Densitometric and Clinical Evaluation of Immediate Versus Delayed Implants

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Abstract: A total of 40 Frialit-2 step screw implants were installed to replace lost single mandibular teeth. Patients were divided into two groups according to the time of implant installation; an immediate and a delayed group. Patients were followed up radiographically and clinically for one year after prosthetic connection. The study parameters included bone density, mobility, gingival index, Probing depth and gingival crevicular fluid. No mobility was detected in either group. It was found that the alveolar bone density in the implant interface increased in both immediate and delayed groups, which reflects a positive clinical finding. The other clinical parameters are reported in detail. At the end of the study period no significant differences were found between the study parameters in the two techniques, which leaves the merits of immediate technique as it rehabilitates function and esthetics quickly and that satisfies the patient after the loss of a tooth.

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1. Introduction:

The use of dental implants has increased tremendously in recent years because of their excellent long-term prognosis. With the improvement of dental health, more patients and dentists would not want to prepare intact adjacent teeth for crowns and inlays. Hence the concept of single tooth replacement emerged as a preferable treatment option. Nowadays a single tooth replacement has become a common treatment undertaken in prosthetic dentistry.

Immediate implant is defined as placement of the implant immediately into the fresh extraction socket. After exodontia, the natural pattern of bone resorption could result in a deficient ridge may be a problem for future implant placement. It has been reported that 40% to 60% of the remaining alveolar bone is lost after extraction.

In addition, the resorptive and remodeling process may be associated with apical and lingual loss of ridge anatomy, which results in alteration and angulation of delayed placement of dental implants (Paul et al., 2004).

It is important to note that with immediate implant placement there is minimal use of surgical drills, because the socket is already found except for a slight increase of the socket length in an attempt to improve primary stability. The decreased surgical trauma of immediate placement type decreases the risk of bone necrosis and permits the bone remodeling process to occur, i.e., the healing period is rapid and allows the woven bone to be transformed into lamellar bone. In addition, the natural socket is rich in periodontal cells and more predictable. To achieve a good osseointegrated implant with a high degree of predictability, the implant must be sterile, biocompatible, inserted with a traumatic surgical procedure, placed with initial stability, and non-functionally loaded during healing period.

Furthermore, regeneration of bone is usually a problem after implantation as ingrowths of non-osteogenic connective tissue into the defect around the implant prevents bone formation. Also, to maximize bone growth potential it is essential for the endosseous implant's coronal segment to be in close contact with bone at the alveolar crest, if it is not possible the space between the implant and bone should be filled or covered with a substance that will provide a hospital substrate on which periosteal cells can rapidly migrate toward the implant surface (Ettinger et al., 1993).

The density of available bone in the implantation site has primary influence on treatment planning, implant design, surgical approach, healing time, initial progressive bone loading during prosthetic reconstruction and finally on the prognosis of implantation procedures (Misch, 1990).

The present study aimed to evaluate and compare the efficiency of the two-stage primary immediate implantation versus delayed implantation through densitometry and clinical data.

2. Material and Methods:

Forty patients (28 males and 12 females) were selected from the outpatient clinic department of Oral Surgery, Faculty of Oral Medicine, Cairo University and Research Institute of Ophthalmology for single gap replacement in the lower jaw. The patients' ages ranged from 35-56 years with average age of 39.2 years. They were selected free from any systemic disease. They also had normal occlusion and good alignment with healthy neighboring teeth. The patients were motivated in term of good oral hygiene measures throughout the study.

The buccal and lingual thickness of bone was at least 1 mm. The soft tissue thickness was measured from the sectioned study cast. The bone quantity was assessed according to the contour of the alveolar ridge as proposed by Lekholm and Zarb (1985) and only patients with class A or B were selected for implantation. Bone quality of the implant site was assessed during drilling procedures in the first stage surgery as described by Misch, (1990).

The patients were divided into two groups:

Group I (Immediate implantation): Twenty patients were operated upon to install 20 stepped screw Frialit-2 implants immediately after extraction which was either due to inability to complete endodontic procedures e.g. internal resorption or due to badly decayed or broken beyond repair e.g. vertical fracture. The teeth extracted were 18 lower premolars and 2 lower incisors.

Group II (Delayed implantation): Twenty patients were operated upon to install 20 stepped screw Frialit-2 implants at least 9 months after extraction. The teeth extracted were 18 lower premolars and 2 lower molars.

