EGYPTIAN DENTAL JOURNAL
VOL. 64, 2047:2055, JULY, 2018
I.S.S.N 0070-9484
ORAL SURGERY
www.eda-egypt.org • Codex : 102/1807

SOCKET- SHIELD TECHNIQUE VERSUS GUIDED BONE REGENERATION TECHNIQUE FOR RIDGE PRESERVATION WITH IMMEDIATE IMPLANT PLACEMENT IN THE ESTHETIC ZONE

Hesham Fattouh*

ABSTRACT

Objectives: To evaluate the socket shield technique and compare the survival, stability, esthetic outcome and complication rates of immediate implants in the esthetic zone placed using this technique with the traditional guided bone regeneration technique.

Patients and Methods: 20 Patients were enrolled in this study, they were randomized into two equal groups, after receiving a post extraction implant in the esthetic zone; Group I patients were managed with guided bone regeneration technique, while group II patients were treated with socket shied technique. Functional and esthetic outcomes of the treatment in term of implant survival and marginal bone level were evaluated.

Results: Implant survival rate after 1 year was 100% in both groups. Implants inserted with the socket shield technique demonstrated better values of marginal bone level and were statistically significant.

Conclusions: Socket shield technique is a highly promising addition to dental implantlogy that seems to be a feasible surgical option characterized by better esthetic outcomes when compared to guided bone regeneration technique.

KEYWORDS: Immediate implant- esthetic zone - socket shield - guided bone regeneration - alveolar bone preservation.

INTRODUCTION

The enormous progress that happened in clinical methods and biomaterials technology over the past three decades have offered the clinicians with efficient tools to improve treatment procedures. Accordingly, "osseointegration" has been redefined, influenced by patients increasing expectations regarding improved esthetic outcomes and comfort and reduced time of treatment [(1)].

Healing of extraction sockets undergoes a remodeling process which prompts huge dimensional changes in alveolar bone shape

* Lecturer of Oral and Maxillofacial Surgery, Faculty of Oral and Dental Medicine, Cairo University.

associated with vertical and horizontal bone loss, it is reported that within 6 months following tooth extraction, the alveolar bone resorbs roughly by 3 – 4 mm in both buccal-lingual and coronal-apical directions. Furthermore, the changes of hard and soft tissues have prominently affected the final treatment results, especially within the esthetic zone of humans [2].

To overcome this deformity that adversely influences both the esthetic appearance and the implants osseointegration, ridge preservation techniques and other supportive measures have been considered and a major effort is made under their utilization to achieve the best possible esthetic outcome [3]. These include hard and soft tissue augmentation procedures, flapless implant placement, a more palatal positioning of the implant in the socket, immediate provisionalization and potentially the utilization of platform switching. Despite the positive outcome of all these procedures, it needs to be realized that an optimal esthetic outcome can only be achieved in selected cases as the tissue changes cannot be totally encountered. For this reason, numerous authors guided their efforts to find a solution that could prevent the volume changes which happen after tooth extraction [4-5].

Immediate implant placement after tooth extraction is a well-known and successful treatment option with a comparable success rates as delayed implant techniques, it reduced costs, surgeries and time to rehabilitation, yet cannot prevent the resorption of the alveolar bone [6].

Guided bone regeneration (GBR) procedures helps in decreasing extra bone resorption that normally happens in the initial 6 months after extraction and decreases also the rehabilitation period, however the result of alveolar ridge preservation remains disappointing as ever, and the loss of the blood supply that stems from the periodontal ligament may help to the unpredictable remodeling process while the soft tissue volume contraction is frequently related to the type of the used surgery [7].

Hurzeler et al. [8] in 2010 introduced a new surgical technique aiming to find solution to this sort of problem and make the gingival margin position more predictable, A technique called "socket shield" (SS) has been made up to keep the periodontium in the marginal area on the implant's buccal side by partial root retention on the buccal side during the immediate insertion of the fixture, he experimented first on an animal model and then on humans. Histological examinations carried on that animal model demonstrated that the maintenance of the vestibular root portion determines the development of a layer of so-called ''new cementum'' between the root portion that left in situ and the implant positioned with post extractive method. Besides, no bone remodeling on the buccal side was observed [9].

The aim of this study is to prospectively assess the SS technique and compare the survival and success rate of immediate dental implants inserted with it to that inserted with GBR adopting the same surgical and prosthetic protocol.

