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Original Article

Radiographic Bone Changes around Immediately Placed Immediately Restored Dental Implants in Periodontally Compromised Sites Treated With Duo-Teck Membrane

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ABSTRACT

The aim of this study is to evaluate radiographic success of GBR procedures using Duo-Teck membrane around immediately restored dental implants placed immediately in fresh extraction sockets that showed clinical signs of periodontal disease.In this prospective clinical trial human study, ten patients (four males and six females, 25 to 37 years old) were selected from outpatient clinic of the Department of Oral Medicine, Periodontology, Oral Diagnosis, and Radiology, Faculty of Dentistry, Tanta University. Patients signed an informed consent. Inclusion criteria's of the present study included: age range from 20-40 years of both sexes, absence of any complicating systemic condition that may contraindicate surgical procedures and implant placement, adequate oral hygiene and adequate bone height apical to the alveolus of the failing tooth (≥5 mm) to ensure primary implant stability. After initial examination and treatment planning, all patients underwent the periodontal treatment deemed necessary to facilitate wound healing. Ten teeth were extracted as a result of sever periodontal destruction, followed by immediate implant placement, covering of the periimplant dehisced bone defects with Duo-Teck membrane and immediate implant restoration. Implant survival was evaluated for each patient at 6, 9 and 12-month follow-up period. The bone level was measured as the distance from the implant shoulder to the first bone–implant contact by periapical radiographs. Subtraction radiography was performed to compare and subtract the baseline image from follow up period images at 12 months. The healing period was uneventful for all the patients. The survival rates of the immediately placed implants in the present study were 100%. At the end of the 12-month follow-up period, patients were asymptomatic and showed no signs of infection or bleeding when probed. The periapical radiographs, obtained in a standardized manner, a significant reduction of the bone defect depth at 6, 9 and 12 months when compared to immediate post-operative record. Also massive increase of the mean bone density scores at 12 months when compared to immediate post operative record. Based on the results of this clinical trial,

placement of implants immediately in fresh extraction sockets affected by periodontal disease followed by regenerative procedures using Duo-Teck membrane and finally immediate restoration may be a valid operative technique that leads to predictable results if adequate preoperative and postoperative care is taken.

Keywords: Bone regeneration; dental implantation, endosseous; esthetic, dental; immediate dental implant loading; Duo-Teck membrane

INTRODUCTION

Dehiscences, fenestrations, or other peri-implant defects could be considered common problems during implant placement when optimal restorative results are sought under less than ideal anatomical situations. Guided bone regeneration (GBR) techniques have been successfully applied in the treatment of peri-implant bony defects and for increasing the width and height of the alveolar ridge in experimental animals and in humans. (Buser *et al.,* 1993; Simion *et al.,* 1992; Nevins *et al.,* 1992; Mellonig *et al.,* 1993; Jovanovic *et al.,* 1992).

These techniques utilize barriers to create a secluded space around the defects allowing bone regeneration without the competition of other tissues. When comparing bioabsorbable and nonresorbable membranes, better results with the nonresorbable membranes (Simion *et al.,* 1996) or no differences between the 2 barriers (Nociti *et al.,* 2001) have been reported. Vlaminck *et al.,* (2008) in an animal model and Cornelini *et al.,* (2004) in their clinical trial have demonstrated the successful outcome of dental implants immediately placed in fresh extraction sockets, with or without the use of membranes or regenerative procedures. Lazzara (1989) concluded in his clinical study that the use of guided bone regeneration can result in bone-forming cells that populate the peri-implant space. This technique has been suggested for years in the treatment of peri-implant bone defects for implants placed immediately after tooth extraction. Nemcovsky and Artzi (2002) observed that the barrier membrane, if covered with soft tissues, could predictably allow successful osseointegration for implants placed in fresh extraction sockets. On the contrary, an early exposure of the membrane to the oral cavity can lead to complications, such as bacterial colonization and infection that would require the removal of the membrane (Warrer *et al*., 1991).

Barone *et al.,* (2006) carried out immediate loading of implants placed in fresh extraction sockets in the anterior (premolar to premolar) region to maintain an excellent soft tissue esthetic profile around the implant-prosthetic restoration with a survival rate of 100%.

Since few studies (Anderson *et al*., 2002; Campelo and Camara, 2002; Rocci *et al*., 2003) have focused on immediate loading of implants placed in fresh extraction sockets, with limited data for soft tissue measurements around implants, the aims of the present clinical study were to evaluate the implant survival and the periimplant radiographic changes around immediately provisionalized dental implants placed in fresh extraction sockets in periodontal compromised sites, with GBR procedure using Duo-Teck membrane.