Standardized periapical radiographs were taken before the surgery and throughout the follow up period after two weeks of first step surgery, at prosthetic connection, three months, six months, nine months and twelve months after prosthetic connection. For every patient alginate impressions were taken and a study cast was poured for the estimation of bone dimensions and to prepare a surgical template, which was used for guiding the bucco-lingual and mesio-distal placement of the implant.

The surgical procedure was composed of two stages; the first stage included implants installation. All implants used in the present study were titanium root formed stepped screw Frialit-2 implant with Frios deep profile. The surgical technique used in both immediate and delayed implantation followed that of Quayle et al., 1989. The second stage included the abutment connection, which was placed 3 months after surgery.

The implants was recovered and sealed temporarily by using a suitable gingival former to give the gingival contour. The prosthetic procedure included the construction of a primary cast and special tray upon which a final impression was taken for fabricating a single metal porcelain crown, which was cemented temporarily throughout the follow up period.

A set of data was obtained at the time of surgery, two weeks after surgery, at the prosthetic connection phase and at each follow up visit. Recall visits were scheduled for 3 months, six months, nine months and 12 months. This included measuring the thickness of the buccal and lingual plates of bone, bone quantity and bone quality.

Post-operative parameters used for assessment:

A-Bone density assessment included the construction of the follow up radiographic template, which is a customized acrylic resin guide combined with a plastic film holder. The bite block was attached to the paralleling beam aiming device (XCP, Rinn, Elgin, IL.). Intra-oral periapical radiographs were taken for each abutment using plotnik's technique. The films of each patient were fixed on a transparent plastic sheet. Three vertical lines were drawn (A and B) tangential to the mesial and distal sides of the implant and D in the middle of the implant. Six horizontal lines were drawn perpendicular to the vertical lines and at different levels. The bone densitometer (Wellhofer Dosimetrie-Germany) is a fully automatic device used for scanning and analyzing x-ray films. The densitometer measures the relative values of the relative optical density, which is inversely proportional to the bone density. The values of each of the six studied points with a single reference area were recorded from every radiograph. Every radiograph was measured several times and the coefficient of variation was measured and was found to range between 0.49% and 1.16%.

B-Post operative clinical assessment: included mobility testing, measuring the sulcular depth, assessing the gingival condition using the gingival index scores and also measuring the amount of the gingival crevicular fluid.

3. Results:

A total of 40 Stepped screw Frialit-2 have been placed in 40 patients (28 males and 12 females). Two cases showed loosening after 2 weeks of surgery due to inadequate primary stability. However, they were replaced with two other cases. All implants were installed in the lower jaw. 36 of the implants were installed in the premolar area. Two of the implants were placed in the anterior region, while 2 were installed in the molar area. Implant diameters were 5.5 mm (22 implants), 4.5 mm (14 implants), 3.8 mm (2 implants) and 6.5 (2 implants). The lengths of the implants were 13 mm (24 implants) and 15 mm (16 implants). The bone quality was D2 in 90% of the subjects in the delayed group, while in 10% it was D3. In the immediate group 80% showed D2 bone quality while the remaining 20% showed D3.

The cause of extraction of the immediate was either a non-restorable carious lesion (70%) or the inability to complete endodontic treatment (30%).

Post Operative Data:

A: Radiographic Evaluation:

Subjects were radiographed at 2 weeks after first stage surgery, at prosthetic connection time, after 3 months, 6 months, 9 months and 12 months after loading.

The calculated means of the optical film density in the delayed group are presented in figure 1. It is generally noticed that there was a reduction in the optical film density (decrease radiolucency) throughout the follow-up periods except in the three months period of the mesial side in the delayed group. In addition, the mesial side showed more radiolucency than the distal side.

The significance between the mesial and distal sides is shown in tables 1 and 2. While the mesial is significantly more radiolucent than the distal in all follow up periods of the immediate group the delayed only showed significance at the prosthetic, 3 and 6 months time.

