REVIEW ARTICLE

Socket-shield Technique vs Conventional Immediate Implant Placement for Esthetic Rehabilitation: A Systematic Review and Meta-analysis

Ahmed S Salem[1], Bassant Mowafey[2], Salwa A El-Negoly[3], Mohammed E Grawish[4]

Abstract

Aim: The present systematic review and meta-analysis (SR/MA) aimed to test the null hypothesis that there is no difference between socket-shield technique (SST) and conventional immediate implant placement (CIIP) as an esthetic rehabilitation option for permanent human anterior teeth, against the alternative one of a difference.

Background: Socket-shield technique is considered as a highly promising procedure that has the potential to prevent resorption of anterior alveolar ridges, maintains white and pink esthetics, and provides a solution for esthetically critical cases. Controlled randomized clinical trials (RCT) and nonrandomized ones had been identified by searching the following databases: Google Scholar, Scopus, and PubMed. Literature search was determined from January 2010 up to June 2020. Hand searches were also accomplished for relevant abstracts, books, and reference lists. The eligibility criteria included prospective observational controlled RCTs and non-RCTs. Populations: patients with endodontically treated/nonrestorable permanent mature anterior teeth indicated for extraction. Interventions: the sockets were subjected to immediate implant placement using SST. Controls: implants placed with SST compared with those of CIIP. Outcome: the pink esthetic score measured for esthetic rehabilitation. To assess article quality, the Cochrane risk-of-bias tool was used by two independent authors. The data across quantitative studies were analyzed using comprehensive MA software.

Review results: The initial search found out 172 references through the search strategy and three additional ones were recognized through hand searching. After being filtered, 101 references were screened and recorded. After the inclusion and exclusion criteria were applied, only seven unduplicated prospective controlled RCTs and non-RCTs were involved in the quantitative MA. At the 6-month evaluation period, the total standard difference in mean was 1.07 and I^2 test value measuring heterogeneity was 77.182, whereas at the 12-month period, the total standard difference in mean was 1.43 and I^2 test value measuring heterogeneity was 64.914.

Conclusion: SST had a positive effect on the esthetic rehabilitation for anterior teeth better than CIIP. However, this conclusion was dependent on a very few well-conducted prospective RCT and non-RCT. Further RCTs with longer observational time, proper methodology, and of larger sample size are still required to adequately answer the question of the present SR.

Clinical significance: There is limited knowledge about the appropriateness of SST in the field of implant dentistry, specifically for esthetic consideration. This SR/MA confirmed the positive effect of the SST over CIIP for esthetic rehabilitation for anterior teeth.

Systematic review registration: PROSPERO, identifier CRD42020194086.

Keywords: Anterior teeth, Conventional immediate implant technique, Pink esthetic score, Socket-shield technique, Systematic review and meta-analysis.

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Introduction

Resorption of the alveolar bone surrounding the socket is a natural consequence that occurred after tooth extraction. The alveolar ridge undergoes an inevitable vertical and horizontal bone loss, mainly at the external bone envelope.[1] Ridge preservation needs complex soft and hard-tissue reconstruction to accomplish esthetically appealing results, especially in the anterior regions. Immediate implant placement, grafting, socket preservation, and a traumatic extraction are the techniques that were introduced to prevent alveolar bone resorption of freshly extracted sockets. These modalities were aimed to stop the collapse of cortical plates and to maintain its appropriate dimensions.[2] The amount of ridge conserved by these procedures is still doubtful and entire regeneration and/or complete preservation of the extraction sockets have not been achieved yet.[3]

Partial extraction therapy (PET) is a controlled approach developed to revolutionize the branch of dental implants

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prosthetics. The PET aimed to find a method preventing alveolar bone resorption occurred after conventional tooth extraction, specifically in cosmetically challenging zones.[4] The conceptualization of PET involves three dissimilar techniques: root submergence (RST), pontic-shield (PST), and SST, and a combination thereof.[5] The RST retains the normal supporting system of the tooth in the pontic area to preserve alveolar bone structure and to assist in the creation of an esthetically favorable results, specifically in cases of multiple adjacent missing teeth.[6] The PST was produced by Gluckman et al.[7] aiming to preserve the alveolar bone at areas proposed for pontic development where the RST is contraindicated and it is recommended when there is a periapical lesion located near the root apex. The technique entails the preparation of the extraction socket to be filled with a resorbing bone graft material and then the socket preferably sealed with a soft tissue membrane. The surgical wound is left to heal for at least of 3 months and subsequently pontic pressure is steadily applied to develop the pontic site. The main advantage of these procedures is to conserve the soft tissue contours which will permit an outstanding profile for the pontic. It will also prevent its potential collapse over time and maintain the alveolar ridge dimension.[8]