MATERIALS AND METHODS

Patient selection

Ten patients were selected from outpatient clinic of the Department of Oral Medicine, Periodontology, Oral Diagnosis, and Radiology, Faculty of Dentistry, Tanta University. All patients were provided with written and verbal information about the study and those who fulfilled the criteria were invited to participate in the study. All patients were given informed consent to participate in the study and had the right to withdraw from the study at any time, without consequences to their future care.

Patients were selected according to the following criteria: age ranged from 20- 40 years of both sexes, adequate bone height apical to the alveolus of the failing tooth (≥5 mm) to ensure primary implant stability, good oral hygiene, completion of skeletal growth, with nil growth considerations affecting implant therapy, psychological acceptance to dental implants and the involved procedures as explained to each patient, and patients should be in apparent good health with no contraindications for surgery, patients with sever periodontitis (chronic or aggressive periodontitis) with anterior periodontally hopeless teeth based on clinical and radiographic assessments according to Flemmig (1999). Teeth were characterized as hopeless if they presented with two or more of the following criteria: loss of 75% of the supporting bone; probing depth (PD) >8 mm; grade III mobility; poor crown/root ratios; root proximity; and a history of periodontal abscess.

Patients were excluded according to the following criteria: the need for prior augmentation of the implant site, presence of persistent and unresolved infection in the implant site, history of smoking, drug or alcohol abuse, poor oral hygiene, presence of systemic conditions that would be a risk factor for the placement of dental implants , severe bruxism or clenching habits and malocclusion, pregnancy, bisphosphonate therapy and history of radiotherapy in the head and neck region for malignancies, chemotherapy for treatment of malignancy.

Duo-Teck is a membrane made of lyophilized collagen of equine origin. Duo-Teck is a biocompatible and quickly resorbable membrane. Thickness of Duo-Teck membrane is about 1mm, estimated resorption time is about 15 days and it is supplied in packaging of 20×20 mm in blister. Duo-Teck differs from other membranes as it is coated on one side with a film of micronized bone, also of equine origin. This coating increases its consistency and stability, allowing good protection of grafts together with a correct reposition of soft tissues.

All patients received prophylactic antibiotic therapy of 2 g amoxicillin (or 600 mg clindamycin if allergic to penicillin) 1 hour before the extraction and implant placement procedures, and they continued to take the antibiotic postoperatively, 1 g amoxicillin (or 300 mg clindamycin) twice daily for 5 days. All patients rinsed for 1 minute with 0.2% chlorhexidine mouthwash before the surgery (and twice a day for the following 3 weeks) and were treated under local anesthesia using lidocaine with adrenaline at 1:50,000.

All the patients were treated with the same surgical technique consisting of a tooth extraction and simultaneous implant placement. In brief, a full-thickness flap was elevated, and two releasing incisions were performed, extending over the mucogingival junction. Tooth extractions were performed gently to minimize the trauma. After extraction, the socket was carefully curetted, and, subsequently, the implant bed was prepared according to the standard procedure with standard drills following the palatal bony wall as a guide with maximum use of the bone apical to the removed tooth. The longest possible implants were placed with the implant platform placed at the marginal level of the buccal wall. All the implants showed good primary stability. Duo-Teck membrane was used to cover the implant and bone defect.
At the time of surgery, provisional crowns were fabricated and seated. 9 months later, permanent restorations were cemented.

Post-operative care

The patients were asked to perform the following measures: cold packs for the first 8 hours, soft diet for the first week, 1 g amoxicillin (or 300 mg clindamycin) was prescribed 2 times per day for 5 days, ketoprofen 150mg was prescribed twice per day for 5 days, warm chlorhexidine gluconate 0.1% mouth wash twice per day in the second post-operative day and was continued for two weeks, avoidance of the surgical site while brushing and eating, the sutures were removed after 7-10 days post-surgically, one week later the operation site was again checked to ensure complete soft tissue healing, and finally and the patients were seen monthly for prophylaxis.

All patients participated in a personally tailored supportive periodontal treatment (follow-up visit at 3 months after treatment) comprising periodontal debridement, root planing at sites

with probing depth >5 mm, and polishing. At these visits, the condition of the soft tissues, the patient's discomfort, and any prosthetic complications were evaluated. The overall level of oral hygiene was also evaluated, and additional instructions were given as needed. Last, once a year, a clinical and radiographic evaluation was performed.

The patients were examined clinically and radiographically at 6, 9 and 12 month from implant placement for the following criteria:

I) Implant survival according to Gunne *et al.*, (1992): Implant survival was defined in the following way: the implant was clinically immobile when examined after the crown was clinically removed, there was no pain in the implant area, and radiographs did not demonstrate any radiolucency or other pathological conditions adjacent to the implant.

