group I

and 0.89 in Group II and that on the mesial side was 0.90 in Group I and 0.89 in Group II. Maximum amount of papilla fill was observed after 6 months (T3) of loading with a mean of 1.30 in Group I and 1.89 in Group II on the distal side and a mean of 0.120 in Group I and 1.78 in Group II on the mesial side.

Table 2 shows a comparison of papilla fill between the two groups using repeated measures ANOVA. The table shows the papilla fill, which occurred from 10 days to 6 months. A statistically significant difference was seen in the papilla fill with F value of 14.090 and 18.502 on the distal and mesial sides, respectively.

Table 2: Comparison of papilla fill between the two groups using repeated measures ANOVA

		Tests of within-subjects effects				
		Measure: Papilla levels				
Patient	Source	Type III sum of squares	df	Mean square	F	Significance
Distal	Time (Huynh-Feldt)	8.074	2.579	3.130	14.090	<0.0001
	Time × group (Huynh-Feldt)	0.864	2.579	0.335	1.507	0.229
Mesial	Time (Huynh-Feldt)	8.284	2.124	3.899	18.502	<0.0001
	Time × group (Huynh-Feldt)	1.126	2.124	0.530	2.514	0.092

Table 3: *Post hoc* pair-wise analysis with time: Bonferroni's correction with groups

		Pair-wise comparisons			
		Measure: Papilla fill			
Patient	Group (I)	Group (J)	Mean difference (I−J)	SE	Significance[a]
Distal	Immediate	Delayed	−0.275	0.301	0.374
	Delayed	Immediate	0.275	0.301	0.374
Mesial	Immediate	Delayed	−0.372	0.317	0.256
	Delayed	Immediate	0.372	0.317	0.256

Based on estimated marginal means. [a]Adjustment for multiple comparisons: Bonferroni. SE: Standard error

Table 4: *Post hoc* pair-wise analysis with time: Bonferroni's correction with time

			Measure: Papilla fill		
Patient	Time (I)	Time (J)	Mean difference (I−J)	SE	P
Distal	1	2	−0.15	0.113	1
		3	−0.472	0.121	0.007
		4	−0.85	0.177	0.001
	2	3	−0.322	0.109	0.053
		4	−0.7	0.18	0.007
	3	4	−0.378	0.134	0.072
Mesial	1	2	−0.3	0.086	0.017
		3	−0.572	0.116	0.001
		4	−0.894	0.174	0.001
	2	3	−0.272	0.098	0.079
		4	−0.594	0.147	0.005
	3	4	−0.322	0.109	0.053

SE: Standard error

Table 3 shows the comparisons done of the distal and mesial papilla with both the groups using Bonferroni's *post hoc* test and the results indicated the differences observed in both groups, and the mean difference was not significant for both the distal papilla (0.374) and the mesial papilla (0.256).

Table 4 shows the comparisons done of the distal and mesial papilla with different time intervals using Bonferroni's *post hoc* test and the results indicated the differences observed in each time period. The mean difference was significant in the distal papilla during the time intervals of 1–3, 1–4, and 2–4 and was not significant in the time intervals of 1–2, 2–3, and 3–4. The mean difference was significant in the mesial papilla during the time intervals of 1–2, 1–3, 1–4, and 2–4 and was not significant in the time intervals of 2–3 and 3–4.

DISCUSSION

Excellent esthetic outcomes were reported with immediate provisional restorations following immediate implant placements. One of the advantages of provisionalization following immediate implant placement is that it maintains the interproximal soft-tissue height around the implant restorations.[5,6] Although the problem with inadequate papilla has been identified, and attempts have been made to correct the problem with various surgical techniques, the regeneration of the papilla adjacent to the dental implant is still difficult to perform and often not predictable.[7] A study was conducted in which it was found that 64.3% of papillae had a score of 2 while the remaining 35.7% had a score of 3 according to the Jemt (1997) papillary index. No Class 0, Class 1, or Class 4 interproximal papillae at 1-year follow-up were noted. Thus, use of guided bone regeneration was able to maintain the papillae height and appearance.[8]

The implants used in the study have a Morse taper connection and also exhibit platform switching. Here, the cross section of the abutment is smaller than the width of the top of the implant because of the tapered implant abutment connection. The Morse taper, precisely 5.7° taper of the cone and 2.35 mm in length, produces a considerable amount of frictional retention between the tapered abutment and the implant providing antirotation properties and is impervious to bacterial colonization which in turn reduces crestal bone resorption, thus maintaining the papilla levels. Both concepts of platform switching and Morse taper connection must have resulted in a good volume of papilla in this study.

The papilla included in this study did not present any signs or symptoms of inflammation; therefore, misinterpretation of increased papilla volume due to inflammation was avoided. The interpretation of clinical papilla is a difficult task since many different clinical situations can be encountered while studying single-tooth implant restorations.

Limitation of the current study is that the analysis was done on a vertical level and did not take into consideration the buccolingual volume of the papilla. The single-tooth restoration is a specific entity and the distance between the mesial and distal sides of an implant is never the same.[9] Therefore, the present study analyzed the papilla as a unit and focused on the vertical dimensions related to the implant and adjacent teeth.

Jemt index[10] used in the current study gives us a brief idea about the absence or presence of volume of papilla. The score judged with the help of photographs is quite subjective. With the data obtained from the study, Tables 3 and 4 show that the value increases with time as the difference is always negative, whereas there was no statistically significant difference when both the groups were compared for the papilla fill.

Immediate placement and loading can achieve predictable results compared to the delayed placement with immediate loading.[11] If the tooth is extracted atraumatically preserving the papillae and the bone and provisionalized immediately, esthetic contour of the tooth is maintained which is comparable with the natural tooth.

CONCLUSION

Implant survival seen was 95%. The mean distal and mesial papilla fill observed was more in Group I and in Group II at the follow-up of 6 months. There was no statistically significant difference seen in the volume of papilla between Groups I and II. There was a statistically significant difference seen in both the groups on the distal and mesial sides from the initial stage to the follow-up period of 10 days, 3 months, and 6 months. Hence, further studies need to be carried out supporting this

study, with more number of participants. Immediate implant placement and provisionalization may provide the patient with a tooth-like restoration, with elimination of a removable temporary prosthesis, so the actual benefits may result from patient comfort rather than papilla morphology.

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Conflicts of interest
There are no conflicts of interest.

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