

Original article

Dimensional changes of hard and soft tissue after immediate implantation in comparison with conventional tooth extraction

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Abstract:

Introduction: Immediate implantation in single-root teeth has been claimed to possess some benefits, especially bone preservation. The aim of this study was to evaluate ridge changes after immediate implantation in comparison with tooth extraction and dental socket healing. **Methods and Materials:** In this study, 21 patients with hopeless single-root teeth were selected. After impression and cast making, the patients were divided into test and control groups. Each group included twelve dental sockets. For all teeth the extraction was performed atraumatically. Measurements included bucco-lingual ridge dimensions at 3mm and 7mm apical to an imaginary line connecting the CEJs of the two adjacent teeth (CEJ line) as well as vertical distance between the mentioned line and bone crest at the mesiobuccal, midbuccal, distobuccal, mesiopalatal, midpalatal, and distopalatal aspects. In addition, soft tissue measurements similar to hard tissue ones were taken using stone casts and acrylic stents. In test group immediate implantation was carried out following extraction whereas in the control group dental sockets were left for natural healing. Four months after the operation, in both groups, the flap was reflected and measurements taken at baseline were repeated. **Results:** Vertical changes of soft tissues in test group were significantly less than control group at all points except in mid-buccal aspect (p=0.033 for mesiobuccal, p=0.026 for distobuccal, p=0.004 for midpalatal, p=0.002 mesiopalatal, p=0.022 for distopalatal, p=0.016 for distal, p=0.048 for mesial). Horizontal dimension change of soft tissue at 7mm apical to the CEJ line in test group, were also significantly less than control group (p= 0.051). Vertical changes of hard tissue, measured in all points, in test group were less than those of control group. These changes were significant in mid-buccal, mid-palatal, mesiopalatal and distopalatal points (p= 0.046, 0.029, 0.020 and 0.026 respectively). Horizontal changes of hard tissue at 3 mm and 7 mm apical to the CEJ line in test group were also less than control group. However, this was significant only at the 3mm point (p=0.028). **Conclusion:** According to the results of this study, it can be concluded that immediate implantation is to some extent effective in reducing the expected vertical and horizontal bone and soft tissue changes occurring following conventional tooth extraction and natural socket healing. Further investigation is warranted to determine the optimum method of preventing these changes.

Key Words: soft tissue; implantation; tooth extraction

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Introduction :

Repair of extraction socket is always accompanied by the loss of width and height of alveolar ridge. Many different methods were evaluated for preservation of ridge or socket after tooth extraction and all of them have been somehow effective in prevention of width and height decrease of ridge. Preserving the surrounding tissue of extracted tooth could conservatively and significantly omit or decrease aggressive bone surgery methods. When a tooth is extracted and prepared for implant, prevention of alveolar bone recession is ideal.

Time of implantation relative to the time of tooth extraction is a controversial subject among many clinicians. Dependent on the quality and quantity of existing bone and the ability of clinician and patient, implantation could be immediate, delayed, or staged after tooth extraction. According to this definition, immediate implantation is done at the time of tooth extraction.¹

The main advantage of immediate implantation is reducing the healing time. Because of putting implant at the time of tooth extraction, bone repair is immediately started after tooth extraction.²