PATIENTS AND METHODS

A prospective study was performed on 20 patients selected and categorized from the outpatient clinic of the Department of Oral and Maxillofacial Surgery, Faculty of Oral and Dental Medicine, Cairo University. Patients were older than 18 years; they were 12 females and 8 males. All patients were treated with an immediate nonfunctional loading single implant in the esthetic zone of the anterior maxilla. Our research was carried in accordance with international standards of quality for clinical trials, the Declaration of Helsinki in its revised version (Seoul, Korea, 2008), all participants were informed and signed an informed consent clarifying the type of intervention and possible complications.

Inclusion criteria included: Patients with a single tooth indicated for extraction in the maxillary

anterior esthetic zone (central incisor, lateral incisor, canine), both neighboring teeth mesial and distal to the tooth to be extracted were present. Exclusion criteria included: patients who are not candidates for either implant in general or immediate implant in specific (poor oral hygiene – aggressive periodontitis – bruxism - systemic disease affecting healing process – acute infection related to the tooth to be extracted and heavy smokers) 'Light smokers were subjected to a smoking stop protocol for 1 week before and at least 4 weeks after implant placement', also immediate implants with a primary stability less than 30 N cm were excluded from this study.

Surgical protocol

Preoperative cone beam computed tomography (CBCT) demonstrated: sufficient socket width for group I and sufficient width palatal to the planned facial root section for group II to accommodate a standard 4.1 x 13 mm implant. All surgical procedures were performed by the same team of surgeons; antimicrobial prophylaxis with clindamycin HCL (Dalacin C; Pfizer, Belgium) 300 mg started one hour before surgery and proceeded three times daily for 1 week after the surgery was prescribed to all patients, preoperative rinse with chlorhexedine solution 0.2% was used for the patients. Following local anaesthesia, mucoperiosteal flap was elevated including intracrevicular incisions extending to the mid-facial aspect of at least both neighboring teeth, and then fully reflecting papillae then the treatment plan continue according to the patient's group categorization:

Group I: Control group (Guided bone regeneration 'GBR' group)

The procedures proceeds by an atraumatic tooth extraction utilizing periotomes with an effort to preserve the integrity of the socket bonny walls. Granulation tissue was removed by a spoon curette. The drilling was conducted to the palatal wall and the osteotomy was intended to have as much implant engagement for the bone apical to the extraction socket with the implant table placed 2 mm below the facial crest. The jump gap was grafted with a xenogeneic deproteinize bone mineral granules (0.25 – 0.5 mm size, BioOsss® Spongiosa) followed by the adaptation of BioGide® collagen membrane. (Geistlich Biomaterials, Wolhusen, Switzerland) tightly surrounding the neck of the implant **(Fig. 1)**.

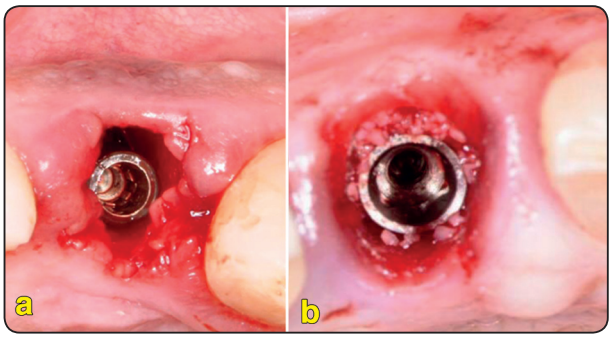

Fig. (1) (A): immediate implant placement (B): bone graft filling the jumping gap

Group II: Study group (socket shield 'SS' group)

The surgery proceeds by dividing the root by high-speed handpiece with coolant and a long shank cuting bur in a mesiodistal direction along its long axis apical as far as possible dividing the tooth root into facial and palatal halves with the intention of keeping the facial root section unmanipulated and attached to the tooth socket. Periotomes were then embeded between the palatal root section and the alveolar socket wall and this section of root was then carefully removed **(Fig. 2a)**.

The rest of the root section was then reduced coronally to 1 mm above the alveolar crest, and thinned to a concave contour by careful application in an apico-coronal and mesiodistal direction with a long shanked round diamond bur **(Fig. 2b)**. The tooth socket's palatal wall and apex were then curetted to expel any tissue or infective remnants and the root section was checked for immobility

with a sharp probe followed by implant insertion in that space with the same mean as group I **(Fig. 2c)**. It is to be noted that if during the surgical procedure, the portion of root utilized for protection showed mobility, the remaining root portion was extracted and the SS surgical technique was not performed, this patient completed the study as a member of group I with their surgical protocol.

In both groups of the study; final sitting of the implant fixture was at least at 30 N cm (performed with a torque-controlled ratchet). Screw-type bone level titanium implants with a platform switch design was used. A temporary chair side crown was then constructed with an emergence profile to support the coronal tissues and connected to the implant at the end of the surgery while ensuring adequate space between the SS and the temporary in group II, allowing the soft tissue growth between the provisional and the SS, inability to do this would lead to a SS that is not covered with soft tissue. The implant was restored after 6 months by screw-retained porcelain fused to metal crown **(Fig. 3)**.

Clinical follow-up:

Patients were clinically followed-up at 1, 4 weeks and 3, 6, and 12 months postoperatively, clinical parameters assessment include: implant mobility, presence/absence of any sign of infection, presence/absence of pain, perimplant soft tissue swelling and numbness, while esthetic assessment was done by the pink esthetic score (PES) at baseline, 3, 6 and 12 months as described by **Fürhauser et al**. [10] Fürhauser suggested that PES is a suitable instrument for reproducibly evaluating soft tissue around implants. The PES evaluates the esthetic outcome of soft tissue around implants in the anterior zone by recording seven points for the mesial and distal papilla, alveolar process deficiency and soft-tissue level, contour, color and texture. Each variable is assessed with a 2–1–0 score, with 2 being the best and 0 being the worst score. The mesial and distal papillae were assessed for completeness, incompleteness or absence. All other variables are evaluated by comparison with a corresponding tooth in the anterior region. The

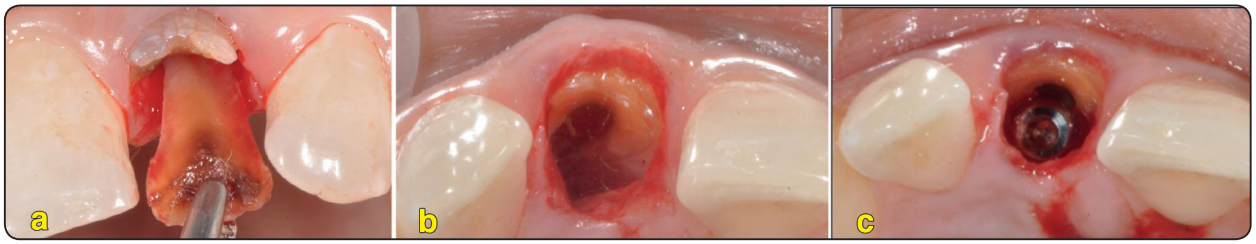

Fig. (2) Socket shield technique. (A): removal of the palatal root part (B): reduction of the bucal part of the root (C): dental implant placement

Fig. (3) Monitor healing process after 6 months during implant restoration in socket shield case

highest possible score reflecting a perfect match of the peri-implant soft tissue with that of the reference tooth was 14.

Radiographic follow-up:

Intra-oral periapical radiographs with parallel technique were performed immediately after implant placement and after 3-6 and 12 months to evaluate the level of marginal bone and also the degree of resorption of the residual root. In order to standardize the radiographic evaluation, the film was kept parallel using plastic film holders (Schick technologies, Long Island, NY, USA) and the x-ray beam kept perpendicular, in addition all the radiographs were performed by the same operator and with the same device; an image analysis software (Autocad 2006, version Z 54.10, Autodesk, San Rafael, CA, USA) was used, The software calculated bone remodeling and root resportion at the mesial and distal aspects of the implants. The distance was measured from the mesial and distal margin of the implant neck to the most coronal point where the bone or the root appeared to be in contact with the implant. For each implant, mean values of mesial and distal records were used. For each pair of measurements, mean values were used **(Fig. 4)**.

Statistical Analysis

Statistical analysis was performed using SPSS (Statistical package for the social sciences-IBM® SPSS® Statistics Version 20 for Windows, IBM Corp., Armonk, NY, USA). The data were represented as mean ± standard deviation (SD). Data were explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests. For parametric data; Student t-test was used to compare variables between the two groups. For non-parametric data; Mann-Whitney U test was used. The results were considered statistically significant if the p value was less than 0.05.

RESULTS

20 patients completed a 12 months follow-up were included in this investigation. Each patient received only a single implant in the esthetic zone and was a member of the GBR control group or the SS study group. No noticeable clinical complications were observed at 1, 3, 6, and 12 months from implant placement, only normal pain and swelling at the 1 week follow-up. No implant failures were recorded after 1 year. All the patients demonstrated a good bone level ‘‘stability’’ in both the control and study groups but a lower rate of

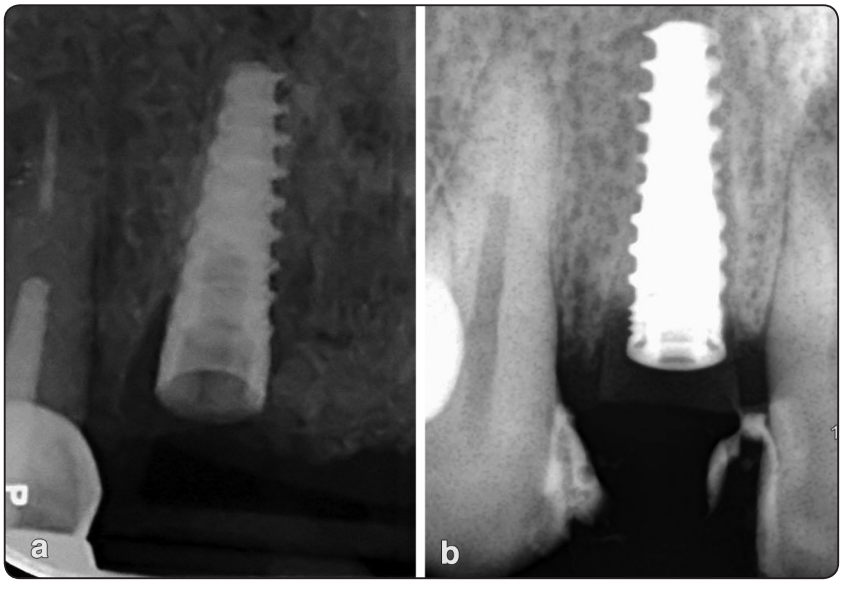

Fig. (4) Implant fixture radiograph after 6 months for (A) Patient from GBR group (B): Patient from SS group

crestal bone resorption was recorded in the study group at all the time points which was statistically significant (P<0.05). Regarding the SS study group; the average marginal bone loss was 0.418 ± 0.138 at 3 months, 0.639 ± 0.116 at 6 months and 0.693 ± 0.109 after 1 year. While in the GBR Control group, the average marginal bone loss was 0.619 ± 0.118 at 3 months, 0.979 ± 0.169 after 6 months, and 1.06 ± 0.24 after 1 year **(Table 1) (Fig. 5A)**.

Esthetic Assessment

The PES was recorded by Intraoral photographs from the esthetic baseline and follow-up appointments, according to **Furhauser et al**. [10], after points were analyzed, patients of the SS study group showed higher value of PES at all the time, the difference between the two groups was statistically signifigant (P<0.05). In the SS group, the average PES was 11.4 ± 0.84 at 3 months, 11.2 ± 0.91 at the 6 months, and 11.1 ± 0.73 after 1 year. While in the Control GBR group, the values were 10.6 ± 0.69 at 3 months, 10.3 ± 0.48 at 6 months, and 10.2 ± 0.42 after 1 year **(Table 1) (Fig. 5B).**

DISCUSSION

The present study demonstrates that immediate implant placement for single-tooth replacement in the anterior maxilla regardless the utilized technique is a successful treatment with high predictability where post extraction healing and healing from implant insertion coincide within one surgical stage. The standard protocol with at least 2 consecutive surgeries in the same site may result in more tissue damage [11]. However, immediate

TABLE (1) Evaluation of marginal bone loss and PES in the two groups at different time points

	M. bone 3M		M. bone 6M		M. bone 1y		PES 3M		PES 6M		PES 1y	
	SS	GB	SS	GB	SS	GB	SS	GB	SS	GB	SS	GB
Mean	0.418	0.619	0.639	0.979	0.693	1.064	11.4	10.6	11.2	10.3	11.1	10.2
SD	0.138868	0.118458	0.116757	0.169539	0.109955	0.240287	0.843274	0.699206	0.918937	0.483046	0.737865	0.421637
	P< 0.05		P< 0.05		P< 0.05		P< 0.05		P< 0.05		P< 0.05	

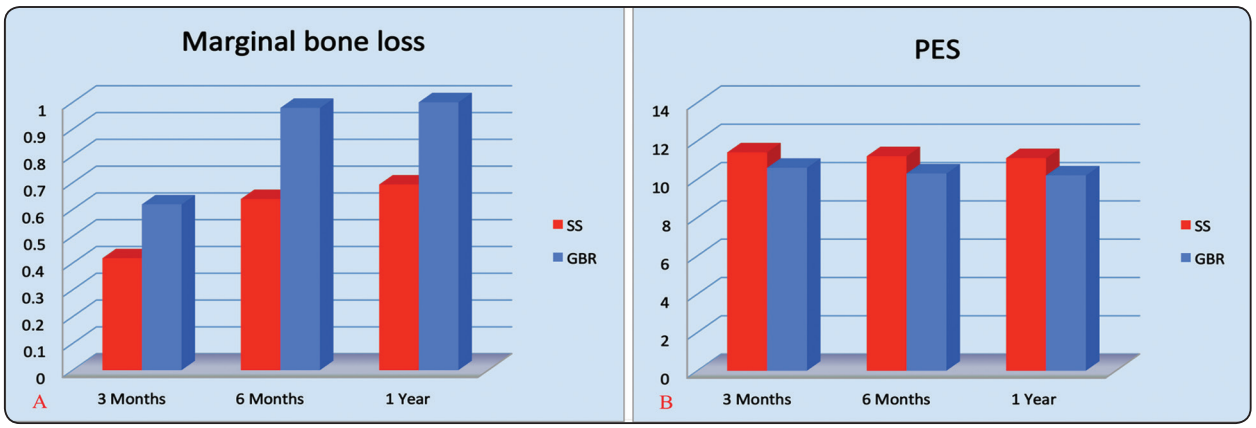

Fig. (5) Bar chart representing the difference between the two groups (A): marginal bone loss – (B): PES

implant placement alone still does not prevent the biological phenomenon of buccal bone resorption as showed in a lot of previous investigations [2].

In our study we compared 2 surgical methods utilizing the same surgical and prosthetic protocol. The clinical result of the SS technique was characterized by a higher esthetic score (in term of marginal bone level), but results are equivalent to the GBR techniques regarding the dental implant survival rate. We attributed this to the ability of GBR technique to reduce the amount of ridge resorption without prevention the loss of interdental bone and papillae. This is consistent with the studies that declared; complete maintenance of ridge volume after tooth extraction with preservation techniques using GBR technique as a primary prevention is not yet possible [12].

We found our results competent with **Abadzhiev et al.** [13] who described a clinical study with 25 patients comparing the traditional approach for immediate implant placement with the socket shield technique. In their report, the traditional approach was clearly inferior regarding the esthetic outcomes.

Prior to the SS technique, the implant surgeon select between an immediate implant placement protocol with an augmentation of the jump gap and a delayed approach with more surgical intervention to correct an already existing ridge defect. The principle of SS is to prepare the root of a tooth indicated for extraction in such a way that the buccal / facial root section stays in-situ with intact physiologic relation with the buccal plate. The root section's periodontal attachment apparatus (periodontal ligament (PDL), attachment fibers, root cementum, vascularization and alveolar bone) is intended to remain vital in order to achieve volumetric stability of the buccal / facial tissues and keep up the buccal bone [2]. Also the reduced cost of the SS technique was a marvelous point that needs to be considered.

The first clinical outcome of the SS technique was specified by **Hürzeler et al.** [8]; they reported successful osseointegration of an implant placed simultaneous to the SS technique with excellent esthetic outcomes, their histological examination indicated absence of osteoclastic and remodeling activity with the PDL of the buccal plate related to the retained root free of any inflammatory response. **Malmgren and coworkers** [14] had also revealed successful tissue regeneration around submerged roots since more than 3 decades ago. **Siormpas et al.** [15] reported that retention of the buccal fragment of the root can lead to successful osseointegration of the implants in healthy adult patients.

Buser et al. [5] introduced a novel concept: let the implants be surrounded by a functional periodontal ligament with conclusion that implant got firmly attached to the remaining root portions, while **Kan et al.** [8] have reported a case with a modified SS technique for inter implant papilla preservation with great success in maintaining the periodontium and the bone level, where the shield was left more in the interproximal than the buccal region.

On the other hand and in contrary to what we concluded, **Chen et al.** [17] reported that preservation of the buccofacial tissues, does not offer absolute preservation for the buccal plate, they mentioned 0.72 mm of buccal resorption after installing final restoration. Recently, complications of bone loss and infection were mentioned when implants were placed in contact with unnoticed remaining root pieces at the time of extraction possibility that the socket-shield may pose a risk of infection to implants put in close proximity [18].

No signs of resorption of the root parts that left in situ were observed in the present research. However, such phenomenon was observed by some investigators in other studies, it resolved spontaneously without affecting the success of implant rehabilitation [19].

One of the considerable drawbacks of the SS we found, is the absence of the standardized protocol for the technique; there are few references that mention

the thickness and height of the root segments in the SS technique; some people suggest that the root piece should be at the same level of the buccal alveolar ridge, so the hazard for root fracture can be reduced [20]. While others prefer that the root should be at least 1 mm higher than the alveolar ridge since a greater amount of the periodontal ligament can be held, which may be beneficial to the maintenance of soft tissue [21]. It is obvious that very good results were reported regarding SS technique whereas few other publications had a high number of adverse effects and complications. This most likely clarifies that the SS procedure might be technique sensitive.

Similar to what we concluded of the high survival rate of immediate implant with the GBR technique but with imperfect esthetic results, numerous studies reported that GBR is a predictable surgical procedure with high success rate, one of these studies monitored the implants placed simultaneously with GBR procedures using resorbable or non-resorbable membranes over 12 years and reported that it revealed a high survival rate ranging from 91.9% to 92.6% [22]. Other studies investigated how the insertion of immediate dental implant fixtures in fresh extraction sockets adjunct with grafting the whole gap between the bony socket wall and the implant surface with xenogenic bone granules was able to preserve a greater amount of alveolar ridge volume when compared with an extraction socket that was left to heal with the conventional way [23]. However, many reports declared that applying GBR at the external surface of the ridge does not prevent the resorption process, even with the use of a resorbable collagen membrane with simultaneous immediate implant; the bone resorption cannot be eliminated [24].

CONCLUSION

Although scientific evidence is still lacking, one can declare that SS is a safe technique that offers better esthetic results compared with the GBR technique, it provides the advantages of immediate implant placement with low morbidity and a rather favorable cost-advantage ratio.

LIMITATIONS

Data from long term clinical researches regarding SS technique are still lacking to utilize this technique as routine in everyday practice, the height and the thickness of the root segment in relation to the alveolar bone has to be standardized more precisely.

REFERENCES

1. Tonetti MS, Cortellini P, Graziani F, et al. Immediate versus delayed implant placement after anterior single tooth extraction: the timing randomized controlled clinical trial. J Clin Periodontol 2017;44: 215–224.
2. Araujo, M.G. & Lindhe, J. Dimensional ridge alterations following tooth extraction. An experimental study in the dog. Journal of Clinical Periodontology2005; 32: 212–218.
3. Lin, G.H., Chan, H.L. & Wang, H.L. Effects of currently available surgical and restorative interventions on reducing midfacial mucosal recession of immediately placed single-tooth implants: a systematic review. Journal of Periodontology 2014; 85: 92–102.
4. Khzam, N., Arora, H., Kim, P., Fisher, A., Mattheos, N. & Ivanovski, S. Systematic review of soft tissue alterations and esthetic outcomes following immediate implant placement and restoration of single implants in the anterior maxilla. Journal of Periodontology 2015; 86: 1321–1330.
5. Buser, D., Janner, S.F., Wittneben, J.G., Bragger, U., Ramseier, C.A. & Salvi, G.E. 10-year survival and success rates of 511 titanium implants with a sandblasted and acid-etched surface: a retrospective study in 303 partially edentulous patients. Clinical Implant Dentistry and Related Research 2012; 14: 839–851.
6. Chen S.T., Buser D. Esthetic outcomes following immediate and early implant placement in the anterior maxilla - a systematic review. Int J Oral Maxillofac Implants 2014; 29 Suppl: 186-215.
7. Fickl S, Schneider D, Zuhr O, et al. Dimensional changes of the ridge contour after socket preservation and buccal overbuilding: an animal study. J Clin Periodontol. 2009; 36(5):442–448.

8. Hurzeler MB, Zuhr O, Schupbach P, et al. The socket-shield technique: a proof-of-principle report. J Clin Periodontol 2010; 37:855–862.

9. Baumer D, Zuhr O, Rebele S, et al. The socket-shield technique: first histological, clinical, and volumetrical observations after separation of the buccal tooth segment—a pilot study. Clin Implant Dent Relat Res 2015; 17:71–82.

10. Fürhauser R, Florescu D, Benesch T, et al. Evaluation of soft tissue around single-tooth implant crowns: the pink esthetic score. Clin Oral Implants Res 2005;16:639–44.

11. Kan, J.Y., Rungcharassaeng, K., Lozada, J. & Zimmerman, G. Facial gingival tissue stability following immediate placement and provisionalization of maxillary anterior single implants: a 2- to 8-year follow-up. International journal of Oral and Maxillofacial Implants 2011; 26: 179–187.

12. Bäumer D, Zuhr O, Rebele S, Schneider D, Schupbach P, Hürzeler M. The socket-shield technique: first histological, clinical, and volumetrical observations after separation of the buccal tooth segment - a pilot study. Clin Implant Dent Relat Res. 2015;17(1):71-82.

13. Abadzhiev, M., Nenkov, P. & Velcheva, P. Conventional immediate implant placement and immediate placement with socket-shield technique – Which is better. International Journal of Clinical Medicine Research 2014; 1: 176–180.

14. Malmgren B, Cvek M, Lundberg M, Frykholm A. Surgical treatment of ankylosed and infra positioned reimplanted incisors in adolescents. Scand J Dent Res. 1984; 92(5):391-9.

15. Siormpas, K.D., Mitsias, M.E., Kontsiotou-Siormpa, E., Garber, D. & Kotsakis, G.A. Immediate implant placement in the esthetic zone utilizing the "root-membrane" technique: clinical results up to 5 years post loading. International Journal of Oral and Maxillofacial Implants. 2014; 29: 1397–1405.

16. Kan, J.Y. & Rungcharassaeng, K. Proximal socket shield for inter implant papilla preservation in the esthetic zone. International Journal of Periodontics and Restorative Dentistry. 2013; 33: e24–e31.

17. Chen CL, Pan YH. Socket Shield Technique for Ridge Preservation: A Case Report. J Prosthondontics Implantology. 2013; 2(2):16-21 .

18. Langer L, Langer B, Salem D. Unintentional root fragment retention in proximity to dental implants: a series of six human case reports. *Int J Periodontics Restorative Dent*. 2015; 35(3):305-313.

19. Davarpanah M, Szmukler-Moncler S. Unconventional implant treatment: Implant placement in contact with ankylosed root fragments. A series of five case reports. Clin Oral Implants Res 2009; 20:851–856.

20. Murata M, Akazawa T, Mitsugi M, Um IW, Kim, KW, Kim YK. Human dentin as novel biomaterial for bone regeneration. In: Pignatello R, ed. *Biomaterials - Physics and Chemistry*. Croatia: InTech; 2011: 127-140.

21. Nampo T, Watahiki J, Enomoto A, Taguchi T, Ono M, Nakano H, Yamamoto G, Irie T, Tachikawa T, Maki K. A new method for alveolar bone repair using extracted teeth for the graft material. *J Periodontol*. 2010; 81(9):1264-1272.

22. Jung R.E., Fenner N., Hämmerle C.H., Zitzmann N.U. Long term outcome of implants placed with guided bone regeneration (GBR) using resorbable and non-resorbable membranes after 12 14 years.Clin Oral Implants Res. 2013 Oct; 24(10):1065-73.

23. Qabbani A, Razak NH, Kawas S, et al. The efficacy of immediate implant placement in extraction sockets for alveolar bone preservation: a clinical evaluation using three-dimensional cone beam computerized tomography and resonance frequency analysis value. J Craniofac Surg. 2017; 28:e318–e325.

24. Caneva M, Botticelli D, Salata LA, Scombatti Souza SL, Carvalho Cardoso L, Lang NP. Collagen membranes at immediate implants: a histomorphometric study in dogs. Clin Oral Implants Res. 2010; 21(9):891.