II) Radiographic evaluation: Standardized periapical radiographs were taken at the time of implant placement, 6, 9 and 12 months after implant placement. The first radiographs after surgery were taken with the implant in situ with temporary restoration, and subsequent radiographs with the restoration were standardized using a radiographic stent.

A) Marginal bone level: These standardized radiographs were used by Image J software program to calculate:

a) Mesial marginal bone level: the distance from the shoulder of the implant to the first visible bone-to-implant contact (BIC) mesially.
b) Distal marginal bone level: the distance from the shoulder of the implant to the first visible bone-to-implant contact (BIC) distally.

B) Bone density changes: Subtraction radiography was performed to compare and subtract the baseline image from follow up period images at 12 months. Subtraction procedures were carried out using image analyzer software.

Statistical Analyses

Statistical analyses, including descriptive statistics for all clinical and radiographic parameters, were performed during the entire follow-up period. Implant clinical measurements were calculated by averaging the readings of each implant parameter for each patient, because the within patient variation was much lower than among patient variation. Subsequently, the means and medians were calculated among the means per patient at each study time point. The comparison within the group among the different time points was performed with dependent Student t test (statistically significant at a level of a = 0.05). The P value was set at <0.05 with the Bonferroni corrections for multiple comparisons. All the data were analyzed using dedicated statistical software.

RESULTS AND DISCUSSION

15 patients with anterior periodontally hopeless teeth of the maxillary arch were identified and approached to participate in the study. 10 patients fulfilled the inclusion and exclusion criteria and signed informed consent for participation in the study. The reasons for the 5 excluded patients included: one patient due to lack of interest in implant therapy, one patient due to inadequate bone volume for implants, one smoker patient, one patient due to malocclusion, and one diabetic patient.

The 10 patients participated in this study, consisted of 6 females and 4 males. The mean age of subjects was 30.30±5.65, with an age ranging from 22 to 37 years. Six patients had a history of treated periodontitis. All subjects completed the study for the period of data collection.

(Immediate implants with Duo-Teck membrane)

Fig (a): Preoperative O.P.G.

Fig (b): Preoperative periapical x-ray.

Fig (c): Preoperative view

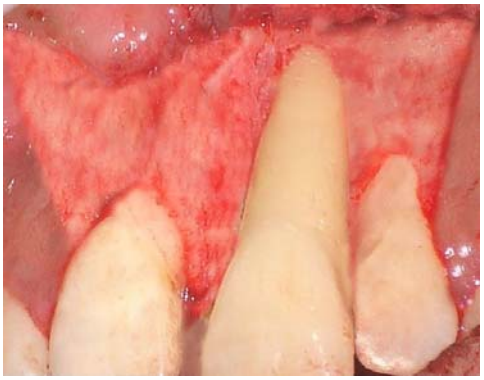

Fig (d): Flap reflection.

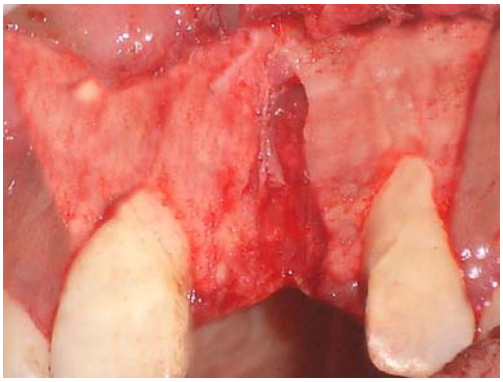

Fig (e): Extraction of the involved tooth

Fig (f): The extracted tooth

(Immediate implants with Duo-Teck membrane)

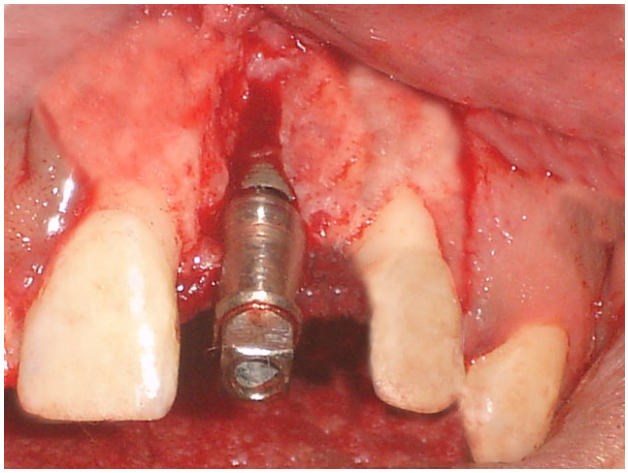

Fig (g): Final implant position.

Fig (h): Preparation of the membrane.

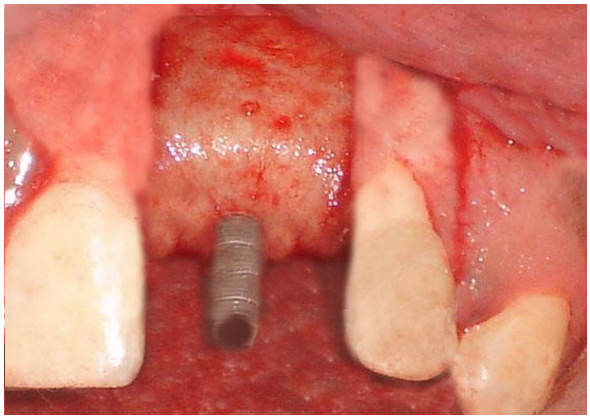

Fig (i): Adaptation of the membrane.

Fig (j): Flap closure.

Fig (j): Postoperative healing.

Fig (j): Final restoration.

Location of implants

A total of 10 implants, 3 dental implants were placed in the upper right central region, 1 in the upper right lateral, 2 in the upper left central, 3 in the upper left lateral and 1 in the upper left canine.

Survival of implants

The cumulative overall survival rate of all implants placed was 100%.

Marginal bone level

It was found that the mean bone defect depth immediately postoperatively was 5.85±1.42. The mean bone defect depth dropped to 0.40±0.24 at 6, 9 and 12 monthes. Comparing the means of marginal bone defect level throughout the follow up period of group A1 using 2-tail paired samples t-test, it was found that a significant decrease of the vertical defect depth at 6, 9 and 12 months when compared to immediate post operative record as all t values were 1.32 ($P<0.05$).(table 1 and 2)

Table1: Mean Vertical Defect Depth of all groups throughout the follow-up period.

Test period	Mean marginal bone level		
	X±SD	Min	Max
Immediately postoperative	5.85±1.42	3.91	8.57
6 months postoperative	1.35±0.89	0.16	0.92
9 months postoperative	1.35±0.88	0.16	0.92
12 months postoperative	1.35±0.88	0.16	0.92

Table 2: 2-tail Paired samples test of the mean Vertical Defect Depth throughout the follow-up period.

	Paired Differences					t	P-value 2-tailed
	Mean	SD	SE	95% Confidence Lower	95% Confidence Upper		
Vertical Defect Depth Immediate PostOperative - Vertical Defect Depth 6month	5.45	1.30	0.41	4.51	6.38	1.32	0.00*
Vertical Defect Depth Immediate PostOperative - Vertical Defect Depth 9month	5.45	1.30	0.41	4.51	6.38	1.32	0.00*
Vertical Defect Depth Immediate PostOperative - Vertical Defect Depth 12month	5.45	1.30	0.41	4.51	6.38	1.32	0.00*

SD: Standard deviation, S E : Standard of error, * : Statistical significant difference

Bone Density

It was found that the bone density of group A2 ranged from 102.18 to 123.54 with mean 116.13±7.11 (Table 3).

Table 3: Mean Bone Density of all groups throughout the follow-up period

N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
10	116.13	7.11	2.24	111.05	121.22	102.18	123.54

DISCUSSION:

The concept of immediate implant loading has recently become popular due to fewer traumas, reduction in overall treatment time, decrease in hard and soft tissue resorption, increase in patient's acceptance, along with better function, aesthetics and has a psychological benefit also (Singh *et al*., 2012). Immediate restoration provides the benefit of shorter

treatment time and elimination of the need for provisional removable prostheses. Recent studies of immediate restoration of dental implants reported survival rates range between 85% and 100% (Chang and Wennström, 2010; Grütter and Belser 2009; Horwitz *et al*., 2012; Strub *et al*., 2012). For comparison, Chang and Wennström (2010) in a publication of a prospective evaluation which reported on implant restoration, results showed survival rate of 95% at 8 weeks. Grütter and Belser (2009) found that the survival of immediately loaded implants was 97.3% after 1 year. However, for immediately placed implants with immediate restoration and occlusal loading, the survival rate dropped by approximately 10% (Grütter and Belser, 2009).

The overall survival rate of immediately restored implants in the present study was 100%. The results of the present study were comparable to results of immediately restored dental implants in periodontally treated patients obtained by Horwitz *et al.,* (2012) with survival rate greater than 90%. In a literature review (Horwitz *et al*., 2012) , implant survival rates of immediately loaded implants with immediate or delayed implant placement ranged from 95·8% to 100%.

Patients with a history of periodontal disease, or periodontally compromised patients might be at significantly higher risk for implant failure and greater marginal bone loss compared with periodontally healthy subjects (Safii *et al*., 2010). Shibly *et al.,*(2010) compared bone regeneration and esthetic outcome between immediate and conventional loading of dental implants placed immediately after extraction in patients with a history of periodontal disease. In the immediate loading group the implant survival rate at 2 years was 96.7% and the corresponding figure in the conventional loading group was 93.3%. Shibly and colleagues (Shibly *et al.,* 2010) concluded that immediate loading of a single implant placed in a fresh extraction site in periodontally compromised patients resulted in similar bone gain and soft tissue esthetic outcomes compared to delayed loading.

In the present study, none of the patients showed any persistent pain, tenderness, infection or swelling. This could be attributed to the high biocompatibility and excellent tissue response to biomedical titanium alloy (Oshida *et al.,* 2010).

In the present study, radiographic investigations were carried out using serial periapical radiographs made by long-cone paralleling technique. Standardization of radiographs was approved by using personalized bite registration and XCP, for proper positioning and alignment of the x-ray long-cone to ensure reproducibility and facilitate serial radiograph comparison. As a consequence, the angulations between the X-ray source, the object and the film are standardized. All radiographs are taken using the same X-ray machine at the same settin (Neena *et al.,* 2011)**.**

The reported mean bone defect in our study showed a significant reduction of the bone defect depth at 6, 9 and 12 months when compared to immediate post operative record. This result is in agreement with other studies, which have reported that immediate loading in the maxilla is a predictable and reliable treatment option, with high survival rates and limited peri-implant bone loss after 2 years (Vervaeke *et al.,* 2013)**.**

Pal *et al.,* (2011) compared the success rate of implant placed immediately in extraction socket vs implant placed delayed in extraction socket regarding gingival condition, bone condition clinically and radiographically. Results showed no bone loss in patients of implant placed immediately at any time interval, while the mean bone loss in delayed group patients at 4th week was 0.50 mm, and at 12^{th} week, it was 1.2857 mm. moreover, Schropp *et al.,* (2003) reported that new bone formation occurs in infrabony defects associated with immediately placed implants in extraction sockets. Chen *et al.,* (2004) observed that comparison between immediate and delayed implantation sites showed a trend toward higher percentage of defect height and defect area at delayed sites (ranges between studies for defect height, 86% and 97%; for defect area, 86% and 97%) compared with immediate sites (defect height 77–95%; defect area 77–95%).

The present study showed that there was a significant and rapid reduction of the mean vertical defect depth in the first three months post-operatively in both groups when compared

to that at 6, 9 months. This could be explained by Stanoiu and Surpateanu (2011) who stated that Duo-Teck membrane has good osteoconductive and osteoinductive activity, Duo-Teck membrane presents no contraindication in fact; the equine collagen did not cause allergy as potentially allergenic lacks amino acids (tyrosine and histidine), Duo-Teck membrane can stimulate the alveolar bone and periodontal tissue regeneration. Also, Di Stefano *et al.*, (2012) concluded that the deantigenated equine bone is biocompatible and undergoes osteoclastic remodelling. Moreover, Di Stefano and colleagues 2012 stated that equine collagen membrane and equine pericardium membrane acted as effective barriers for guided bone regeneration.

Evaluation of bone density changes in the jaw bones in the peri-implant regions is of interest when studying the healing response after bone grafting procedures. The use of subtraction radiography is not a new concept and has been utilized in dentistry for several decades (Hausmann *et al*., 1985). Grondahl *et al.* ,(1987) found that there was a higher inter-observer agreement in estimating periodontal bone changes from subtraction radiographs compared to conventional radiographs. Janssen *et al.*,(1989) examined the detection thresholds of different radiographic methods it was found that the smallest periodontal bone changes were detected with the quantitative digital subtraction technique compared to the other methods. Digital subtraction radiography has also been used to assess the progression of untreated periodontitis (Hausmann *et al*., 1986), the efficacy of potential new treatments for periodontitis (Jeffcoat *et al*., 1991), the bone changes after guided tissue regeneration (Wenzel *et al*., 1992), treatment of furcations (Cury *et al*., 2004), and periodontal treatment in general (Nummikoski *et al*., 2000)**.** Quantitative analysis of the grey scale information was developed to allow assessment of the amount of bone loss and gain (Woo *et al*.,2003). Wakoh *et al.,* (2006) reported quantitative evaluation of bone change around implants from digital dental imaging, and to consequently advocate the subtraction technique in longitudinal assessment of amount of bone change for implant performance.