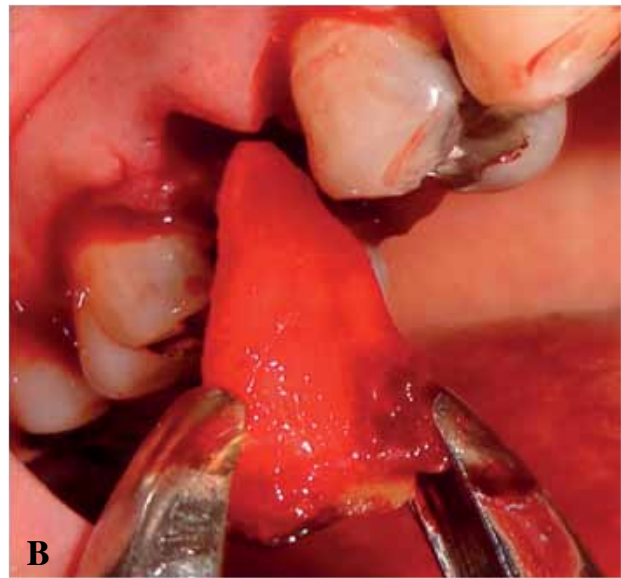


Fig 1 . A & B : Hopeless tooth was extracted atraumatically in each group

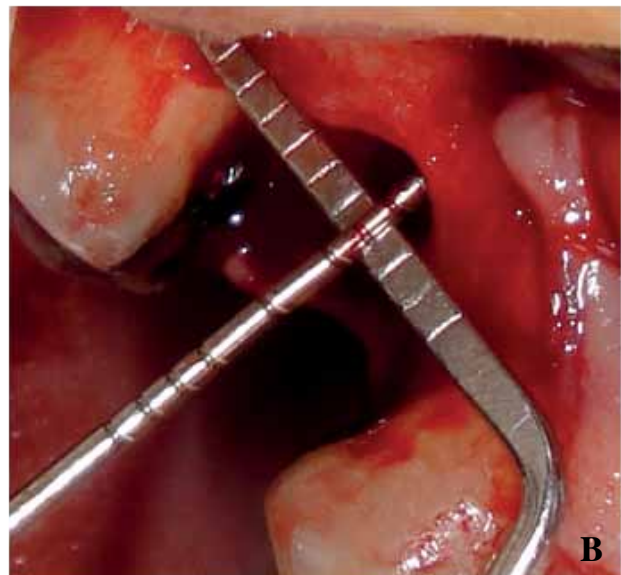
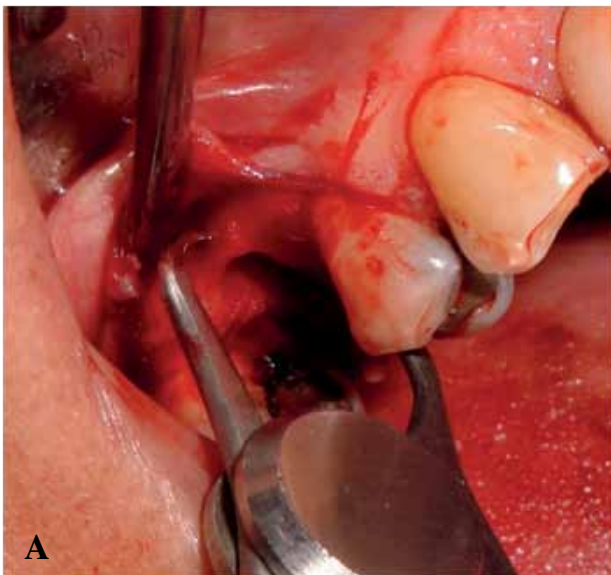


Fig 2 . A: Buccolingual dimension of the bone was measured by a cliper at midbuccal aspect 3, and 7 mm apical to an imaginary line connecting the CEJs of the two adjacent teeth (CEJ line). B: the vertical distance between the mentioned line and bone crest at the midbuccal, midbuccal, distobuccal, mesiopalatal, midpalatal, and distopalatal aspects were measured.