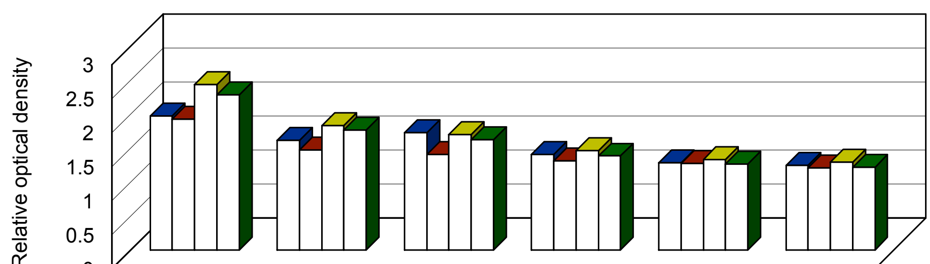
Table 1: Shows the significance of the difference between the mean of the mesial side versus the mean of the distal side in the Delayed group.

Delayed group - Mesial vs. Distal						
Time	**Mean difference**	**±S. D**	**±S. E.**	**t value**	P	
2 weeks	0.046	0.089	0.028	1.56	0.153	NS
Prosthetic	0.139	0.138	0.044	3.18	0.011	S
3 months	0.319	0.186	0.059	5.44	0.000	S
6 months	0.094	0.12	0.038	2.48	0.035	S
9 months	0.008	0.074	0.032	0.37	0.716	NS
12 months	0.037	0.055	0.017	2.17	0.058	NS

Table 2: Shows the significance of the difference between the mean of the Mesial side versus the mean Distal side in the Immediate group.

Immediate – Mesial vs. Distal						
Time	**Mean difference**	**±S. D**	**±S. E.**	**t value**	P	
2 weeks	0.146	0.053	0.017	8.75	0.000	S
Prosthetic	0.064	0.079	0.025	2.55	0.031	S
3 months	0.074	0.066	0.021	3.56	0.006	S
6 months	0.083	0.051	0.016	5.18	0.001	S
9 months	0.065	0.066	0.021	2.96	0.016	S
12 months	0.074	0.065	0.020	3.63	0.005	S

Mean difference of the Mesial side =(point1+point2+point3)/3 Mean difference of the Distal side =(point4+point5+point6)/3
S. D. =Standard deviation of the difference. S = Significant at P< 0.05 S. E. = Standard error of the difference.
NS = In significant at P> 0.05 P = Probability level.



	2 weeks	Prosthetic	3 mon.	6 mon.	9 mon.	12 mon.
Delayed mesial	1.968	1.608	1.721	1.401	1.276	1.245
Delayed distal	1.922	1.469	1.402	1.305	1.267	1.208
Immediate mesial	2.429	1.827	1.697	1.462	1.329	1.291
Immediate distal	2.281	1.763	1.623	1.379	1.264	1.217

Fig. 1: Histogram illustrating the mean values of the relative optical density of the mesial and distal sides of both groups.

Table 3: Paired t-test for the mean differences in optical density for different levels at different follow up periods for the Delayed group.

Group		Periods	Mean diff.	±SD	Paired t	DF	P	
Delayed	**Level 1**	2 weeks- Prosthetic	0.415	0.049	26.71	9	.000	S
		Prosthetic- 3 months	-.015	0.071	-0.64	9	.536	NS
		3 months- 6 months	0.235	0.086	13.81	9	.000	S
		6 months- 9 months	0.011	0.058	-1.57	9	.152	NS
		9 months- 12 months	0.055	0.032	1.48	9	.161	NS
	Level 2	2 weeks- Prosthetic	0.447	.0629	22.434	9	.000	S
		Prosthetic- 3 months	-0.024	.0938	-.809	9	.439	NS
		3 months- 6 months	0.191	.1622	3.723	9	.005	S
		6 months- 9 months	0.080	.0949	2.666	9	.026	S
		9 months- 12 months	0.040	.0326	1.830	9	.312	NS
	Level 3	2 weeks- Prosthetic	0.357	.0737	15.444	9	.000	S
		Prosthetic- 3 months	-0.031	.0965	-1.016	9	.336	NS
		3 months- 6 months	0.201	.1123	5.659	9	.000	S
		6 months- 9 months	0.052	.0431	3.853	9	.004	S
		9 months- 12 months	0.042	.0342	1.789	9	.215	NS