CONCLUSION

The present study showed massive increase of the mean bone density scores at 12 months when compared to immediate post operative record. The results of the present study are supported by Carneiro *et al.,*(2012) who assessed longitudinal quantitative changes in bone density around different implant loading protocols and implant surfaces measured by digital subtraction radiography; they concluded that implant loading protocol induced mineral bone gain around single-tooth implants after the first year under function. The results of the present study could be explained by Vijayalakshmi *et al.,* (2013) who stated that the space maintenance and membrane coverage of biodegradable Duo-Teck membranes have the potential to support bone formation as they are supported by bone graft material to resist collapse. Moreover, The results of the present study could be explained by Degidi and Piattelli (2003), Calandriello *et al.,* (2003), Romanos *et al.,* (2005) and Ghanavati *et al.,* (2006) who found that immediately loaded implants' micromovements can improve osseointegration and can dramatically increase the bone density. Also it was shown that immediate loads can increase the mineralization rate in bone-implant interface (Ghanavati *et al*., 2006).

REFERENCE

Anderson, E., H.R. Haanaes, and B.M. Knutsen. 2002. Immediate loading of single-tooth ITI implants in the anterior maxilla: A prospective 5-year pilot study. *Clin. Oral Implants Res.* 13:281–287.

Barone, A., L. Rispoli, I. Vozza, A. Quaranta, and U. Covani. 2006. Immediate restoration of single implants placed immediately after tooth extraction. *J. Periodontol.* 77:1914–1920.

Buser, D., and K. Dula. 1993. Localized ridge augmentation using guided bone regeneration. I. Surgical procedure in the maxilla. *Int. J. Periodontics Restorative Dent.* 13:29- 45.

Calandriello, R., M. Tomatis, R. Vallone, B. Rangert, and J. Gottlow. 2003. Immediate occlusal loading of single lower molars using Brånemark System Wide-Platform TiUnite implants: an interim report of a prospective open-ended clinical multicenter study. *Clin. Implant Dent. Relat Res.* 5 Suppl 1:74-80.

Campelo, L.D., and J.R.D. Camara. 2002. Flapless implant surgery: A 10-year clinical retrospective analysis. *Int. J. Oral Maxillofac. Implants.* 17:271–276.

Carneiro, L.S., H.A. da Cunha, C.R. Leles, and E.F. Mendonça. 2012. Digital subtraction radiography evaluation of longitudinal bone density changes around immediate loading implants: a pilot study. *Dentomaxillofac. Radiol.* 41(3):241-247. doi: 10.1259/dmfr/89401091.

Chang, M., and J.L. Wennström. 2010. Peri-implant soft tissue and bone crest alterations at fixed dental prostheses: A 3-year prospective study. *Clin. Oral Implants Res.* 21:527–534.

Chen, S.T., T.G. Jr. Wilson, and C.H. Hammerle. 2004. Immediate or early placement of implants following tooth extraction: Review of biologic basis, clinical procedures, and outcomes. *Int. J. OralMaxillofac. Implants.* 19(suppl):12–25.

Cornelini, R., F. Cangini, and J. Wennstrom. 2004. Bio-Oss and biodegradable barrier membranes to support healing\ following immediate post-extraction placement of transmucosal dental implants: A controlled clinical trial. *Int. J. Periodontics Restorative Dent.* 6:555-563.

Cury, P.R., N.S. Araujo, J. Bowie, E.A. Sallum, and M.K. Jeffcoat. 2004. Comparison between subtraction radiography and conventional radiographic interpretation during long-term evaluation of periodontal therapy in Class II furcation defects. *J. Periodontol.* 75(8):1145-1149.

Degidi, M., and A. Piattelli. 2003. Immediately loaded bar-connected implants with an anodized surface inserted in the anterior mandible in a patient treated with diphosphonates for osteoporosis: a case report with a 12-month follow-up. *Clin. Implant Dent. Relat. Res.* 5(4):269-272.

Di Stefano, DA., M. Andreasi Bassi, L. Cinci, L. Pieri, and G. Ammirabile. 2012. Treatment of a bone defect consequent to the removal of a periapical cyst with equine bone and equine membranes: clinical and histological outcome. *Minerva Stomatol.* 61(11-12):477-90.

Ghanavati, F., S.S. Shayegh, H. Rahimi, D. Sharifi, F. Ghanavati, N. Khalesseh, and B. Eslami. 2006. The effects of loading time on osseointegration and new bone formation around dental implants: a histologic and histomorphometric study in dogs. *J. Periodontol.* 77(10):1701-1707.

Grondahl, K., H. Grondahl, Wennstrom, and L. Heijl. 1987. Examiner agreement in estimating changes in periodontal bone from conventional and subtraction radiographs. *Journal of Clinical Periodontology*. 14: 74-79.

Grütter, L., and U.C. Belser. 2009. Implant loading protocols for the partially edentulous esthetic zone. *Int. J. Oral Maxillofac. Implants.* 24(suppl): 169–179.

Gunne, J., P. Astrand, K. Ahlén, K. Borg, and M. Olsson. 1992. Implants in partially edentulous patients. A longitudinal study of bridges supported by both implants and natural teeth. *Clin. Oral Implants Res.* 3(2):49-56.

Hausmann, E., L. Christersson, R. Dunford, U. Wikesjo, J. Phyo, and R. Genco. 1985. Usefulness of subtraction radiography in the evaluation of periodontal therapy. *Journal of Periodontology.* 56: 4-7.

Hausmann, E., R. Dunford, U. Wikesjo, L. Christersson, and K. McHenry. 1986. Progression of untreated periodontitis as assessed by subtraction radiography. *Journal of Periodontal Research.* 21: 716-721.

Horwitz, J., L. Levin, E. Gabay, O. Zuabi, and E.E. Machtei. 2012. Immediate restoration of delayed placement of dental implants in patients with treated periodontal disease: 1-year results. *Int. J. Oral Maxillofac. Implants.* 27(6):1569-1575.

Janssen, P., W.P. Helderman, and J. Aken. 1989. The detection of in vitro produced periodontal bone lesions by conventional radiography and photographic subtraction radiography using observers and quantitative digital subtraction radiography. *Journal of Clinical Periodontology.* 16: 335-341.

Jeffcoat, K., R. Page, M. Reddy, A. Wannawisute, P. Waite, K. Palcanis, R. Cogen, R. Williams, and C. Basch. 1991. Use of digital radiography to demonstrate the potential of naproxen as an adjunct in the treatment of rapidly progressive periodontitis. *Journal of Periodontal Research*. 26: 415-421.

Jovanovic, S.A., H. Spiekermann, and EJ. Richter. 1992. Bone regeneration around titanium dental implants in dehisced defect sites: A clinical study. *Int. J. Oral Maxillofac. Implants.* 7:233-245.

Jr. Nociti, F.H., M.A.N, Machado, C.M. Stefani, E.A. Sallum, and A.W. Sallum. 2001. Absorbable versus nonabsorbable membranes and bone grafts in the treatment of ligatureinduced peri-implantitis defects in dogs. A clinical investigation. *Clin. Oral Impl. Res.* 12:115-121.

Lazzara, R.J. 1989. Immediate implant placement into extraction sites: Surgical and restorative advantages. *Int. J. Periodontics Restorative Dent.* 9:332-343.

Mellonig, J.T., and R.G. Triplett. 1993. Guided tissue regeneration and endosseous dental implants. *Int J Periodontics Restorative Dent*. 13:109-119.

Neena, I.E., A. Ananthraj, P. Praveen, V. Karthik, and P. Rani. 2011. Comparison of digital radiography and apex locator with the conventional method in root length determination of primary teeth. *J. Indian Soc. Pedod. Prev. Dent.* 29(4):300-304. doi: 10.4103/0970-4388.86371.

Nemcovsky, C.E., and Z. Artzi. 2002. Comparative study of buccal dehiscence defects in immediate, delayed, and late maxillary implant placement with collagenmembranes: Clinical healing between placement and second-stage surgery. *J. Periodontol.* 73:754-761.

Nevins, M., and J.T. Mellonig. 1992. Enhancement of the damaged edentulous ridge to receive dental implants: A combination of allograft and the Gore-Tex membrane. *Int. J. Periodontics Restorative Dent.* 12:97-111.

Nummikoski, P., B. Steffensen, K. Hamilton, and S. Dove. 2000. Clinical validation of a new subtraction radiography technique for periodontal bone loss detection. *Journal of Periodontology.* 71: 598-605.

Oshida, Y., EB. Tuna, O. Aktoren, and K. Gencay. 2010. Dental Implant Systems. *Int. J. Mol. Sci*. 11: 1580-1678.

Pal, U.S., N.K. Dhiman, G. Singh, R.K. Singh, S. Mohammad, and L.R. Malkunje. 2011. Evaluation of implants placed immediately or delayed into extraction sites. *Natl. J. Maxillofac. Surg.* 2(1):54-62. doi: 10.4103/0975-5950.85855.

Rocci, A., M. Martignoni, and J. Gottlow. 2003. Immediate loading in the maxilla using flapless surgery, implants placed in predetermined positions, and prefabricated provisional restorations: A retrospective 3-years clinical study. *Clin. Implant Dent. Relat. Res.* 5(suppl 1):29–36.

Romanos, G.E., T. Testori, M. Degidi, and A. Piattelli. 2005. Histologic and histomorphometric findings from retrieved, immediately occlusally loaded implants in humans. *J. Periodontol.* 76(11):1823-1832.

Safii, S.H., R.M. Palmer, and R.F. Wilson. 2010. Risk of implant failure and marginal bone loss in subjects with a history of periodontitis: A systematic review and meta-analysis. *Clin. Implant Dent. Relat. Res.* 12:165–174.

Schropp, L., L. Kostopoulos, A. Wenzel. 2003. Bone healing following immediate versus delayed placement of titanium implants into extraction sockets: A prospective clinical study. *Int. J. Oral. Maxillofac. Implants.* 18:189–199.

Shibly, O., N. Patel, J.M. Albandar, and A. Kutkut. 2010. Bone regeneration around implants in periodontally compromised patients: a randomized clinical trial of the effect of immediate implant with immediate loading. *J. Periodontol.* 81(12):1743-1751. doi: 10.1902/jop.2010.100162.

Simion, M., A. Scarano, L. Gionso, and A. Piattelli. 1996. Guided bone regeneration using resorbable and nonresorbable membranes: A comparative histologic study in humans. *Int. J. Oral Maxillofac. Implants.* 11:735-742.

Simion, M., M. Baldoni, and D. Zaffe. 1992. Jawbone enlargement using immediate implant placement associated with a split-crest technique and guided tissue regeneration. *Int. J. Periodontics Restorative Dent.* 12:463-471.

Singh, A., A. Gupta, A. Yadav, T.P. Chaturvedi, A. Bhatnagar, B.P. Singh. 2012. Immediate placement of implant in fresh extraction socket with early loading. *Contemp. Clin. Dent.* 3(Suppl 2):S219-22. doi: 10.4103/0976-237X.101099.

Stanoiu, T.G., and M. Surpateanu. 2011. Additive plastic surgery, modern component of marginal periodontitis. Complete treatment. Doctoral dissertation. University of Medicine and Pharmacy, Craiova. Bucharest, Romania.

Strub, J.R., B.A. Jurdzik, and T. Tuna. 2012. Prognosis of immediately loaded implants and their restorations: a systematic literature review. *J. Oral Rehabil.* 39(9):704-717. doi: 10.1111/j.1365-2842.2012.02315.

Vervaeke, S., B. Collaert, and H. De Bruyn. 2013. Immediate loading of implants in the maxilla: survival and bone loss after at least 2 years in function. *Int. J. Oral Maxillofac. Implants.* 28(1):216-221. doi: 10.11607/jomi.2606.

Vijayalakshmi, R., C.S. Rajmohan, D. Deepalakshmi, and G. Sivakami. 2012. Use of platelet rich fibrin in a fenestration defect around an implant. *J. Indian Soc. Periodontol.* 16(1):108-112. doi: 10.4103/0972-124X.94616.

Vlaminck, L., T. Gorski, L. Huys, J. Saunders, E. Schacht, and F. Gasthuys. 2008. Immediate postextraction implant placement in sheep's mandibles: A pilot study. *Implant Dent.* 17:439-450.

Wakoh, M., K. Nishikawa, T. Otonari, M. Yamamoto, T. Harada, T. Sano, Y. Yajima, and T. Ooguro. 2006. Digital subtraction technique for evaluation of peri-implant bone change in digital dental imaging. *Bull Tokyo Dent. Coll.* 47(2):57-64.

Warrer, L., K. Gotfredsen, E. Hjørting-Hansen, and T. Karring. 1991. Guided tissue regeneration ensures osseointegration of dental implants placed into extractionsockets. An experimental study in monkeys. *Clin. Oral Implants Res.* 2(4):166-71.

Wenzel, A., K. Warrer, and T. Karring. 1992. Digital subtraction radiography in assessing bone changes in periodontal defects following guided tissue regeneration. *Journal of Clinical Periodontology.* 19: 208-213.

Woo, B., K. Zee, F. Chan, and E. Corbet. 2003. In vitro calibration and validation of a digital subtraction radiography system using scanned images. *Journal of Clinical Periodontology.* 30: 114-118.