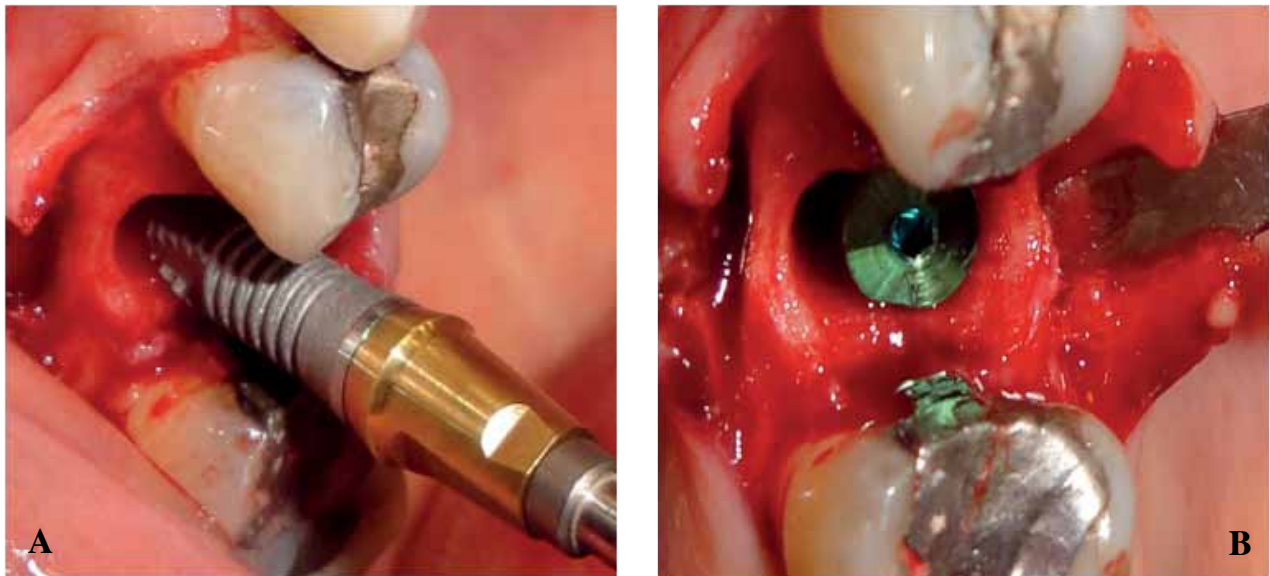


Fig 3 . A&B : in the test group immediate implant was implemented

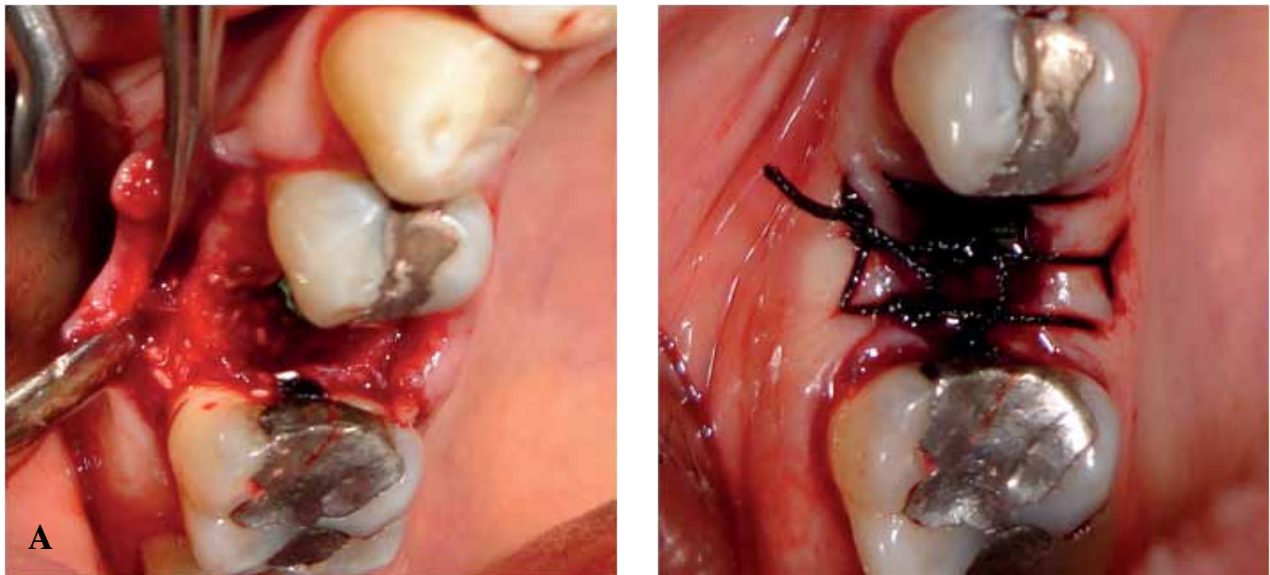


Fig 4 . A : If the width of the gap around the implants was more than 2 mm, it was filled with DFD-BA and absorbing membrane was installed.

B : flaps were replaced back to their places and sutured with 3-0 silk

A possible disadvantages of immediate implantation include the possible need to mucogingival surgery (to correct the repositioned tissues because of flaps) and bone graft (to fill the empty spaces around the implant).³

Chen et al.⁴ reviewed immediate implantation and concluded that this method leads to preservation of socket and surrounding jawbones and prevention of jawbones atrophy. Another conclusion was that the survival rate and clinical advantages of both immediate and conventional implantations are similar.

The primary remodeling starts after tooth extraction

and it continues even after delayed implantation. It has been calimed that the continuation of socket remodeling after immediate implantation could negatively affect the esthetic outcome of such technique if used at esthetically important regions.⁵ Covani et al⁶ measured the buccolingual width reduction between immediate and delayed implantation methods were 1.9 mm and 3 mm respectively as compared to the pre-extraction bone position. Quiryne⁷ evaluated 351 studies and reported that failure of immediate implantation hd been less than 5 percent, and if these implants were loaded immediately the percentage would increase.

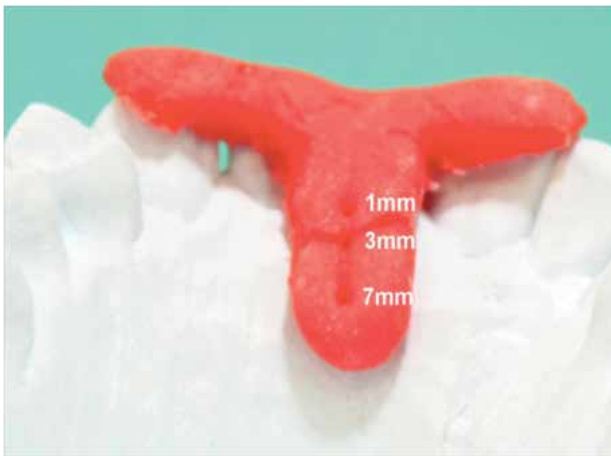


Fig 5 : stone casts and acrylic stents were used to take the following measurements

In a study, Lindhe et al⁸ concluded that immediate implantation did not have the ability to prevent the ridge atrophy after tooth extraction, and both buccal and lingual bones resorbed to some extent leading to marginal loss of marginal osteointegration and recession which was more pronounced at buccal than lingual aspect. In a study conducted by Botticelli⁹ on 21 recently extracted teeth, it was shown that, 4 months after immediate implantation, ridge remodeling could not be prevented completely, although in this study no grafting material and membrane were used to fill the space between the bone and implant, this result was similar to Al-Hezaimiet al¹⁰ reports that concluded immediate implant placement did not prevent or minimize bone remodeling in extraction sites.

Furthermore, Araujo¹¹ evaluated the efficacy of bone graft in the buccal gap around the immediate implant that indicated Bio-oss Collagen modified the process of hard tissue healing, and improved the level of marginal bone-to-implant contact. more studies are needed to investigate gap grafting

around immediate implant clinically. Therefore, the purpose of this study was to measure the ridge dimension changes following immediate implantation together with bone grafting in the gap between the implant and the socket walls.

Materials and Methods:

This study was conducted on 21 patients, 13 female and 8 male subjects with average age of 39 (21-43 years old) and with single rooted teeth deemed to be extracted for various reasons and replaced by implant treatment. The exclusion criterion included smoking, presence of large periapical radiolucency, an actively suppurating fistula, as well as the lack of bony plates requiring bone augmentation. After completing an informed consent form approved by the Ethical Committee of Mashhad University of Medical Sciences, impression was taken using silicon impression material and stone casts were made for further measurements. The patients were randomly divided in 2 groups. One group received immediate implantation (test) and another group was assigned to delayed implant treatment (control). In each group, there were 12 tooth sockets. Starting 2 days before surgery, patients took 500mg amoxicillin tid and 0.2 % chlorhexidine mouthwash for 10 days.

After local anesthesia (lidocain with 1:100000 epinephrin), the tooth was extracted atraumatically. Buccolingual dimension of the bone was measured by a clipper at midbuccal aspect 3 and 7 mm apical to an imaginary line connecting the CEJs of the two adjacent teeth (CEJ line). In addition, the vertical distance between the mentioned line and bone crest at the mesobuccal, midbuccal, distobuccal, mesiopalatal, midpalatal, and distopalatal aspects were measured. At the distal and mesial aspects the vertical distance between the CEJ of the adjacent tooth and the proximal socket bone crest was



Fig 6 . In 4 months after implantation in test group, A&B : hard tissue measurements were done, C :insertion of healing abutment

Table 1: Vertical soft tissue recession at midbuccal, mesiobuccal, distobuccal, midpalatal, distopalatal, mesial, and distal aspects of test and control sites.

Tooth aspect	group	mean ±SD	median	P-value
Midbuccal	Test group	1.04 ± 0.71	1	0.266
	Control group	1.22 ± 0.74	1.25	
Mesiobuccal	Test group	0.79 ± 0.72	0.5	0.033
	Control group	1.32 ± 0.74	1.25	
Distobuccal	Test group	0.75 ± 0.52	0.5	0.026
	Control group	1.32 ± 0.75	1.25	
Midpalatal	Test group	0.58 ± 0.52	0.5	0.004
	Control group	1.32 ± 0.75	1.25	
Mesialpalatal	Test group	0.43 ± 0.64	0.5	0.002
	Control group	1.32 ± 0.74	1.25	
Distopalatal	Test group	0.68 ± 0.71	0.5	0.022
	Control group	1.32 ± 0.74	1.25	
Distal	Test group	0.79 ± 1.19	0.5	0.016
	Control group	1.32 ± 0.75	1.25	
Mesial	Test group	0.78 ± 1.02	0.5	0.048
	Control group	1.32 ± 0.74	1.25	

Table 2: The buccal horizontal loss of soft tissue at 1, 3, and 7 mm apical to CEJ of the two adjacent teeth.

Vertical distance to the line joining the 2 adjacent buccal CEJs	1mm		3mm		7mm	
	mean ±SD	median	mean ±SD	median	mean ±SD	median
Test group	3.55 ± 4.01	1.65	1.5 ± 1.7	0.9	1.42 ± 1.24	0.45
Control group	4.75 ± 3.20	4.85	3.58 ± 4.24	2.5	2.22 ± 2.62	1.65
P-value	0.502		0.545		0.051	

measured.

In the control groups no further treatment was carried out whereas in the test group immediate implant was implemented. After incision, a flap was raised, bone preparation was performed and implants (Biohorizons implant system, Birmingham, USA) were installed according to standard protocol. If the width of the gap around the implants was more than 2 mm, it was filled with demineralized freeze-dried bone allograft (DFDBA) (Cenobone, HamanandSazeBaft, Iran) and absorbable membrane (Cenobone, HamanandSazeBaft, Iran) was installed where needed. Then flaps were replaced back to their places and sutured with 3-0 silk. For pain relief, 400 mg. Ibuprofen was prescribed. After 10 days, sutures were removed.

To measure the soft tissue contours in each group, stone casts and acrylic stents were used

to take the following measurements: vertical distance between the reference point on the stent and the gingival margin at midbuccal, distobuccal, mesiobuccal, midpalatal, distopalatal, mesial and distal aspects. Furthermore, buccolingual measurements of the soft tissue contour were carried out at 1, 3 and 7 mm apical to CEJ line.

In 4 months the impressions were repeated and all measurements were repeated. Moreover, the same hard tissue measurements were taken. For the immediate implant group, this corresponded with the implant recovery second stage surgery and healing abutment insertion, whereas in the control group this was at the time

of implant insertion. Baseline and follow up CBCT x-rays were used to confirm the clinical measurements were needed.

For the statistical analysis paired t test was used to test the difference between pre and post implant changes within each group. Two sample t test were used to test the significance of difference between the changes occurred in the test and control groups. A statistical package was used (SPSS, version 4).

Findings:

(Table 1). Vertical soft tissue recession took place at all study teeth after 4 months. This held true for both test and control groups. However, recessions in the test group were consistently lower than the control group. Only at midbuccal region the difference between test and control groups was not significant.

(Table 2) demonstrates the horizontal soft tissue change at midbuccal regions measured at differing apical distance in relation to CEJs of the 2 adjacent teeth. This variation in control group was more than that of test group, but it was not statistically significant at 1 and 3 mm levels. However the difference was significant at 7 mm level.

(Table 3). Vertical hard tissue recession took place at all study teeth after 4 months. This held true for both test and control groups. However, recessions in the test group were consistently lower than the control group. Only at mesiobuccal, distobuccal and distal regions the difference between test and control groups were not significant.

Table 3: Vertical hard tissue resorption at midbuccal, mesiobuccal, distobuccal, midpalatal, distopalatal, mesipalatal, mesial, and distal aspects of test and control sites.

Tooth aspect	group	mean ±SD	median	P-value
Midbuccal	Test group	0.25 ± 2.25	0.75	0.046
	Control group	1.04 ± 2.58	1.5	
Mesiobuccal	Test group	0.26 ± 1.87	0.25	0.0703
	Control group	0.99 ± 0.65	1	
Distobuccal	Test group	0.41 ± 3.05	0.62	0.656
	Control group	0.64 ± 0.68	0.75	
Midpalatal	Test group	0.12 ± 3.54	0.25	0.029
	Control group	1.3 ± 0.73	1	
Mesipalatal	Test group	0.08 ± 4.25	0	0.020
	Control group	1.03 ± 0.49	1	
Distopalatal	Test group	1.08 ± 2.75	0.5	0.026
	Control group	0.95 ± 0.56	1	
Distal	Test group	0.75 ± 2.01	0.75	0.761
	Control group	0.79 ± 0.66	1.70	
Mesial	Test group	1.5 ± 1.94	1	0.741
	Control group	1.080 ± 0.50	1	

Table 4: The buccal horizontal loss of hard tissue at 1, 3, and 7 mm apical to CEJ of the two adjacent teeth.

Vertical distance to the line joining the 2 adjacent buccal CEJs	3mm		7mm	
	mean ±SD	median	mean ±SD	median
Test group	0.71 ± 3.57	0	0.67 ± 3.75	0.55
Control group	2.89 ± 2.92	1.8	1.97 ± 1.26	1.5
P-value	0.028		0.090	

(Table 4) demonstrates the horizontal hard tissue change at midbuccal regions measured at differing apical distance in relation to CEJs of the 2 adjacent teeth. This variation in control group was more than that of test group, but it was not statistically significant at 7 mm level. However the difference was significant at 1 and 3 mm levels.

Discussion:

Our data indicated that although some bone resorption took place in the immediate implantation group, this was far less pronounced than that observed in the conventional extraction group. Chen et al⁴, and Wagenberg et al¹² have reported that immediate implantation could bring about success rates similar to conventional protocol. On the

contrary, Lindhe et al⁸ stated that immediate implantation could not prevent bone and soft tissue shrinkage observed following extraction. It sounds that if wide gaps are filled during immediate implantation, bone alterations could be prevented to a large extent. Araujo et al¹¹ and Park¹³ reported that when the gap between the implant and buccal plate is filled with bone biomaterial, the reduction in vertical and horizontal dimensions is diminished.

The results of this study were similar to De Rouk¹⁴ study. They reported that immediate implantation together with immediate provisionalization could result in a satisfactory esthetic outcome. Our figures in terms of soft and hard tissue alterations corroborate well with those of DeRouk et al. Likewise, Grandi et al¹⁵ and Felice et al¹⁶

reported that acceptable esthetic outcome could be expected in immediate implantation.

Evaluations of vertical variations of soft tissue in this study showed that in test group, at all regions of buccal and lingual surfaces, soft tissue reduction was significantly less than control group. However, in midbuccal sites this variation was not significant. It sounds that midbuccal sites are more prone to bone resorption whether or not the immediate implantation is performed. Presumably, thin bundle bone of the buccal aspect will lose its source of nourishment following extraction, giving rise to bone reduction. Nevertheless, the bone and soft tissue reduction at midbuccal sites were still smaller when immediate implantation was carried out. Our study results indicated that previous notions that immediate implantation could not prevent bone alteration observed following tooth extraction is not justified. Particularly our measurements showed that mesial and distal aspects of fresh extraction socket could be maintained more efficiently if an immediate implantation is carried out. However, it sounds that midbuccal portion of periodontium is more prone to resorption after immediate implantation as compared to other sites. Perhaps, Soft tissue augmentation procedures could partly offset this drawback.

In this study, evaluation of horizontal dimensions of soft tissue was also performed and it was more in all points (1, 3, and 7 mm from CEJ of two adjacent teeth) in control group. Few studies evaluated these dimensions with such details.

In our study, evaluating the alterations of hard tissue was performed in both vertical and horizontal dimensions. Evaluation of vertical dimensions showed that in all of 8 points (midbuccal, midpalatal, mesial, distal, distobuccal, distolingual, mesiobuccal, mesiolingual) the changes were less in test group than control group. However, despite the differences, vertical changes at distal and mesial points were not significant presumably, because of the presence of enough bone bulk in these regions and consequently less reduction. The results of this study were similar to Chen, Wagenberg and Nowzari^{4,12,18}, but different from Botticelli, Covani, Lindhe, Araujo studies^{9,6,8,17}. The reason might be the fact that in our study, hard tissue changes were evaluated in 8 points and the gaps greater than 2 mm between implant and crest, were filled with DFDBA, which could prevent more reductions.

Evaluation of horizontal changes showed that the difference at 3 mm between two groups was significant but not at 7 mm. In 3 mm regions, the thickness of bone tablet is low, so reduction is more probable.

Further studies are required using larger sample size. In addition, it is required to directly compare immediate implantation with delayed implantation on sockets preserved by bone substitutes.

Conclusion: This study showed that immediate implantation may prevent vertical and horizontal alveolar bone and soft tissue reduction as compared to natural socket healing.

Conflict of interest: None

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