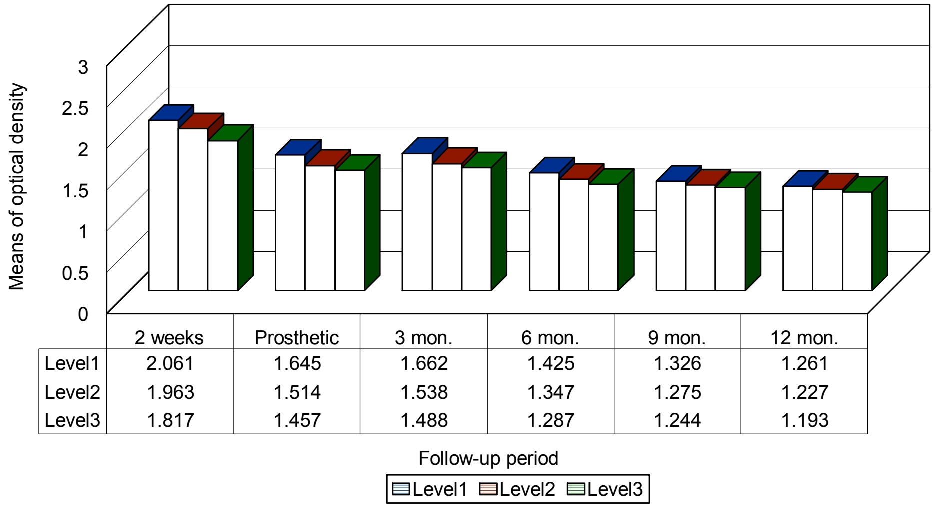
SD =Standard deviation of the difference.
P = Probability level.
S = Significant at $P < 0.05$
NS = Insignificant at $P > 0.05$

Table 4: Paired t-test for the mean differences in optical density for different levels at different follow up periods for the Immediate group.

Group		Periods	Mean diff.	±SD	Paired t	DF	*P*	
Immediate	**Level 1**	2 weeks- Prosthetic	0.526	0.048	34.650	9	.000	S
		Prosthetic- 3 months	0.140	0.062	7.122	9	.000	S
		3 months- 6 months	0.225	0.052	13.514	9	.000	S
		6 months- 9 months	0.124	0.068	5.724	9	.000	S
		9 months- 12 months	0.030	0.061	1.593	9	.146	NS
	Level 2	2 weeks- Prosthetic	0.570	0.055	32.668	9	.000	S
		Prosthetic- 3 months	0.126	0.081	4.930	9	.001	S
		3 months- 6 months	0.256	0.051	15.957	9	.000	S
		6 months- 9 months	0.119	0.070	5.355	9	.000	S
		9 months- 12 months	0.048	0.063	2.371	9	.142	NS
	Level 3	2 weeks- Prosthetic	0.5880	0.060	30.633	9	.000	S
		Prosthetic- 3 months	0.1374	0.069	5.130	9	.001	S
		3 months- 6 months	0.2390	0.057	13.214	9	.000	S
		6 months- 9 months	0.1299	0.069	5.884	9	.000	S
		9 months- 12 months	0.049	0.085	1.945	9	.084	NS

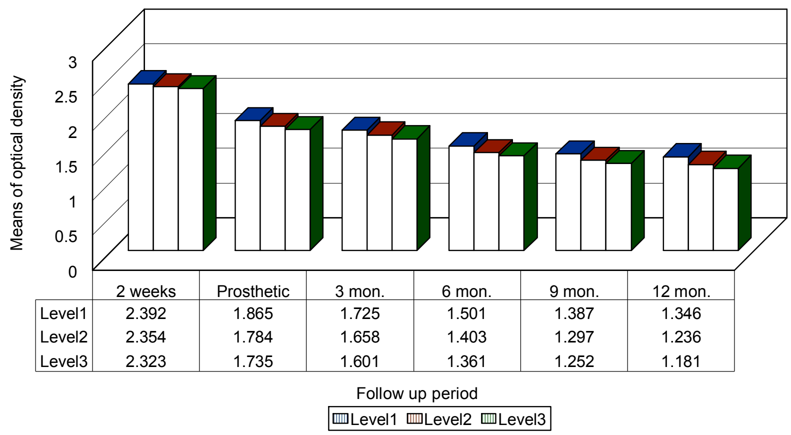
SD =Standard deviation of the difference.
P = Probability level.
S = Significant at $P < 0.05$
NS = Insignificant at $P > 0.05$

Also the bone density in different levels in both groups was noted to have the lowest values in the cervical levels and the highest vales in the apical levels (Figures 2 and 3).



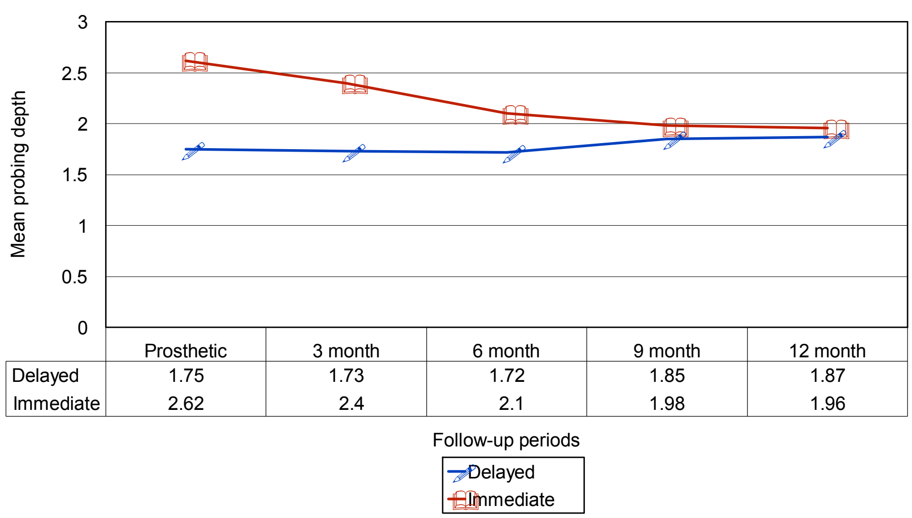
	2 weeks	Prosthetic	3 mon.	6 mon.	9 mon.	12 mon.
Level1	2.061	1.645	1.662	1.425	1.326	1.261
Level2	1.963	1.514	1.538	1.347	1.275	1.227
Level3	1.817	1.457	1.488	1.287	1.244	1.193

Fig. 2: Histogram illustrating the mean values of the relative optical density of different levels of the Delayed group during the follow-up period.



	2 weeks	Prosthetic	3 mon.	6 mon.	9 mon.	12 mon.
Level1	2.392	1.865	1.725	1.501	1.387	1.346
Level2	2.354	1.784	1.658	1.403	1.297	1.236
Level3	2.323	1.735	1.601	1.361	1.252	1.181

Fig. 3: Histogram illustrating the mean values of the relative optical density at the different levels of the immediate group during the follow-up period.



	Prosthetic	3 month	6 month	9 month	12 month
Delayed	1.75	1.73	1.72	1.85	1.87
Immediate	2.62	2.4	2.1	1.98	1.96

Fig. 4: Curve representing the change in the mean values of probing depth at different follow-up periods in both groups.

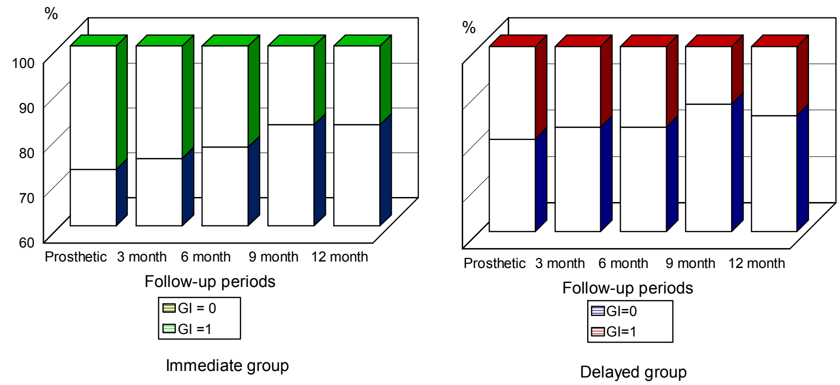


Fig. 5: Histogram representing the percentage changes in the mean gingival index scores in theImmediate and Delayed groups during the follow-up period.

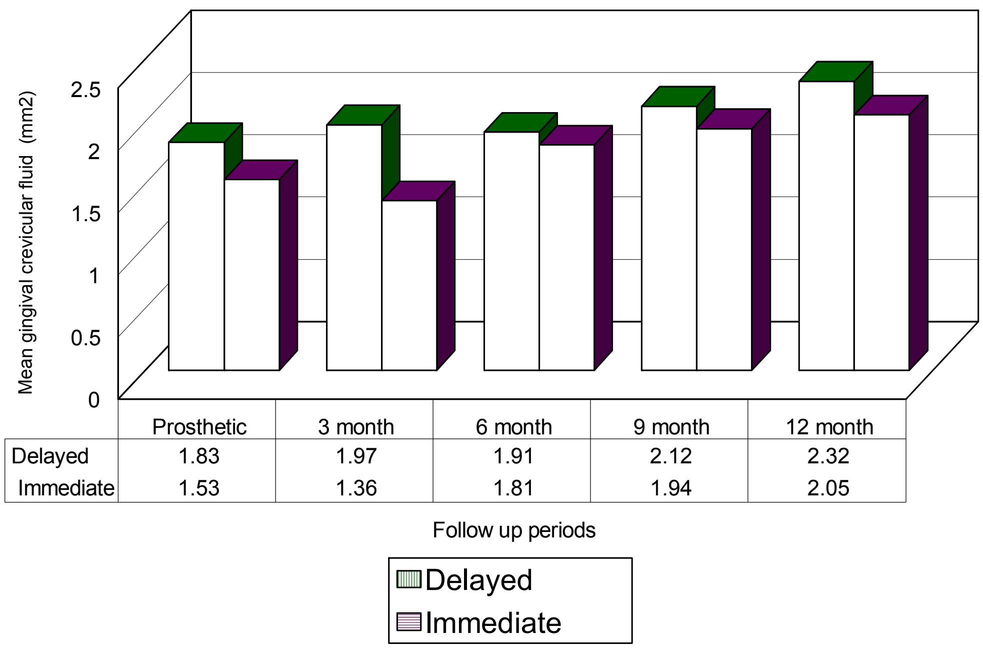


Fig. 6: Histogram showing the mean values of the gingival crevicular fluid in the Delayed and Immediate groups during the follow-up period.

Figures 2 and 3 showed the optical film density in the three chosen levels it is noted that the decrease in the optical film density in the same level throughout the study periods. Also in the same study period the optical film density decreased apically. Tables 3 and 4 demonstrate the significance of the difference of the optical density for the three levels at each successive period in the delayed and immediate groups respectively.

Figure 4 shows the mean probing depth of both groups at different follow up periods. Even though the difference was significant at the beginning of the study however this significance disappeared after 12 months. Figure 5 shows the mean gingival indices scores in both groups during the follow up periods.

4. Discussion:

The readings of the optical film in the densitometer depend upon the amount of bone trabeculae and the marrow spaces in the measured area. Decrease of the bone density takes place when the bone trabeculae decreases and marrow spaces increases. Younis et al, (2009) demonstrated that the potential exists for bone healing and remodeling in fresh extraction socket defects associated with immediately placed implants.

In our study, it was found that the optical film density in the mesial of the implants were more radiolucent than those of the distal sides which reflect less bone density in the mesial sides (Tables 1 and 2). These results denote that the mesial aspects showed less bone density than the distal sides, this could be attributed to distribution of forces from the implant to the socket wall, which might be due to the mesial vector of forces, which are the same forces that cause the mesial drift of natural teeth. These were described to initiate from occlusion or from the surrounding soft tissue (Tencate, 1998).

Another observation worth mentioning is that in the delayed group both proximal sides showed more bone density than the immediate proximal sides (Fig. 1). This is in agreement with Bansal et al. (2014) who confirmed that better clinical and radiographic outcomes for initial bone preparation followed by a 2-week delay in implant placement. this could be due to the better initial adaptation of the prepared socket to the recipient implant, which follows certain measurements for the drills used and implant size and shape. This is in agreement with the findings of Quayle *et al.* (1989) who reported that at the time of immediate implantation small voids inevitably exist between the implant and tooth socket especially at the cervical margin in some areas. Also the less bone density in the immediate group especially in the first months could be attributed to the previous pathological condition of the tooth before implant installation e.g. periodontal disease or periapical abscess. Another explanation for the less bone density in the immediate group is the trauma of the extraction procedure may precipitate micro-cracks at the socket walls. However, the results showed that there is an increase in bone density throughout the follow up periods in both techniques, this might be due to bone apposition at the interface of the implant and increased mineralization of bone. This finding is substantiated by Garetto et al. (1995) who found that the remodeling rate of bone immediately adjacent to and within 1 mm of the implant is higher than the bone distant from the interface i.e. higher than normal alveolar bone.

This study confirms the continuous increase in bone density throughout the follow up period as generally accepted by most studies (Roberts et al. 1987; Braggen et al. 1991). Many researchers (Dubrez et al., 1990; Deas et al., 1991) confirm that increase in bone density is regarded as a positive clinical finding. On the contrary, Strid (1985) reported that bone implant interface decreases during the first months following surgical insertion of implants in cases of delayed implantation.

It was noticed that the bone density was almost the same after one year, which indicates that the effect of the technique on bone density is minimized by time. This is in agreement with Michney et al. (1989) who concluded that based on bone density levels it was possible to place implants in fresh or healed extraction sites with equal chances of success. Also Brose et al. (1989) supported these results and reported that after 6 months of bone remodeling the bone density around the implant in fresh and healed extraction sites showed no difference.

The difference between the bone density levels in the successive follow up periods was found to be significant in all of the immediate group and most of the delayed group (Tables and 4) except in the last follow up period (9-12 months) where it was non-significant in both groups. This may reflect a slower mineralization process in the last interval of the study and showed no difference between the two techniques at this period.

This result could be attributed to the narrow dimension of the socket at the apex and the better initial mechanical contact between the implant surface and the wall of the socket. This agrees with that reported by Quayle et al. (1989) who found small voids at the cervical margin more than that at the apical level in the immediate implantation.

One of the decisive factors for assessing the implant success is the implant mobility (Smith and Zarb, 1989). Also Misch (1995) reported that mobility is the major determinant factor for the implant health. In the present study all implants in both groups were rated as non-mobile throughout the study, which, reflects successful Osseo integration of the end osseous implants.

In the present study the mean values of the probing depth was higher in the immediate group than the delayed group specially in the early intervals, this could be explained according to the reason mentioned by Mensdroff-Pouilly et al. (1994) who reported a tendency of primary immediate implants to form deeper gingival pockets than the delayed implantation and attributed this to the fact that primary immediate implants are marked by occasional losses of attached gingiva. The decrease in the probing depth till 6 months follow up was noted in the delayed group could be attributed to the reaction of marginal soft tissue to the superstructure system; this is in agreement with the findings of Amer (1994). Also the decrease in the probing depth of the immediate group could be attributed to the pre-existing thickness of gingival margin before the implant insertion. This may be 7 mm or more depending on the surgeon’s manipulation as Naert et al. (1993) reported. The present study suggests the decrease in the probing depth during the early intervals could be attributed to the smooth surface of the upper collar of the implant. Similar observation was reported by Quirynen and Van Steenberghe (1992). On the other hand increase in the probing depth in the later intervals on the present study may reflect improper control of oral hygiene. Also it was noticed that, the interproximal probing depth was higher compare to lingual and buccal sites in both groups. This may be due to the easier accessibility on the buccal and lingual sides than on the proximal sides. This finding is substantiated by the results published by other researchers (Lorenzoni et al., 1990; Gomez et al., 1997; Bragger et al., 1997).

The gingival index scoring in the present study in the delayed group showed decrease number of inflamed surfaces starting from the prosthetic connection time (20%) till it reaches 9 months period after prosthetic connections (12.5%), which reflects a healthy Osseo integration. Later in increases insignificantly to 15% at 12 months period, this may be due to the improper control of oral hygiene. In the immediate group the number of the inflamed surfaces decreased throughout the follow up period . The differences between the two techniques throughout the follow period was found to be non significant which reflects the equality of the two techniques.

As regard the crevicular gingival fluid amount, although the results showed a tendency for increase in the mean values of the amount in both groups (Figure 4), this increase was found to be non significant, this increase may be due to mild inflammation or due to one of the reasons that increase gingival crevicular fluid e.g. tooth brushing or hormonal disturbance as listed by Martin and Noble (1974) (Figures 5, 6), this results is in agreement with the findings of Amer (1994). However, Branemark et al. (1977) considered the gingival fluid as a secondary aid for evaluation of the implant success.

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