JO JOURNAL OF OSSEOINTEGRATION periodontics and prosthodontics

Effectiveness of partial extraction technique used to preserve ridge before immediate implantation

S. A. ELSAYED[1-2], A. B. ALOLAYAN[2], H. M. R. SHOKIER[1-3], S. Y. ALGHAZY[2], E. M. EL-ROOS[3-4], T. OMAR[3], H. ELSISI[3], H. ANSA[5-6]

[1]Department of Oral and Maxillofacial Surgery, Faculty of Dental Medicine for Girls, Al Azhar University, Cairo, Egypt
[2]Department of Oral and Maxillofacial Surgery, Taibah University Dental College & Hospital, Al-Madinah Al-Munawwrah, Saudi Arabia
[3]Department of Oral and Maxillofacial Surgery and rehabilitation, Diagnostic science - Prosthodontic division, Faculty of Dentistry, UMM-Al Qura University, Makkah Al Mukarramah, Saudi Arabia
[4]Department of prosthodontics, Faculty of Dental Medicine, Cairo University, Cairo, Egypt
[5]Department of Basic Clinical Oral science, UMM-Al Qura University Dental College & Hospital, Makkah Al Mukarramah, Saudi Arabia
[6]Department of Oral biology, Faculty of Dental Medicine, Alexandria University, Alexandria, Egypt

TO CITE THIS ARTICLE
Elsayed SA, Alolayan AB, Shokier HMR, Alghazy SY, El-Roos EM, Omar T, Elsisi H, Funsa H. Effectiveness of partial extraction technique used to preserve ridge before immediate implantation. J Osseointegr 2022;14(2):136-142.

DOI 10.23805/JO.2022.14.13

KEYWORDS Socket shield; Immediate implant; Ridge preservation; Partial extraction.

ABSTRACT

Aim Although partial extraction technique (PET) is an exciting emerging technique, there is still minimal evidence regarding its effectiveness in preserving the buccal cortical bone simultaneously with immediate implant insertion. The present study aimed to systematically evaluate the available clinical data concerning PET before immediate implantation.
Material and methods A comprehensive systematic search was conducted which included a simple search strategy, using different electronic databases. Fourteen selected clinical human studies (7 clinical trials and 7 case series) out of 139 were included. The data retrieved from the selected studies included: study design, sample size, age, gender, study setting, site andside of technique application, author's names, journal title, year of publication, statistical tests used, and follow up prognostic results. Accuracy was confirmed by three researchers whom assessed all collected data.
Results There were 619 implants inserted using the PET in the included studies ,96.6 % of them were performed on the maxillary anterior and premolars region. The patients' age ranged from 24 to 83 years. Follow up ranged from 12 to 60 months. Implant failure was reported in 1.6% of the cases, infection in 1% and 3.1% had shield exposure and resorption problems. Clinical esthetic parameters and other radiographic evaluations revealed comparable results in favor of PET over conventional post extraction implant placement techniques.
Conclusion Based on the results of this review, the PET provided clinically acceptable results regarding ridge preservation in the esthetic zone of the maxillary anterior teeth. Future randomized controlled studies are needed to confirm the efficacy of this technique in different places of the jaw.

INTRODUCTION

Clinicians have been challenged to preserve or improve hard and soft tissues during and after treatment. Soft tissue recession after extraction plays a major role in this challenge. Immediate implant placement has been associated with a higher resorption rate of surrounding tissuaes (1). Many techniques have been used to preserve extraction sockets to improve the success rate of the loaded implants and for maintenance of optimum aesthetics. Guided bone regeneration, using membranes, papilla preservation techniques, in addition to immediate implant placement were some of the applied techniques in this regard (2,3).
Hurzeler et al. (4) were the first investigators to present the partial extraction technique (PET) in 2010. They reported that PET protocol, decreased the resorption process after tooth extraction. They claimed that it would help in preserving the buccal bone after extraction. The histologic study by Hurzeler et al. was an animal model that demonstrated the formation of cementum on implant surfaces placed in contact with intentionally retained roots.
The technique principle was to section the remaining root (anterior and posterior) while preserving the buccal portion of the tooth and keeping it attached to its buccal bone. The lingual portion of the root was removed; an immediately implant was placed (5,6). The idea for buccal bone preservation with this shielding technique depended on undisturbed vital periodontal attachment apparatus of the remaining buccal part of the root that prevent the expected post-extraction bundle bone remodeling. There was minimal evidence in the published literature in the last decade regarding the usability of PET technique in the