The SST was developed to maintain highly vascular periodontal ligament and associated bundle bone close to the buccal part of the root with the significance of avoiding physiologic remodeling of the buccal bone plate that occurred after conventional tooth extraction.[9] Hürzeler et al.[10] reported that during implant placement, holding the buccal part of the root could be advantageous in maintaining the buccal bone plate and does not seem to interfere with osseointegration. The histological findings revealed a newly formed bone in the small gap between implant in contact with the tooth fragment and cementum formation on implant surfaces positioned in contact with intentionally retained roots. This technique offers a high esthetic outcome with effectual preservation of facial tissue contours.[11]

Numerous classifications and modifications were introduced for the socket-shield (SS) procedures to outfit different clinical conditions. Kumar and Kher[1] proposed a classification of six categories according to the preparation design and role of shields in treatment planning. These are multiple buccal, lingual (palatal), interproximal, half C buccal, full C buccal, and buccal ones. Also, slightly different SS approaches are necessary with certain clinical situations likely as performing an SST for upper canines, C-shaped shields for adjacent implant sites, SS for management of a fenestration defect, staged socket shield procedure (Glocker's technique), and adjacent teeth socket shields.[12] However, SST is associated with certain threats, likely as the development of peri-implant infections or the formation of a peri-implant periodontal membrane along with resorption associated with the usual biological long-term complications.[13]

Before dental implant therapy, inadequate preparation of the hard and soft tissues especially in the anterior esthetic zone gives unsatisfactory results as expected in some cases. The rationale for performing this SR/MA came from the fact that a consistent technique for ridge preservation may be weighed as a substitute for the conventional ones to prevent vertical and horizontal bone changes after tooth extraction especially in the anterior esthetic zone. SST has been recently introduced in the field of dental implants prosthetics to overcome the negative consequences of tooth extraction such as soft and hard tissue augmentation. Consequently, this SR will afford a decision-making process based on scientific evidence for the healthcare provider and clinician for the appropriateness of this technique in the field of implant dentistry. Considering the lack of high-quality evidence-based consensus guidelines about the effectiveness of the SST for esthetic rehabilitation of anterior teeth, therefore the present study aimed to conduct a SR/MA comparing between SST and conventional immediate implant protocol as an esthetic rehabilitation option for permanent human anterior teeth. The objective of the present study was dependent on a research question; is there a difference between SST and CIIP for permanent anterior teeth esthetic rehabilitation?

Source of support: Nil
Conflict of interest: None

Materials and Methods

Protocol and Registration

This SR adhered to the Preferred Reporting Items for SRs and MA PRISMA checklist and the guidelines provided by the Cochrane Handbook for SRs were also followed. The clinical question was organized and formulated in accordance to the PICO system (P: population, I: intervention, C: controls, O: outcome) for the research question construction. The population was adult patients with endodontically treated/nonrestorable permanent mature anterior teeth indicated for extraction; the intervention was immediate implant placement using SST; the comparator was CIIP; the outcome was the pink esthetic score measured for esthetic rehabilitation of anterior teeth; and the design of the studies was RCT and non-RCT. This SR/MA had been recorded in the PROSPERO for the international prospective register of SRs (registration number CRD42020194086).

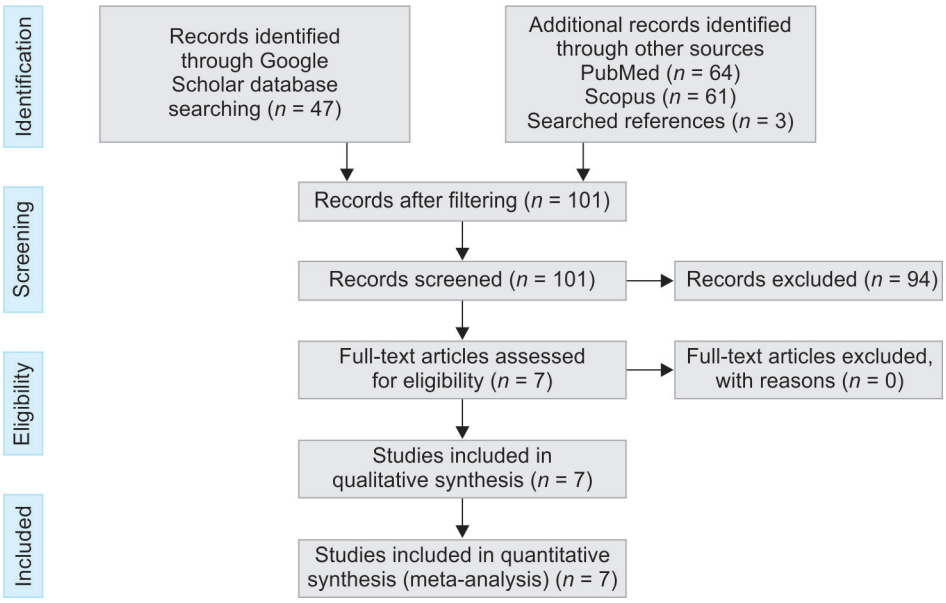
Information Sources and Search Strategy

The PROSPERO and the Cochrane Database of SRs (CDSR) were searched in June 2020 and presented three articles registered for SR onto the PROSPERO database and none was found onto CDSR. One of these SRs compared the performance of type II and III implant placement in single tooth sites of the anterior areas, the second one is an evidence-based updated SR on the SST, and the third study evaluated the effect of height and thickness of remaining root segments on the success of SST. Then, a literature search was performed by two independent authors (MG and AS) based on multiple electronic databases of Google Scholar, Scopus, and PubMed. Terms such as "socket shield technique," "root submergence technique," "root membrane technique," and "anterior teeth esthetic rehabilitation" were used in our search. The search strategy used in PubMed was accustomed for use in the Google Scholar and Scopus databases. The keywords were combined with three basic Boolean operators: AND, OR, and NOT. Hand searches were also accomplished for relevant abstracts, books, and reference lists.

Data Filtering

When available, the articles obtained were subjected to filtering using the following strategy; the text availabilities were abstracts, free, and nonfree full texts; the article types were RCT and non-RCT; the publication date was from January 2010 up to June 2020; the species were humans; the gender was male or female;

Flowchart 1: Flowchart for articles included in meta-synthesis and MA according to the preferred reporting items for SRs and MAs guideline



and the age was more than 16 years and there was no restriction for language type.

Eligibility Criteria

The inclusion criteria (IC) comprised the following: (1) Studies are prospective observational RCTs or non-RCTs; (2) Selected teeth were endodontically treated/nonrestorable permanent anterior teeth indicated for extraction; (3) The fresh sockets were subjected to dental implant placement using SST and/or conventional one; (4) All cases had at least a 1-month follow-up period; and (5) The outcome measures were assessed by clinical indices and/or radiographic images. Exclusion criteria (EC) were: (1) Immature teeth of incomplete root apex formation; (2) Teeth with external/internal resorption, vertical root fractures on the buccal aspect, and horizontal fractures below bone level; (3) Teeth with periodontitis and periodontal diseases; (4) Root portions were not left back intentionally to preserve buccal bone crest; (5) Patients subjected to delayed implant placement; (6) Laboratory and animal-based studies, qualitative and/or quantitative reviews, commentaries, letters to the editor, and case series/case reports; and (7) Studies not related to SST for implant placement. Full-texts adjudged by abstracts and title to be relevant were evaluated independently by two authors (BM and SN) for specified eligibility criteria. Any disagreements in the study selection were resolved through discussion with a third author (MG).

Studies Selection and Data Collection

Two authors (AS and BM) read and screened all the relevant titles and abstracts and carefully chosen the studies related to immediate implant placement depending on the eligibility criteria. Each author tabulated the data of importance. From the studies involved, the following information were tabulated: authors, publication date, journal name, study design, number of enrolled patients, gender, average age, number of used implants, implant distribution, type of loading, outcome measure, and follow-up period. In certain instances, the authors of the involved studies were contacted via e-mail in case of additional information was required or any data were missing. If the information could not be identified in an online abstract or on the whole publication was considered as "not provided."

Risk of Bias in Individual Studies

To assess article quality, two independent authors (MG and SE) used the Cochrane Collaboration's tool for assessing the risk of bias for the human RCT.[14] It is concerned with evaluating (1) Random sequence generation, (2) Allocation concealment, (3) Blinding of participants and personnel, (4) Blinding of outcome assessment, (5) Incomplete outcome data, and (6) Selective outcome reporting. For consistency, any disagreements in the assessment were resolved through discussion with a third author (AS).

Statistical Analysis

Degree of chance—adjusted agreement (κ coefficient value) was used to determine the interreviewer reliability. Comprehensive meta-analysis (CMA) software (version 3, Biostat Inc., Englewood, New Jersey, USA) was used for creating a forest plot and additionally to find the standard difference in means and 95% confidence interval as effect size (ES) values. The data introduced were the means, standard deviation, and sample size.

Results

The kappa value for the agreements of interexaminer variability was 0.79.

Studies Selection

The initial search found out 172 references through the search strategy and three additional ones were recognized through hand searching. After being filtered, 101 references were screened and recorded. After the inclusion and exclusion criteria were applied, only seven unduplicated prospective controlled RCTs and non-RCTs[15–21] were included in the qualitative meta-synthesis and quantitative MA (Flowchart 1, Table 1).

Table 1: Databases involved and the search terms used with the number of references obtained after filtering and applying the eligibility criteria

Database	*Search terms (number of references)*	*Filter (number of references)*	*Number of references (IC/EC)*
Google Scholar	"Implant socket-shield technique" (47)	2010:2020 (39)	Bramanti et al.[15] Sun et al.[16]
PubMed	Socket-shield technique (64)	2010:2010; clinical trials (2)	Bramanti et al.[15] Sun et al.[16]
Scopus	TITLE-ABS-KEY (socket AND shield AND technique) (61)	TITLE (socket AND shield AND technique) AND [LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2010)] AND [LIMIT-TO (DOCTYPE, "ar")] (60)	Bramanti et al.[15] Sun et al.[16] Abd-Elrahman et al.[17] Xu et al.[18]
Searched references	(3)	(3)	Mathew et al.[19] Fattouh[20] Hana and Omar[21]

Studies Characteristic

Two studies performed at 2018,[15,20] one at 2019,[18] and four at 2020.[16,17,19,21] Five studies were RCT[15–17,20,21] and the other two were non-RCT.[18,19] The total numbers of patients subjected to the CIIT or SST were 189 with the least number for the study performed by Mathew et al.[19] as only 10 patients were involved and the highest numbers were for the studies performed by Bramanti et al.[15] and Hana and Omar[21] as 40 patients were involved for each study. The participants were male and female patient in the studies accomplished by Sun et al.,[16] Abd-Elrahman et al.,[17] Xu et al.,[18] Fattouh,[20] and Hana and Omar[21] while the gender was not provided by the studies of Bramanti et al.[15] and Mathew et al.[19] The age of the participants was more than 18 years in all the studies and the age was not provided for the study that was performed by Bramanti et al.[15] The total numbers of implants were 204 from which 102 implants were used with CIIT and the other 102 implants were used with SST. The implant distributions were single or multiple and the type of loading was immediate. The outcomes measured were peri-implant soft tissue and the bone level, survival rate, and implant stability, and all the studies evaluated the pink esthetic score. The evaluation period ranged from 12 to 36 months (Table 2).

Pink esthetic scores were measured at 0 day, 3, 6, 12, 24, and 36-months, respectively, for CIIP and SST. Four studies shared a 6-month evaluation period[15–17,20] and five studies shared a 12-month evaluation period.[16,18–21] At the 6-month evaluation period, the lowest mean values were 8.85 ± 1.81 for CIIP and 11.2 ± 0.91 for SST and the highest values were 11.73 ± 1.67 for CIIP and 12.30 ± 0.86 for SST. Meanwhile, at the 12-month evaluation period, the lowest mean values were 9.63 ± 1.34 for CIIP and 11.1 ± 0.73 for SST and the highest values were 11.83 ± 0.94 for CIIP and 13.25 ± 0.75 for SST (Table 3).

Risk of Bias within Studies

The evaluation results proposed by the Cochrane Collaboration were summarized in Table 4. The risk of bias in the RCT was acceptable according to the Cochrane risk-of-bias assessment (Table 4).

Meta-analysis

Based on the homogeneity of the data provided for measuring pink esthetic scores at 0 day, 3, 6, 12, 24, and 36 months for CIIP and SST, only four studies were included in the MA at 6-month evaluation period,[15–17,20] whereas five studies were involved in MA at 12 months.[16,18–21] Regarding four studies selected at 6-month evaluation period and when using the fixed effect model, the highest relative weight was for the study performed by Bramanti et al. (32.86)[15] while the lowest one was for the study performed by Fattouh (15.54).[20] The standard difference in mean, standard error, variance, lower limit, upper limit, *Z*-value, *p*-value, and weight for each study determined by the fixed effect model is shown in Table 5. The total standard difference in mean was 1.07. It was higher for the study performed by Abd-Elrahman et al. (2.09)[17] while it was lower for the study performed by Sun et al. (0.16).[16] A total significant difference was found between the four studies ($p = 0.00$). There was a nonsignificant difference between the two groups for the study performed by Sun et al. ($p = 0.67$).[16] I^2 test value measuring heterogeneity was 77.182 and τ^2 value reflecting the amount of true heterogeneity was 0.512 (Table 6). The standard difference in mean and 95% CI revealed that SST is favorably advantageous over CIIP for the esthetic rehabilitation of anterior teeth as all the studies fallen within the range from no effect (0.00) to positive effect (3.00) (Fig. 1).

Regarding five studies involved in MA at 12-months,[16,18–21] and when using the fixed effect model, the highest relative weight was for the study performed by Mathew et al. (25.00)[19] while the lowest one was for the study performed by Fattouh (13.18).[20] The standard difference in mean, standard error, variance, lower limit, upper limit, *Z*-value, *p*-value, and weight for each study determined by the fixed effect model is shown in Table 7. The total standard difference in mean was 1.43. It was higher for the study performed by Hana and Omar (2.10)[21] while it was lower for the study performed by Sun et al. (0.41).[16] A total significant difference was found between the five studies ($p = 0.00$). There was a nonsignificant difference between the two groups for the study performed by Sun et al. ($p = 0.27$).[16] I^2 test value measuring heterogeneity was 64.914 and τ^2 value reflecting the amount of true heterogeneity was 0.318 (Table 8). The standard difference in mean and 95% CI revealed that SST is favorably advantageous over CIIP for the esthetic rehabilitation of anterior teeth as all the studies fallen within the range from no effect (0.00) to positive effect (3.00) (Fig. 2).

Discussion

It was unclear whether the SST will provide a plausible outcome for esthetic rehabilitation of anterior teeth. The reasons for this

Table 2: Characteristics of the studies included in the meta-synthesis

Ref	*Year*	*Journal*	*Study design*	*Pt (N)*	*Gender*	*Age*	*Imp (N)*	*Imp distribution*	*Type of loading*	*Outcome measures*	*Follow-up*
Google Scholar											
Bramanti et al.[15]	2018	J Craniofac Surg	RCT	40	Not provided	Not provided	40	Single	Immediate	The pink esthetic score, survival rate, marginal bone level	36-months
Sun et al.[16]	2020	Clin Oral Implants Res	RCT	30	23 males 7 females	>25 years	30	Single	Immediate	The pink esthetic score, soft-tissue recession, modified plaque index, modified sulcus bleeding index, probing depth, implant stability quotient, buccal plate width, buccal plate height	24-months
Scopus											
Abd-Elrahman et al.[17]	2020	Clin Implant Dent Relat Res	RCT	25	14 females 11 males	30.9 ± 5.5	40	Single/ multiple	Immediate	The pink esthetic score, dimensional changes in the labial bone plates, implant stability quotient	6-months
Xu et al.[18]	2019	Hua Xi Kou Qiang Yi Xue Za Zhi	Non-RCT	24	12 males 12 females	39.08 ± 9.5	24	Single	Immediate	The pink esthetic score, success rate, patient satisfaction	12-months
Searched references											
Mathew et al.[19]	2020	IJISRT	Non-RCT	10	Not provided	>25 years	10	Single	Immediate	The pink esthetic score, peri-implant soft tissue, and the bone level	12-months
Fattouh[20]	2018	E.D.J	RCT	20	12 females 8 males	>18 years	20	Single	Immediate	The pink esthetic score, implant survival, marginal bone level	12-months
Hana and Omar[21]	2020	J UoD	RCT	40	26 males 14 females	≥25 years	40	Single	Immediate	The pink esthetic score, implant survival	12-months

Table 3: Pink esthetic scores measured at 6 and 12 months for CIIP and SST

		RCT and non-RCT (Mean ± SD)									
		6-months						*12-months*			
		Implant						*Implant*			
Study	*Pt*	*CIIP*	*SST*	*CIIP*	*SST*	*Study*	*Pt*	*CIIP*	*SST*	*CIIP*	*SST*
Bramanti et al.[15]	40	20	20	11.05 ± 1.53	12.30 ± 0.86	Sun et al.[16]	30	15	15	11.53 ± 1.73	12.20 ± 1.57
Sun et al.[16]	30	15	15	11.73 ± 1.67	12.00 ± 1.77	Xu et al.[18]	24	12	12	11.83 ± 0.94	13.25 ± 0.75
Abd-Elrahman et al.[17]	25	20	20	8.85 ± 1.81	12.00 ± 1.12	Mathew et al.[19]	40	20	20	10.80 ± 0.83	12.20 ± 0.83
Fattouh[20]	20	10	10	10.3 ± 0.48	11.2 ± 0.91	Fattouh[20]	20	10	10	10.2 ± 0.42	11.1 ± 0.73
						Hana and Omar[21]	40	20	20	9.63 ± 1.34	12.26 ± 1.04

Table 4: Risk-of-bias summary of RCT according to the Cochrane collaboration's tool

Author	*Bramanti et al.*[15]	*Sun et al.*[16]	*Abd-Elrahman et al.*[17]	*Xu et al.*[18]	*Mathew et al.*[19]	*Fattouh*[20]	*Hana and Omar*[21]
Random sequence generation	−	−	−	+	+	−	+
Selection bias (allocation concealment)	−	−	−	?	?	?	?
Performance bias (blinding of participant)	−	−	−	?	?	?	?
Detection bias (blinding of outcome assessment)	−	−	−	?	?	?	?
Attrition bias (incomplete outcome data)	−	−	−	−	+	−	−
Reporting bias (selective reporting)	−	−	−	?	?	?	?
Grading system							

Low risk of bias − High risk of bias + Unclear risk ?

Table 5: Results of MA performed by CMA software for the ES for both SST and CIIP as an esthetic rehabilitation of anterior teeth at 6-month evaluation period

	Statistics for each study							
Study name	*Std. diff in means*	*Standard error*	*Variance*	*Lower limit*	*Upper limit*	*Z value*	*p value*	*Weight (fixed)*
Bramanti et al.[15]	1.01	0.34	0.11	0.35	1.67	3.00	0.00	32.86
Sun et al.[16]	0.16	0.37	0.13	−0.56	0.87	0.43	0.67	27.68
Abd-Elrahman et al.[17]	2.09	0.39	0.15	1.32	2.86	5.32	0.00	23.92
Fattouh[20]	1.24	0.49	0.24	0.28	2.19	2.53	0.01	15.54

Table 6: Model (fixed)

ES and 95% confidence interval	
Std diff in means	1.07
Standard error	0.19
Variance	0.04
Lower limit	0.69
Upper limit	1.44
Test of null [2-tail]	
Z-value	5.55
p-value	0.00
Heterogeneity	
Q-value	13.147
Df [Q]	3
p-value	0.004
I^2	77.182
τ-squared	
τ squared	0.512
Standard error	0.549
Variance	0.302
τ	0.715

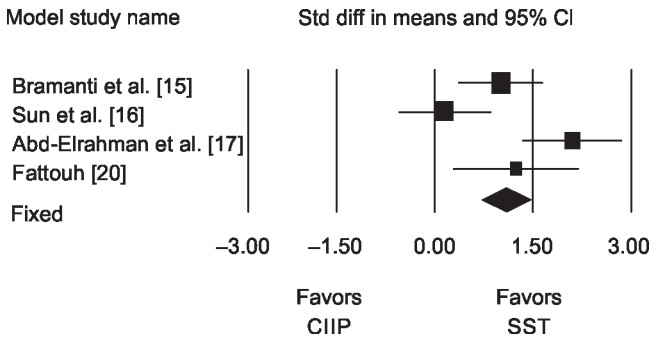


Fig. 1: Forest plot of the results of the MA for the studies selected at 6-month evaluation period. The black diamond represents the pooled ESs whereas the black squares and error bars signify the standardized difference (Std diff) values in the means (ES) and 95% confidence interval (CI) values, respectively

uncertainty were attributed to lack of well-designed prospective RCT, retrospective studies that exist in limited numbers and are of inconsistent design, and the existing case reports are of very limited scientific value.[22] Therefore, our study was designed to answer a specific research question through identifying, evaluating, summarizing, and analyzing the findings of all relevant individual studies.

Calculating the ES is a method to describe quantitative results of the experimental effects in terms of measures of magnitude as it determines sizes of differences between group' means. According to Cohen,[23] an ES of 0.8 is considered a large effect, 0.5 is a moderate effect, and 0.2 is a small effect. Our results showed a large effect for the SST over CIIP for esthetic rehabilitation of anterior teeth at 6-month and 12-month evaluation periods with a standard difference in means 1.07 and 1.43, respectively. Tan et al.[24] reported that maintaining an adequate thickness of the root, delicate surgical procedures and rigorous case screening are the key to achieve a good esthetic outcome of implant treatment with SST. Results obtained by Tiwari et al.[25] demonstrated better preservation of the bone through the SST and thus eliminating the need for any bony substitutes especially in the esthetic zone. Additionally, Durrani et al.[26] concluded that SST may become the future noninvasive therapy for the preservation of soft and hard tissues around an oral implant in esthetic zones.

Table 7: Results of MA performed by CMA software for the ES for both SST and CIIP as an esthetic rehabilitation of anterior teeth at 12-month evaluation period

	Statistics for each study							
Study name	*Std. diff in means*	*Standard error*	*Variance*	*Lower limit*	*Upper limit*	*Z value*	*p value*	*Weight (fixed)*
Sun et al.[16]	0.41	0.37	0.14	−0.32	1.13	1.10	0.27	24.91
Xu et al.[18]	1.67	0.47	0.22	0.74	2.60	3.52	0.00	15.08
Mathew et al.[19]	1.69	0.37	0.14	0.97	2.41	4.58	0.00	25.00
Fattouh[20]	1.51	0.51	0.26	0.52	2.51	2.98	0.00	13.18
Hana and Omar[21]	2.10	0.39	0.16	1.33	2.88	5.34	0.00	21.82

Table 8: Model (fixed)

ES and 95% confidence interval	
Std. diff in means	1.43
Standard error	0.18
Variance	0.03
Lower limit	1.07
Upper limit	1.79
Test of null [2-tail]	
Z-value	7.78
p-value	0.00
Heterogeneity	
Q-value	11.401
Df [Q]	4
p-value	0.002
I^2	64.914
τ-squared	
τ squared	0.318
Standard error	0.351
Variance	0.123
τ	0.564

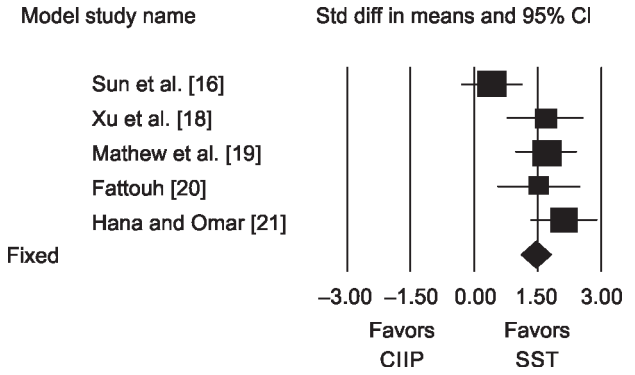


Fig. 2: Forest plot of the results of the MA for the studies selected at 12-month evaluation period. The black diamond represents the pooled ES whereas the black squares and error bars signify the standardized difference (Std. diff.) values in the means (ES) and 95% confidence interval (CI) values, respectively

The fixed effect model was used as we assumed that the true ES for all studies is identical, and the only reason the ES varies between studies resulted from sampling error.[27] The selection of the fixed effect models was dependent on the fact that all studies in the analysis share a common ES as the participants involved nearly have the same age and all of them were subjected to the same surgical conditions. Heterogeneity between-studies' variability was assessed using the I^2 statistic for measuring inconsistency. The heterogeneity thresholds were determined as $I^2 = 75\%$ (high), $I^2 = 50\%$ (moderate), and $I^2 = 25\%$ (low).[28] Our results showed that a moderate-to-high inconsistency between selected studies with I^2 values 77.182 at 6-month and 64.914 at 12-month evaluation periods. The estimate of the between-study variance was measured using τ^2 value. It follows that τ^2 will increase as either the variance within-studies decreases and/or the observed variance increases. τ^2 value at 6 months was 0.512 and at 12 months was 0.318. The heterogeneity between studies comes from patient characteristics and specific interventions or procedures. Staehler et al.[29] developed a standardized step-by-step protocol after 12 years of experience for the SST. Additionally, patient characteristics likely as gender, age, and general condition should be evaluated and standardized before doing any prospective RCT. Melsen et al.[30] defined statistical heterogeneity as the larger differences in the outcome measured for the individual studies than could be expected to result from chance alone, which may result from methodological or clinical heterogeneity. Methodological heterogeneity is considered as the differences in study design and risk of bias and clinical heterogeneity likely as the differences in patient populations and treatment protocol.

The results of our study come with findings of Lin et al.,[31] Zhang et al.,[32] and Gao et al.[33] who reported that SST may be considered as a clinically feasible treatment option when compared with CIIP could be a better option for esthetic area implantation as it improves the contouring of soft tissue and effectively alleviates the absorption of bone tissue after anterior teeth extraction, and it has the potential to maintain peri-implant tissue stability and buccal tissue contours, improving esthetic and functional outcomes in the esthetic zone. However, the data provided in the previous reports depend mainly on a short evaluation period, and therefore, it remains problematic to predict the long-term outcome of the SST until high-quality evidence becomes available from long-term RCTs to substantiate the current findings.[34,35] Therefore, it is not possible to recommend SST as an alternative treatment modality with the same long-term predictability as CIIP. Among limitation of the present SR and MA was restricting it to English-language publications but this factor appears to have little impact on the effect estimates and conclusions of SRs as reported by Dobrescu et al.[36]

Conclusion

Within the limitations of the present SR/MA, it might be concluded that SST had a positive effect on the esthetic rehabilitation better than CIIP. However, this conclusion was dependent on very few well-conducted prospective RCT and non-RCT.

References

1. Kumar PR, Kher U. Shield the socket: procedure, case report and classification. J Indian Soc Periodontol 2018;22(3):266–272. DOI: 10.4103/jisp.jisp_78_18.
2. Dayakar MM, Waheed A, Bhat HS, et al. The socket-shield technique and immediate implant placement. J Indian Soc Periodontol 2018;22(5):451–455. DOI: 10.4103/jisp.jisp_240_18.
3. Viña-Almunia J, Candel-Martí ME, Cervera-Ballester J, et al. Buccal bone crest dynamics after immediate implant placement and ridge preservation techniques: review of morphometric studies in animals. Implant Dent 2013;22(2):155–160. DOI: 10.1097/ID.0b013e318287a947.
4. 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):377–385. DOI: 10.11607/prd.3111.
5. Gluckman H, Salama M, Du Toit J. Partial extraction therapies (PET) part 1: maintaining alveolar ridge contour at pontic and immediate implant sites. Int J Periodontics Restorative Dent 2016;36(5):681–687. DOI: 10.11607/prd.2783.
6. Salama M, Ishikawa T, Salama H, et al. Advantages of the root submergence technique for pontic site development in esthetic implant therapy. Int J Periodontics Restorative Dent 2007;27(6): 521–527. DOI: 10.11607/prd.00.0775.
7. 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):417–423. DOI: 10.11607/prd.2651.
8. Kumar T, Kulkarni S, Kher U. Pontic site management. In: Kher U, Tunkiwala A, editors. Partial extraction therapy in implant dentistry. Springer, Cham; 2020. p. 159–189. DOI: 10.1007/978-3-030-33610-3_7.
9. Saeidi Pour R, Zuhr O, Hürzeler M, et al. Clinical benefits of the immediate implant socket shield technique. J Esthet Restor Dent 2017;29(2):93–101. DOI: 10.1111/jerd.12291.
10. Hürzeler MB, Zuhr O, Schupbach P, et al. The socket-shield technique: a proof-of-principle report. J Clin Periodontol 2010;37(9):855–862. DOI: 10.1111/j.1600-051X.2010.01595.x.
11. Bäumer D, Zuhr O, Rebele S, et al. Socket shield technique for immediate implant placement–clinical, radiographic and volumetric data after 5 years. Clin Oral Implants Res 2017;28(11):1450–1458. DOI: 10.1111/clr.13012.
12. Kher U, Rajender Kumar P. Variations of the socket shield procedure. In: Kher U, Tunkiwala A, editors. Partial extraction therapy in implant dentistry. Springer, Cham; 2020. p. 129–158. DOI: 10.1007/978-3-030-33610-3_6.
13. Elaskary A. Advances in esthetic implant dentistry. John Wiley & Sons; 2018. DOI: 10.1002/9781119286707.
14. Higgins JP, Altman DG, Gøtzsche PC, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomized trials. BMJ 2011;343:d5928. DOI: 10.1136/bmj.d5928.
15. Bramanti E, Norcia A, Cicciù M, et al. Postextraction dental implant in the aesthetic zone, socket shield technique versus conventional protocol. J Craniofac Surg 2018;29(4):1037–1041. DOI: 10.1097/SCS.0000000000004419.
16. Sun C, Zhao J, Liu Z, 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):181–191. DOI: 10.1111/clr.13554.
17. Abd-Elrahman A, Shaheen M, Askar N, et al. Socket shield technique vs conventional immediate implant placement with immediate temporization. Randomized clinical trial. Clin Implant Dent Relat Res 2020;22(5):602–611. DOI: 10.1111/cid.12938.
18. Xu YM, Huang H, Wang L, et al. Comparison of clinical effects of a modified socket shield technique and the conventional immediate implant placement. Hua Xi Kou Qiang Yi Xue Za Zhi 2019;37(5): 490–495. DOI: 10.7518/hxkq.2019.05.007.
19. Mathew L, Manjunath N, Anagha NP, et al. Comparative evaluation of socket shield and immediate implant placement. IJISRT 2020;5(4):1364–1369. https://www.ijisrt.com/assets/upload/files/IJISRT20APR879.pdf.
20. Fattouh H. Socket-shield technique versus guided bone regeneration technique for ridge preservation with immediate implant placement in the esthetic zone. Egypt Dent J 2018;64(3):2047–2055. DOI: 10.21608/edj.2018.76748.
21. Hana SA, Omar OA. Socket shield technique for dental implants in the esthetic zone, clinical and radiographical evaluation. J UoD 2020;23(1):69–80. DOI: 10.26682/sjuod.2020.23.1.8.
22. Blaschke C, Schwass DR. The socket-shield technique: a critical literature review. Int J Implant Dent 2020;6(1):52. DOI: 10.1186/s40729-020-00246-2.
23. Cohen J. Statistical power analysis for the behavioral sciences. New York: Academic Press; 1977. DOI: 10.1016/c2013-0-10517-x.
24. Tan Z, Fu G, Wen JR, et al. Clinical application and evaluation of socket shield technique. Zhonghua Kou Qiang Yi Xue Za Zhi 2020;55(11): 851–856. DOI: 10.3760/cma.j.cn112144-20200613-00342.
25. Tiwari S, Bedi RS, Wadhwani P, et al. Comparison of immediate implant placement following extraction with and without socket-shield technique in esthetic region. J Maxillofac Oral Surg 2020;19(4): 552–560. DOI: 10.1007/s12663-019-01272-3.
26. Durrani F, