Comparison between immediate implants placement in periapically versus periodontally infected sites

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Abstract: Aim: To compare the clinical periimplant status, survival rate, marginal bone level loss and bone density around the immediate implant placement in periapical infected versus periodontal infected sites. **Patients and methods:** Twenty patients were selected, ten patients suffering from non-restorable periapically infected tooth subjected to immediate implant placement in upper anterior region (Group1) and ten patients suffering from periodontally hopeless tooth subjected to immediate placement in upper anterior region (Group 2). After extraction of each infected tooth, the socket was debrided and the implants were placed immediately. The final restorations and loading were achieved 3 months following placement. Clinical parameters including modified Plaque Index (m PI), modified Gingival Index (m GI) and Pocket Depth (PD) were evaluated in the four surfaces of each implants at intervals 6, 9 and 12 months post-surgically. The marginal bone loss (MBL) and bone density (BD) were assessed at baseline, 3, 6, 9, 12 months of implant placement. Descriptive analysis, paired and unpaired t-test were performed. **Results:** After 12 months, the survival rates were 100% in each group. The means scores of marginal bone level loss in group 1 were significant higher than group 2 at the different intervals. The means scores of bone density in group 1 were significant higher than group 2 at the different intervals. At baseline the mean scores of bone density were very highly significant difference between the two groups. This difference gradually decreased during the follow up periods and become non-significant at 12 months interval. **Conclusions:** Immediate implant replacement of periapically and periodontally infected teeth could be considered promising modality in restoring upper esthetic teeth with high survival rate.

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1. Introduction

The main causes of tooth extraction are dental caries and periodontal diseases [(1)]. The failure of endodontic treatment may due to advanced periapical changes, highly curvature of the roots and over or under root canal treatment. The re- endodontic treatment procedures which may result in permanent damage to the root, that may challenge the maintaining the tooth [(2)]. The inner infection of the palp canal may cause by bacteria that have penetrated into the canal during or after the endodontic treatment. They can survive, multiply and eventually attack. This applies especially to highly pathogenic strains, tolerant to nutrient deficiency and resistant to disinfectants. [(3)]

The limitation of immediate implant of extracted tooth due to infection because the infection can be interfere with the bone healing and the remnant bacteria in the socket can contaminate the implant within the initial phase of healing and therefor the final outcome of osseointegration [(4)]

The most frequent microorganisms isolated from periapical infection were Fusobacterium nucleatum, Prevotella intermedia, Peptostreptococcus micros, Peptostreptococcus anaerobius, Eubacterium alactolyticum, Eubacterium lentum and Wolinella recta [(5)].

In spite to the extraction of the infected tooth generally leads to eradication of the colonized microorganisms [(6)]. The bacteria can persist as a contaminant in apparently healed alveolar bone following extraction of teeth with apical or radicular pathosis which may be reactivated to an infection during clinical implant therapy [(7)]. On the other hands; the periodontal involved tooth may be considered as non-restorative or hopeless and indicated for extraction in presence of two or more of the following criteria; hypermobility, loss of more than 75% of supporting bone, Class III furcation involvement or pocket depths more and equal to 8 mm [(8)].

Dental implants have been used for replacement of periodontal involved tooth as well as in patients without history of periodontitis successfully [(9)]. Immediate implant placement after extraction of a tooth with periapical disease can be obstructed by incomplete osseointegration process of the immediate implant placement in infected socket [(10, 11)]. In contrast to these findings, successful immediate implant placement in infected sockets with chronic periapical disease was determined [(12, 13)].

The advantage of immediate implant placement are preservation of alveolar width and height, shortening the healing period, reduction of the number of surgical sessions, better angulation leading to improved esthetics [14]. The success rate of dental implant depends mainly on the preservation of bone support and the stability of the implant, maintenance of osseointegration and stability in marginal bone level [15].

One of the most important success criteria of dental implant is the marginal bone level around implants [16]. The measurement of marginal bone loss (MBL) over time is regarded as a sensitive tool for evaluation of the prognosis of implants because gradual loss of marginal bone eventually will lead to implant failure. A pathologic decrease in bone level could lead to loss of one anchorage of the implant. During the first year, MBL of a maximum of 1.5 mm has been accepted, whereas MBL of 0.2 mm annually is considered acceptable for subsequent years [17, 18].

The aim of this study is to compare survival rate, clinical periimplant status, marginal bone loss and bone density of immediate implants placed in periapically versus periodontally infected sites.

2. Patients and methods

This retrospective study was carried on twenty adult patients (8 male and 12 female) with non-restorable periapically and periodontally infected teeth. All patients were selected from those patients attending at the out-patients clinic of Oral Medicine and Periodontology Department, Faculty of Dental Medicine, Al-Azhar University (Assiut Branch).

The study protocol was explained in detail to all patients and their consent for participating study was taken.

Inclusion criteria were:

Patients were included in the study according to the following criteria:

1. Medical history without any contraindications to implant therapy;

2- Patient with non-restorable tooth in anterior upper region subjected to be extracted.

3- Adequate bone to allow the placement of implant at least 10-mm-long.

4- Presence of four bony walls of the alveolus.

Exclusion criteria were:

1- Patients with systemic diseases such as uncontrolled diabetes, treated with bisphosphonate or radiation to the head within the past 12 months.

2- Pregnant and lactating women.

3- Patients with severe bruxism or clenching;

4- Patients smoked more than 10 cigarettes per day.

5- Presence of dehiscence, fenestration or gap between the bone of socket and the implant ≥ 2mm.

Patients grouping

Patients were divided into two groups:

Group 1 comprised of ten patients (4 male and 6 female with mean age 34 years ± 8.48) suffering from non-restorable periapically infected tooth subjected to immediate implant replacement in upper anterior region.

Group 2 comprised of the ten patients (4 male and 6 female with mean age 37 years ± 7.55) suffering from non-restorable periodontally involved tooth subjected to immediate implant replacement in upper anterior region.

Clinical evaluation

Through clinical examination, study cast and radiographic evaluation of the bone height and width as well as the pathological status. Initial periodontal therapy was completed prior to extraction and implant placement using ultrasonic scalar. The clinical parameters including modified Plaque Index (m PI), [19] modified Gingival Index (m GI) [20] and Pocket Depth (PD) were recorded in four surfaces of the each implant at intervals 6, 9 and 12 months post-surgically. Also marginal bone level and bone density was evaluated at intervals baseline (Bl) (implant insertion), 3, 6, 9 and 12 months post-surgically:

Implant selection

The implant system used in this study was Zimmer implant (Zimmer dental, 1900 Aston Avenue Carlsbad, CA 92008-7308. USA). It is designed for conventional and immediate loading applications with variable lengths and diameters according to the site of implant placement.

The implant diameter and length were based on clinical and radiographic evaluation of available bone using an X-ray indicator. Implants with widest possible diameter and maximum permissible length were selected depending on the clinical situation and preoperative radiographs.

Surgical procedure

Under local anesthesia, a traumatic extraction was performed. The sockets were thoroughly debrided using bone curettes to remove the granulation tissue and irrigated with normal saline solution. Each socket was evaluated to detect any bony defect as dehiscence or fenestration. For implant placement, the manufacture's recommendations were followed, the selected implants were placed within the body of the alveolus without mucoperiosteal flap and the coronal margin of the fixture was placed at the palatal level of the bone crest. Primary stability was achieved at 35Ncm. The healing abutment placed over implant fixture after initial placement. After three month placement of dental implant the permanent metal ceramic crown was constructed and cemented.

Postoperative home care instructions were given which included tooth brushing, 0.125% chlorhexidine rinse, Hexitol® (The Arab Drug Company for pharmaceutical & chemical industries Cairo A.R.E), and antibiotic medication, "Amoxicillin 875 mg+ Calvulanic acid 125 mg (Augmentin®)" (Medical union Pharmaceuticals, Ismailia, A.R.E) 1 g twice daily, two day before extraction and placement of implant and for one week after with analgesic if needed. The patients were instructed to avoid incising food in the operated sites for 6 weeks. Following the prosthetic reconstruction, the patients were seen at every 3 months for oral hygiene maintenance, re-evaluation and early detection any abnormal unwanted conditions.

Radiographic evaluation

Standardized periapical radiographs were taken by long-cone paralleling technique using film holder and occlusal acrylic bit for each implant site. These radiographs were taken before and immediately after implant placement (baseline) and at intervals 3, 6,9 and 12 months post-operatively (Fig 1, 2, 3).

The x-ray beam of the radiographed sites were received by image plate sensor size 2 that analyzed by photon collection system of vistascan® (Durr Dental Gmb H & Co. Bietigheim- Bissingen, Germany) to produce the image that manipulated by Bioquant ® software analysis program (Bioquant Image Analysis Corporation, Nashville, TN, USA).

The length of the implant fixture was measured and compared to the real fixture length to determine the magnification factor in the image. The maginal bone level was measured at two points mesial and distal to the implants from the end of the implant shoulder to the first visible bone to implant contact (BIC). The mean was calculated in mm according to the magnification factor of the image immediately following implant placement at baseline, 3, 6, 9 and 12 months.

Imaging analysis

The bone density around the implant was evaluated at baseline, 3, 6, 9 and 12 months by using the Bioquant image analysis software. In this software, the area to be measured, which called Regions of Interest (ROI) was selected (color density selection). A single pixel that represents a specific color (white pixels in radiographs) is selected or threshold allowing for automatic selection of all other pixels in the ROI that threshold areas are traced and counted as a number of pixels that can be calculated as a ratio of the whole ROI. Bioquant was used for calculation of the average density of the marginal and crystal bone. Average density is determined based on a scale of 0-256 and the number 256 (8 bits) stands for the whitest pixel on the screen while number 0 represents the areas of the darkest pixels on the screen, the ROI of these radiographs was a rectangle of a fixed size to contain the critical size defect precisely. The program calculates every pixel in the image and then performs the calculations necessary to get one number representing the average density of all the pixels and this number must be between the 0 and 256 values.

Statistical analysis

Results were expressed as mean values ± standard deviation, and means of difference for each variable and analyzed by Graph pad prism (windows version 6; Graph pad software 2007) to produce paired and unpaired t-test of the two groups. The level of significance was at ($P< 0.05$).

3. Results

This study was carried out on twenty patients divided into two groups with non significant difference between the age and sex. All patients complete the study with no sign of any complications and the all implants were stable. Clinical parameters were measured at 6 months of implant insertion (3 months after loading), 9 and 12 months after placement of implant. Means ± standard deviations, P-values and unpaired t- values of clinical parameters (m PI, m GI and PD) in both groups at 6, 9 and 12 were illustrated in table-1. There were non-significant difference regarding to modified Plaque Index (m PI) between the two groups at 6 and 9 months but at 12 months, there was very high significance difference between the two group (P-value <0.0007 and unpaired t- value = 4.093). There was non-significant difference regarding mean scores of modified Gingival Index (m GI) at 6, 9 and 12 months between the two groups. The mean scores of Pocket Depth (PD) revealed non significant difference at 6 months while at 9 and 12 months, there were very high significance difference between the two groups (P-value <0.0001) (Tab-1).

Marginal bone level

The means ± standard deviation, P- value and unpaired t- value of marginal bone level in both groups at baseline, 3, 6, 9, 12 months illustrated in table-2.

There were very high significant difference the marginal bone level loss between the two group at baseline (P-value = 0.0006 and unpaired t- value = 4.126), 6 months (P-value = 0.0009 and unpaired t-value = 3.945) and at 9 months (P-value = 0.0008 and unpaired t- value = 4.047) but at 3 and 12 months, there were significance and high significance difference between the two group (P-value =0.0192 and unpaired t- value = 2.571) and (P-value 0.0023 and unpaired t- value = 3.541) respectively (Tab-2 & Fig- 4).

The marginal bone level loss was increased with periodic intervals within each group at different intervals. There were very high significant differences the mean values of marginal bone level loss within group 1 and group 2 at different intervals (P-value <0.0001) except between the 9 and 12 months in group 1; the difference was decreased to high significant (P-value <0.0012) (Tab- 3 & Fig-4).

Bone density (BD)

The means ± slandered deviations, P- value and unpaired t- test of bone density in both groups at deferent intervals illustrated in table-4.

At baseline the mean scores of bone density in group 1 were 83.7±4.523 while in group 2 were 62.5 ± 8.502. There were very highly significant difference (P- value <0.0001 and unpaired t value = 6.962). This difference gradually decreased during the follow up periods. The mean scores of bone density group 1at 3 month were 88.3±3.622 compared to83.3 ± 3.622 in group 2. This difference were high statistical significant (P- value =0.0064 and unpaired t value =3.086). At 6 months the mean scores of bone density group 1 were 97.38±4.069 while in Group 2 were 91.4 ± 7.09. There were significant difference (P- value =0.0327 and unpaired t value =2.313). At 9 months, the mean scores of group 1 were 107±5.292 while in group 2 were 113 ± 5.375. There were significant difference (P- value =0.0216 and unpaired t value =2.516). At 12 months the mean scores of bone density in group 1 were 119.9 ±4.533 while in group 2 were 122.2 ± 2.898. There were non-significant difference (P- value =0.1932 and unpaired t value = 1.352) (Tab-4 & Fig-5).

Regarding to paired t – test, in group 1, there was high significant difference between the means of bone density at baseline and 3 months (P= 0.0034) and this difference was increased to very high statistical significant in following successive readings within the group (P <0.0001). While in group2; there were very high significant difference between the means of bone density at all successive intervals (P <0.0001) except between 3 and 6 months as well as between 9 and 12 months these differences were decline to become high statistical significant (P=0.0052 and 0.002) respectively (Tab 5).

Table (1): Mean ± standard deviation, P- value and unpaired t- value of clinical parameters (m PI, m GI and PD) in both groups at 6, 9 and 12 intervals

	m PI		m GI		PD	
	Mean ± SD		Mean ± SD		Mean ± SD	
	G 1	G 2	G 1	G 2	G 1	G 2
6 months	0.35 ± 0.175	0.38 ± 0.177	0.35± 0.187	0.37± 0.183	2.22±0.362	2.48±0.142
P- value	0.754 ns		0.889 ns		0.0528ns	
t- value	0.318		0.312		2.073	
9 months	0.475±0.142	0.5 ± 0.204	0.53±0.142	0.55±0.197	1.66±0.356	2.55±0.1581
P- value	0.754 ns		0.749 ns		<0.0001 ****	
t- value	0.318		0.325		7.275	
12 months	0.33 ± 0.121	0.6±0.175	0.4±0.129	0.5±0.234	1.7±0.307	2.33±0.170
P- value	<0.0007***		0.255 ns		<0.0001 ****	
t- value	4.093		1.177		5.631	

Table (2): Mean ± standard deviation, P- value and unpaired t- value of marginal bone level (mm) in the two groups at Bl, 3, 6, 9, 12 months.

	Bl		3 months		6 months		9 months		12 months	
	G 1	G 2	G 1	G 2	G 1	G 2	G 1	G 2	G 1	G 2
Mean	0.439	0.506	0.648	0.719	0.818	0.929	1.128	1.211	1.23	1.313
SD	0.032	0.040	0.068	0.055	0.068	0.057	0.038	0.053	0.066	0.033
P- value	0.0006***		0.0192*		0.0009***		0.0008***		0.0023**	
t- value	4.126		2.571		3.945		4.047		3.541	

Table (3): Mean of differences (MD), P-values and paired t- test of marginal bone level within each group

Interval / months	G1			G 2		
	MD	P- value	t-value	MD	P-value	t-value
Bl vs 3	0.209	<0.0001****	9.176	0.213	<0.0001****	9.054
Bl vs 6	0.379	<0.0001****	16.1	0.423	<0.0001****	23.09
Bl vs 9	0.689	<0.0001****	36.6	0.705	<0.0001****	38.58
Bl vs 12	0.791	<0.0001****	31.57	0.806	<0.0001****	49.59
3 vs 6	0.17	<0.0001****	31.57	0.21	<0.0001****	7.324
3 vs 9	0.48	<0.0001****	21.32	0.492	<0.0001****	25.87
3 vs 12	0.582	<0.0001****	17.21	0.593	<0.0001****	37.04
6 vs 9	0.31	<0.0001****	12.43	0.282	<0.0001****	10.84
6 vs 12	0.412	<0.0001****	16.52	0.383	<0.0001****	17.38
9 vs 12	0.102	=0.0012**	4.626	0.101	<0.0001****	7.734

Table (4): Mean ± slandered deviation, P- value and unpaired t- test of bone density (pixel) in both groups at deferent intervals

	Bl		3 months		6 months		9 months		12 months	
	G 1	G 2	G 1	G 2	G 1	G 2	G 1	G 2	G 1	G 2
Mean	83.7	62.5	88.3	83.3	97.38	91.4	107	113	119.9	122.2
SD	4.523	8.502	3.622	3.622	4.069	7.09	5.292	5.375	4.533	2.898
P-value	0.0001****		0.0064**		0.0327*		0.0216*		0.1932^{ns}	
t- value	6.962		3.086		2.313		2.516		1.352	

Table (5): Mean of differences (MD), P- values, paired- t test of bone density (pixel) within each group at deferent intervals

Interval / months	G 1			G 2		
	MD	P-value	t-value	MD	P-value	t-value
Bl vs 3	4.6	0.0034**	3.944	20.8	<0.0001****	8.297
Bl vs 6	13.68	<0.0001****	10.57	28.9	<0.0001****	8.153
Bl vs 9	23.3	<0.0001****	17.36	50.5	<0.0001****	14.36
Bl vs12	36.2	<0.0001****	28.08	59.7	<0.0001****	24.83
3 vs 6	9.08	<0.0001****	6.911	8.1	0.0052**	3.66
3 vs9	18.7	<0.0001****	9.591	29.7	<0.0001****	11.64
3 vs12	31.6	<0.0001****	17.24	38.9	<0.0001****	38.29
6 vs 9	9.62	<0.0001****	8.924	21.6	<0.0001****	9.142
6 vs12	22.52	<0.0001****	14.61	30.8	<0.0001****	13.66
9 vs12	12.9	<0.0001****	9.254	9.2	0.002**	4.302

Figure (1): Periapical radiograph of immediate implant at baseline

Figure (2): Periapical radiograph of immediate implant at 6 month

Figure (3): Periapical radiograph of immediate implant at 12 month

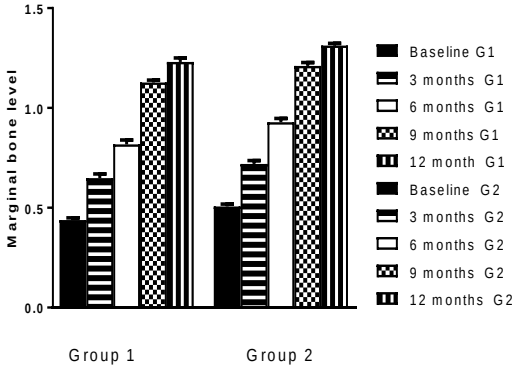

Figure (4): Histogram reveals the mean scores of marginal bone level (mm) in both groups at deferent intervals

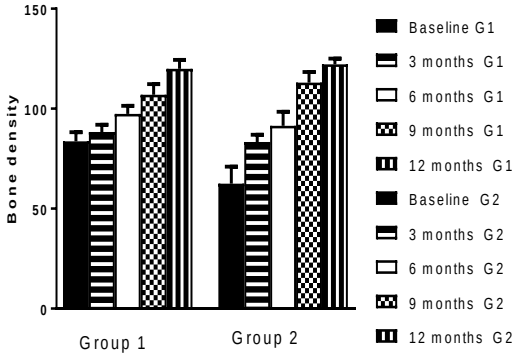

Figure (5): Histogram reveals the mean scores of bone density (pixel) in both groups at deferent intervals

4. Discussion

Intraosseous implants can be placed using three different techniques, including the immediate technique in which the implant is placed immediately after tooth extraction, the early technique, in which the implant is placed after soft tissue healing, and delayed technique, in which the implant is placed after the healing of the alveolar ridge [(21)].

Bone healing and coronal bone remodeling of immediate placed implant after tooth extraction showed that; new bone apposition around the neck of the implants and bone resorption with horizontal width reduction of the bone ridge. The small periimplant bone defects were completely healed without the use of guided bone regeneration (GBR) techniques [(22)]. So small bony gaps less than 2 mm in width were included in the present study and larger defect were excluded and received bone grafting materials.

Although the flap technique allows good accessibility and manipulation of the surgical sites, the flapless technique used in the present study, to avoid increased amount of vertical and horizontal bone resorption associated with flap surgery [(23)].

The primary stability was achieved in the present study by placement the apical end of the fixture at least 4 mm beyond the root apex of the extracted tooth and at least 8 mm length to gain higher primary stability in all cases, this is in accordance with other study concluded that; in most cases, placement of apical end of the dental implant at 3 to 5 mm beyond the apex was sufficient to gain the higher degree of primary stability [(24)].

The survival rates of the immediate placement implants were 100% after 12 months in the periodontal and periapical infected non restorable teeth in the present study. This high success rate may due careful patient selection, control of inflammatory response as well as reducing the number of persistent bacteria in formerly infected socket due to pre and post-surgical antibiotic therapy, complete debridement of granulation necrotic tissues and irrigation. Similar report indicated that; high survival rate and the minimal marginal bone changes was reported in immediate post-extraction implant when placed immediately after extraction of teeth presenting endodontic and periodontal lesions following antibiotic therapy, debridement, and high primary stability [(25)]. Another retrospective study compared the survival rates of immediate implants with and without periapical pathologies. The success rates between the study and control group was 97.5% and 98.7% respectively which was statistically insignificant [(26)].

The effectiveness of implant treatment depends on a number of different factors, including insufficient bone levels at the implant site, periodontal and perapical infections, adverse anatomic conditions, significant bone defects, and the need for augmentation procedures [(2)].

The bone resorption rate of both groups in this study was not exceed the success rate of bone resorption determined by Albrektsson et al. [(17)] they estimated that; successful implant should have less than 1.5 mm bone resorption during the first year of prosthetic treatment and subsequent annual bone resorption rate of less than 0.2 mm.

The delayed loading protocol selected in the present study (3 month after implant placement) to permit the chance of new bone formation and in accordance with other finding suggested that; early occlusal loading during healing may interfere with the ability of new bone being formed to replace the necrotic bone at the implant/bone interface resulting from surgical trauma, significant crestal bone loss,

poor bone apposition in the upper portion of the implant compared to unloaded implants. These differences could be attributed to the effect of early occlusal loading on the implant during initial bone healing [(27)].

The levels of marginal bone loss occurred during the first 6 months were nearly similar to later 6 months, these results were in contrast to results of other study [(28)] which reported that; greatest amount of bone loss occurred during the first 6 months after implant placement in comparison with the later time of implant placement. These results could be attributed to delay loading protocol used in the present study and the difference in implants sites.

The bone density were higher in periapically infected sites at baseline than in periodontally sites and the bone density scores were increased in all follow up periods in both groups when compared with baseline as well as there was a statistically significant increase in bone density around implants placed in periapically infected sites group than periodontally sites group. This can interpreted by; in periodontal infected tooth, the inflammatory condition and its mediators can affect the whole length of the socket of affected tooth while in periapical infected the inflammatory conditions may concentrated to periapical area of the root and after extraction, the healing pattern may become same in both conditions. The mean of bone density was increased with the healing progress and these results in accordance with results of Daife [(29)], he shown that; the mean values of the bone density measurements around the implants in patients received immediate dental implants without any filling material around the implants were 1150 ± 205 (range, 645-1460) at 3 months and 1245 ± 165 (range, 884-1650) at 6 months and the difference in the density scores may due to the variation in the radiographic techniques used.

The results of the present study in parallelism with the study of Fugazzotto that revealed the survival rate immediately placed implants in sites demonstrating periapical pathology versus to immediately placed in pristine sites in maxillary incisor region. The difference in survival rates was non statistically significant [(30)]. The clinical parameters evaluated in this study reveal high success and good the periimplant status. There were non significant difference regarding to m PI between the two groups at 6 and 9 months but at 12 months, there was very high significance difference between the two groups. There was non significant difference regarding mean scores of m GI at 6, 9 and 12 months between the two groups. The mean scores of PD revealed non-significant difference at 6 months while at 9 and 12 months, there were very high significance difference between the two groups. These results were relatively similar to other results confirmed that; immediate implants replacing teeth with and without chronic periodontitis showed no significant differences in implant placed in infected sites compared to implants placed in uninfected sites regarding plaque index and gingival inflammation [(31)].

Conclusions

The results of present study demonstrated high survival rates of immediate placed implants in periapically and periodontally infected sites with no significant difference between them. Immediate placement implants in infected sockets can be indicated as promising compensating modalities in restoring upper esthetic teeth after meticulous debridement of the infected sites and antibiotic therapy. The marginal bone level loss were higher level in periodontally infected sites than periapically infected sites while higher scores of bone density were determined in periapically infected sites than periodontally involved sites. Long-term follow up after 1 year of observation is necessary to follow-up surgical treatment.

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