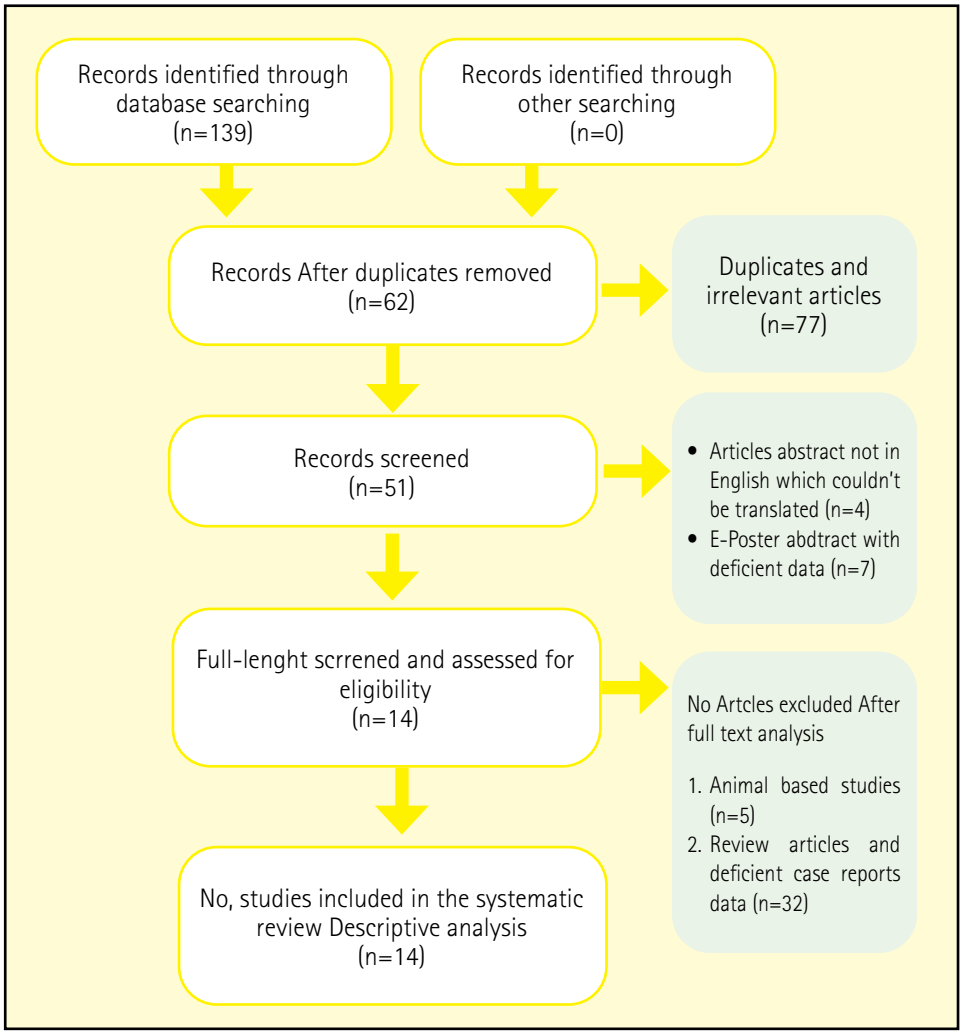

FIG..1 Flow charts of the included studies in the present review.

preservation of the buccal cortical bone simultaneously with immediate implant insertion at different remaining root-implant sites (7–13).

The aim of the present study was to systematically evaluate the clinical evidence regarding the efficacy of PET technique in preserving hard and soft tissues, through exploring the following question: does this technique have sufficient biologic plausibility to improve the outcome of implant therapy from an esthetical, clinical and functional point of view?

MATERIALS AND METHODS

Data sources and searches

A comprehensive systematic search was conducted which included simple search strategy, using the following electronic databases: PubMed, Science Direct, Wiley, Springer, and trial registries through the Saudi digital library internet access from 2010 to January 2020. The keywords used for the search (dental partial extraction therapy OR socket shield technique OR root shield technique) were used in all fields; the search was revised and the study filter was used to choose studies written in English and performed on humans only. Then the selected citations and documents were tracked and retrieved through Scopus access via the Saudi digital Library and then imported to Mendeley search group. The search started in November 2019 and ended collecting optimal search at January 2020.

Study selection and exclusion

A total of 139 studies were collected and then comprehensive revision from all investigators was conducted. All collected studies were thoroughly revised. In addition, studies performed on humans were only included so all animal studies were excluded. Studies that did not apply the PET and prescribe other similar methods were also excluded. Studies performed on sample size more than five were included. Any case reports conducted on less than five patients or abstracts were also excluded. Studies published in English only were included. There was no restriction on age or gender of the study sample (Fig. 1).

Study variables and PICO

Study involved sample population using the PET technique at different jaw sites and compared to traditional dental

No	Study	Age	Sample size	Gender	Site	Side	Study design	Study parameters	prognosis	Follow up period
1	Sun, 2019 (6)	>25 years	30 (15 in each group)	23 men and seven women	Anterior teeth	Not mentioned	Randomized clinical study	Esthetic scores, bleeding, probing depth, implant stability, buccal plate width and height.	Functional and esthetic outcomes might be enhanced after using PET; by preserving alveolar bone volume and peri-implant tissues.	24 months
2	Habashneh, 2019 (11)	aged between 20- and 54-year-old	Five patients	Five male patients	the esthetic zone	Not mentioned	Case report series	Cone beam CT scan taken for some cases illustrating the dimensions of the bone present prior to extraction.	Soft and hard tissue contours can be preserved by the minimally invasive PET.	1 year
3	Hassan, 2018 (21)	Not mentioned	6	Not mentioned	Area between the maxillary first premolars.	Area between the maxillary first premolars.	Case series	CBCT was used for evaluation of bone remodeling and clinical evaluation of soft tissue changes around implant.	Changes in the soft and hard tissues can be avoided by using PET.	1 year
4	Konstantions, 2014 (22)	28-70 Mean age 53	46	20 men 26 women	Anterior maxilla	R&L anterior maxilla	Retrospective case series	They measured the crestal bone loss.	All the implants have 100% survival rate, and good crestal bone. Single apical root resorption was observed without effect on the osseointegration of the implant.	24-60 months
5	Narayan, 2017 (14)	Not mentioned	20	Not mentioned	Aesthetic zone	Aesthetic zone	Case series	Minimal bone loss. (0.36 mm in average)	Implants were integrated smoothly. PET shows good stability of soft and hard tissues.	4 years
6	Tiwari, 2019 (15)	18-30	16	Not mentioned	Upper anterior teeth	R & L	Randomized controlled clinical trial	Labial bone thickness	Apical resorption of 1 shield.	1 year
7	Kher, 2018 (16)	Mean age 54.78 years	17	8 females	Esthetic zone	Esthetic zone	Clinical trial	Success rate	No implant failures (100% survival)	19.71 months
8	Han, 2018 (17)	Mean age 48.2 ± 15.0 years	30 patients and 40 implants	15 Males, 15 Females	Non-restorable single teeth	Non-restorable single teeth	Clinical trial	Stability of the implant, and postoperative complications.	Survival rate of 100%	1 year
9	Bramanti, 2018 (18)	Not mentioned	40 patients randomized to two groups	Not mentioned	aesthetic zone	Not mentioned	Randomized controlled trial	They measured the pink esthetic score.	All implants survived in both groups. Marginal bone level and pink esthetic score showed improved values after using PET	3 years
10	Barakat, 2017 (23)	20-25 years mean age of 35	20 patients and 10 implants	both sexes (8 males and 12 females	maxillary single rooted teeth	Not mentioned	Randomized Controlled Clinical Trial study	They measured the horizontal and vertical bone loss.	SST significantly give better bone level results	18 months
11	Gluckman, 2016 (25)	Not mentioned	(10 (14 PET sites	either gender	Esthetic zone	Either sides	Retrospective case series	Complication rate and need for xenograft.	Surgical closure was required for exposed shields.	18 months

TABLE 1 **Descriptive summary of the included study variables.**

12	Gluckman, 2018 (27)	24-71 (mean 39 years).	128	F (70 implants), M (58 implants).	Maxillary incisors (64%), premolars (22%), canines (14%); maxilla (89.9%), mandible (10.1%).	Not mentioned	Cases series (retrospective)	Implant survival and complication rate.	5 failed implants during osseointegration. Exposure of 16 shields was encountered. Infection was noticed in 3 sites. Migration of 1 shield was noticed.	4 years
13	Igor, 2017 (33)	Not mentioned	21	Not mentioned	Anterior maxilla	Anterior maxilla	Clinical trial	Soft tissue and bone preservation	Screw loosening was occurred with 4 patients. Complications arisen after 1 year were all resolved in 1 visit. Preservation of buccal bone and gingival tissue was achieved by immediate implantation with satisfactory esthetic results.	4 years
14	Siormpas et al., 2018 (34)	18–83 years	182 patients, 250 immediate implants	82 males and 100 females	Anterior maxilla and/or mandible (central and lateral incisors, cuspids, first premolars)	Anterior maxilla and/or mandible	Retrospective clinical study	Implant success and survival rates.	-5 failed implants. - Implant survival rate of 96.5% in 10 years. 3 Root fragment infection.	49.9 months

TABLE 1 Descriptive summary of the included study variables.

implantation techniques. The primary outcome variable used in the present study was the clinical aesthetic parameters which included pink esthetic score, gingival index, bleeding index, probing depth, buccal mucosal curvatures in addition to other radiographic evaluations of crestal bone loss and buccal bone preservation. The secondary outcome parameters included implant survival and rate of complications.

Data extraction and quality assessment

The final selected compatible studies were 14 human clinical studies (7 clinical trials and 7 case series) which included 619 implants inserted using the PET. Two researchers retrieved studies information which included study design, sample size, age, gender, the setting of the study, site of technique application, side, author's names, journal title, year of publication, statistical tests used, and follow up prognostic results. All these data were tabulated in an excel sheet and revised by another investigator. Accuracy was confirmed by three researchers through the assessment of all collected data.

Data synthesis and analysis

The risk of bias was decreased by internal and external assessment of the included studies that were ethically approved and peer-reviewed. To decrease selection and information bias, we strictly adhered to the determined inclusion criteria and included only studies that coincided with them. The risk of analysis bias was decreased by treating the predefined study variables and never switched and repeating the revision of the detailed procedure from two different outcome assessors.

RESULTS

Quality assessment of the included studies

The present study included 14 studies, all studies were clinical trials and retrospective case series that examined benefits, adverse effects and success rate of PET in the preservation of alveolar bone after simultaneous implant insertion. A risk of bias assessment using Cochrane's tool for risk was performed for the four controlled randomized clinical trial included (Table 2). Case series and non-randomized clinical studies were not eligible for quality assessment test.

There were 619 implants inserted via the PET technique in the included studies. Almost all studies were performed on the maxillary anterior and premolar teeth and 3.4% were performed on mandibular single rooted teeth, from which 1.6% failed, 1% had infection and 3.1% had shield exposure and resorption problems. There was a very wide

	Study	Random sequance generation (selection bias)	Allocation concealment (Selection bias)	Blinding of participants and personnel (Performance bias)	Blinding of outcome assessment (Detection bias)	Incomplete outcome data (Attrition bias)	Selective reporting (Reporting bias)	Anything else, idellay pre-specified (Other bias)
1	Sun et al. 2019 (6)	Low risk	Low risk	High risk	High risk	Low risk	Low risk	Unclear risk
2	Tiwari et al. 2019 (15)	Unclear risk	Unclear risk	High risk	High risk	Unclear risk	Low risk	Unclear risk
3	Bramanti et al. 2018 (18)	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Unclear risk
4	Barakat et al. 2017 (23)	Unclear risk	Unclear risk	High risk	High risk	Low risk	Low risk	Unclear risk

TABLE 2 Risk of bias assessment of the included controlled clinical trials.

range of age in the clinical cases, from 24 to 83 years). Clinical esthetic parameters including pink esthetic score, gingival index, bleeding index, probing depth, buccal mucosal curvatures in addition to other radiographic evaluations of crestal bone loss and buccal bone preservation revealed superior results in favor of the PET technique over the conventional post extraction implant placement techniques. The immediate implant survival rate using the PET in this analysis was 98.4%.

DISCUSSION AND QUANTITATIVE ANALYSIS

The selected 14 clinical human studies involved in this systematic review proved the efficacy of PET on bone preservation and implant success, these good results were proved both clinically and radiographically depending on proper selection criteria during their long term follow up periods which ranged from 12-60 months (Table 1). One of the main selection criteria for success of this technique is the condition of the remaining roots that act as a shield to prevent bone resorption, it must be free from any active inflammation as these forms could cause technique failure. Preservation of vascularity of the tooth fragment is guaranteed through flapless surgery (14–21).

Esthetic outcomes were promising in most studies including gingival index, emerging profile, and esthetic index together with improvement in bone crest level, buccal shield preservation without serious complication mentioned (22). Kan and Kitichai (10) in 2013 used the technique to save upper central incisor in 45 years women and was able to preserve the inter-implant papilla.

Durable minimum thickness of remaining part of the root by only 1.0 to 1.5 mm with the length of about 4–6 mm proved its validity as the shield in PET with most of the clinical studies involved taking into account that the increased thickness of remaining part may be one of the factors causing the failure, as the fate of root pieces that are left after extraction could result in postoperative complications such as infection, cyst formation, sinus tracks, and inflammation (1). Removal of the apex for the remaining root shield is a non-negotiating recommendation of the successful PET. Gandhi in 2019 (12) proved that leaving apical root parts without sectioning will increase the risks of compromised outcome or cofactor in implant failure or infection.

Retaining 1 mm of tooth structure occlusal to the ridge crest level was claiming that its potential for buccal bone preservation, and for the preservation of dentogingival fibers, too (23,24). But a new recommendation for better bone preservation, a decrease of root exposure and internal resorption that is supported by most of clinical studies (15), is the chamfer created in the remaining root shield 2 mm below the bone crest which facilitated the crown contouring with minimum complications.

Palatal placement of implants with lack of root–implant palpation with 2 mm "gap" is recommended in many clinical cases of our analysis without graft material, as this gap can be filled with a sufficient amount of bone without the use of any graft material as supported by Hazel's histologic examination that revealed bone, cementum, and periodontal tissue had been formed in the gap; moreover, absence of graft is radiographically accepted by the stability of marginal bone levels around implants. This was also supported by the results of Kher, 2018 (16), who applied the PET without any augmentation in 17 patients and obtained excellent results without any complication in the postoperative period that ranged from 12 to 42 months and an average of 19 months (16).

Implant showed high success rate with proper osseointegration that reached to almost 98.4 percent in our systematic review and goes in accordance with other analysis proved by different clinical studies as done by Gluckman and Maurice in 2017, who recorded a high success rate of PET with a survival rate of 96.1% during a follow up period of 1-4 years. Notably, better clinical results of the PET in bone preservation and absence of root exposure were obtained when a chamfer was

created 2 mm above the shield (24–27).
The main role of the PET that is presented by most of the clinical studies was in the preservation of marginal bone around implants which is documented by plain radiograph or cone-beam computed tomography (CBCT). A one-year follow-up of 43 implants and another 4-year follow-up period of 128 implants out of 132 showed the same marginal bone seal around implants with healthy soft and hard surrounding supporting structure (20,27).
Gluckman (24,25) described in detail the steps of the technique and its prosthetic demands in order to spread the technique application. Nevertheless, most studies conducted in the last ten years on humans were performed on the anterior maxillary aesthetic region, though Schwimer et al. in 2019 (7) described in steps the technique application as a report in posterior molar region and showed satisfactory result outcomes.
Amit and Neel (28) published their systematic review of the PET in 2017 and concluded that it was difficult to predict long term success of this technique. They included, unlike our study, all poster abstract studies, case reports and animal studies which gave heterogeneous variables outcomes; in our study we concentrated on patient-important clinical studies outcomes; all case report studies (29,30) conducted on less than 5 patients, all posters abstracts with insufficient data on the study outcomes were excluded. We noticed that fewer academic departments published studies on this subject and data enrolled from different private settings were published. This may cause insufficient documentation of the technique except thesis documentation attributed to Howard Gluckman.
Description of the sites for implant installation with PET (Table 1) from different clinical studies showed that the majority of cases were in the anterior esthetic region and premolar region (21,27) of the maxilla with only one case at lower mandibular premolar region with the success of implantation in all teeth (31,32). This technique could be the key to rehabilitation of remaining roots especially in the aesthetic regions with successful implantation without major complications of infection or implant loss or need for extra graft (33). However, well-designed, long term randomized trials are needed aiming at comparing the procedures with the conventional technique. Also a more widespread application of PET in the posterior region is needed to prove its efficacy in the preservation of bone and implant success in both cortical rather than cancellous bone type.
We faced some limitations in our study such as the gender effect on the success of this technique. This was due to the lack of information in the reviewed published studies. Another limitation was the role of age on success or failure of the technique as there was a very wide range of age in the clinical cases that ranged from 24 to 83 years). Also some articles did not describe the included subjects or areas in detail, thus complete information could not be reached regarding effect of age and gender. Moreover, publications reviewed used various terms such as root membrane, socket shield technique, PET, or partial extraction therapy. Another important issue is that this technique has promising but still insufficient results, not only in terms of number of cases, but also long term follow-up, histological analysis, and different clinical situations (34).
In addition, metanalysis testing could not be implemented because there are not many papers comparing the PET techniques with the gold standard techniques for alveolar ridge preservation, so it is also a limitation. Most of the published studies were heterogeneous, insufficient long term controlled clinical trial studies were conducted and published regarding this technique and most of them were case series or clinical single group interventional trials which did not include a control group for comparison of the studied intervention (35,36). In addition, different outcome variables were measured such as crestal bone loss, ridge width and survival rate of the immediate implant in a subjective rather than objective manner. The complication reported after insertion, included: buccal bone dehiscence, shield fracture, looseness, or exposure which required surgical closure.

CONCLUSION

Based on the results of this systematic review, the PET provided clinically acceptable results regarding ridge preservation in the esthetic zone of the maxillary anterior teeth.
Future controlled randomized studies with standardized parameters potentially affecting the outcomes should be thoroughly investigated, in particular factors such as the operator skills, clinical procedures, patient characteristics, setting, and site to confirm technique generalizability.

Author contributions

Conceptualization: Shadia A. Elsayed, Hanan MR. Shokier, Shahad Yaseen Alghazy.
Formal Analysis: Shadia A. Elsayed, Albraa B. Alolayan, Haitham Elsisi.
Investigation: Hanan MR. Shokier, Shahad Yaseen Alghazy.
Methodology: Albraa B. Alolayan, Tamer Omar, Ehab M. El-Roos.
Project Administration: Shadia A. Elsayed, Ehab M. El-Roos, Hoda Funsa.
Writing – Original Draft: Hanan MR. Shokier, Shadia A. Elsayed, Tamer Omar, Haitham Elsisi , Hoda Funsa.
Writing – Review & Editing: All authors.

Acknowledgment

The authors are deeply grateful to Mr. Yaseen H. Alghazzi, Language Supervisor, for his great help in editing the manuscript.

REFERENCES

1. Mitsias ME, Siormpas KD, Kotsakis GA, Ganz SD, Mangano C, Iezzi G. The root membrane technique: human histologic evidence after five years of function. Biomed Res Int 2017;2017 :7269467.
2. Fickl S, Zuhr O, Wachtel H. Stappert CFJ, Stein JM, Hurzeler MB. Dimensional changes of the alveolar ridge contour after different socket preservation techniques. J Clin Periodontol 2008;35(10):906–13.
3. Lee I-K, Lim H-C, Lee J-S, Hong J-Y, Choi S-H, Jung U-W. Layered approach with autogenous bone and bone substitute for ridge augmentation on implant dehiscence defects in dogs. Clin Oral Implants Res 2016;27(5):622–8.
4. Hürzeler MB, Zuhr O, Schupbach P, Rebele SF, Emmanouilidis N, Fickl S. The socket-shield technique: A proof-of-principle report. J Clin Periodontol 2010;37(9):855–62.
5. Kumar P, Kher U. Socket shield technique- enhancing pes around immediate implants in esthetic zone- a clinical study. Clin Oral Implants Res 2019;30(S19):17–8.
6. Sun C, Zhao J, Liu Z, Tan L, Huang YL, Zhao L et al. Comparing conventional flap-less immediate implantation and socket-shield technique for esthetic and clinical outcomes: A randomized clinical study. Clin Oral Implants Res 2020;31(2):181–91.
7. Schwimer CW, Gluckman H, Salama M, Nagy K, Du Toit J. The socket-shield technique at molar sites: A proof-of-principle technique report. J Prosthet Dent 2019;121(2):229–33.
8. Petsch M, Spies B, Kohal R-J. Socket shield technique for implant placement in the esthetic zone: a case report. Int J Periodontics Restorative Dent 2017;37(6):853–60.
9. Lker Sözer. Socket shield technique for ridge preservation: a 2 year follow-up case report. Clin Oral Implants Res 2017;28:237–237.
10. Kan JY, Rungcharassaeng K. Proximal socket shield for interimplant papilla preservation in the esthetic zone. Int J Periodontics Restor Dent 2013;33(1):e24–31.
11. Habashneh RA, Walid MA, Abualteen T, Abukar M. Socket-shield technique and immediate implant placement for ridge preservation: Case report series with 1-year follow-up. J Contemp Dent Pract 2019;20(9):1108–17.
12. Bhatavadekar N, Gandhi Y. Inappropriate socket shield protocol as a probable cause of peri-implant bone resorption: a case report. J Maxillofac Oral Surg 2020 Sep;19(3):359-363.
13. Cherel F, Etienne D. Papilla preservation between two implants: A modified socket-shield technique to maintain the scalloped anatomy? A case report. Quintessence Int 2014;45(1):23–30.
14. Narayan TV, Tarun Kumar AB. The Socket Shield Technique: biologic cheating for optimum aesthetics. Clin Oral Implants Res 2017;28(S14):522–522.
15. Tiwari S, Bedi RS, Wadhwani P, Aurora JK, Chauhan H. Comparison of immediate implant placement following extraction with and without socket-shield technique in esthetic region. J Maxillofac Oral Surg 2020 Dec;19(4):552-560. Epub 2019 Aug 17.
16. Kher U, Tunkiwala A, Shanbag S. A graftless socket-shield technique for immediate implant placement in the esthetic zone. Clin Oral Implants Res 2018;29:451–451.
17. Han C-H, Park K-B, Mangano FG. The modified socket shield technique. J Craniofac Surg 2018;29(8):2247–54.
18. Bramanti E, Norcia A, Cicciù M, Matacena G, Cervino G, Troiano G et al. Postextraction dental implant in the aesthetic zone, socket shield technique versus conventional protocol. J Craniofac Surg 2018;29(4):1037–41.
19. Arnab AM. Evaluate the esthetic outcomes when the socket shield technique used in the esthetic zone -vivo study. Clin Oral Implants Res 2019;30(S19):257–257.
20. Alrmali A. Root shield concept for maintaining alveolar ridge contour – Is it a coincidence or a consequence? Clin Oral Implants Res 2019;30(S19):252–252.
21. Koshak HH, Alsayed AM. PC429: Is alveolar ridge can be completely preserved by Socket Shield Technique (SST)? A case report. J Clin Periodontol 2018;45:502–502.
22. Siormpas K, Mitsias M, Kontsiotou-Siormpa E, Garber D, Kotsakis G. Immediate Implant placement in the esthetic zone utilizing the "root-membrane" technique: clinical results up to 5 years postloading. Int J Oral Maxillofac Implants 2014;29(6):1397–405.
23. Barakat DA, Hassan RS, Eldibany RM. Evaluation of the socket shield technique for immediate implantation. Alexandria Dent J 2017;42(2):155–61.
24. Gluckman H, Salama M, Du Toit J. Partial Extraction Therapies (PET) Part 2: Procedures and technical aspects. Int J Periodontics Restorative Dent 2017;37(3):377–85.
25. Gluckman H, Du Toit J, Salama M. The pontic-shield: partial extraction therapy for ridge preservation and pontic site development. Int J Periodontics Restorative Dent 2016;36(3):417–23.
26. Gluckman H, Nagy K, Du Toit J. Prosthetic management of implants placed with the socket-shield technique. J Prosthet Dent 2019;121(4):581–5.
27. Gluckman H, Salama M, Du Toit J. A retrospective evaluation of 128 socket-shield cases in the esthetic zone and posterior sites: Partial extraction therapy with up to 4 years follow-up. Clin Implant Dent Relat Res 2018;20(2):122–9.
28. Gharpure AS, Bhatavadekar NB. Current evidence on the socket-shield technique: A systematic review. J Oral Implantol 2017:395–403.
29. Chen L, Yang Z, Liu X, Lin WS, Tan J. CAD-CAM titanium preparation template for the socket-shield technique. J Prosthet Dent 2020 Jun;123(6):786-790. Epub 2019 Nov 5.
30. Du Toit J, Gluckman H. The modified socket-shield technique. J Craniofac Surg 2018;29(7):2005–6.
31. Walid A-J. Socket Shield Technique - A new approach of immediate implant articles review. Open Access J Dent Sci 2018;3(10).
32. Romero PM. PR565: Crestal ridge width changes when placing immediate implants: socket shield technique versus soft tissue augmentation. J Clin Periodontol 2018;45:313–313.
33. Smojver I, Illeš D, Suši M, Gabri D. Immediate implanto-prosthetic rehabilitation after socket shield technique of implant placement 4 years follow up - a clinical study. Clin Oral Implants Res 2017;28:456–456.
34. Siormpas KD, Mitsias ME, Kotsakis GA, Tawil I, Pikos MA. Mangano FG. The root membrane technique: A retrospective clinical study with up to 10 years of follow-up. Implant Dent 2018;27(5):564–74.
35. Abdelqader Altaweel A, Aziz Baiomy Abdullah Baiomy A, Abdel-Hameed Elsayed S. Effect of Nano-hydroxyapatite and platelet-rich fibrin covered by the amniotic membrane on osseointegration after mandibular piezoelectric ridge splitting. Saudi Dent J 2021;33(1):27–33.
36. Hazzaa HHA, El-Kilani NS, Elsayed SAE, Abd El Massieh PM. Evaluation of immediate implants augmented with autogenous bone/melatonin composite graft in the esthetic zone: a randomized controlled trial. J Prosthodont 2019;28(2):e637–42.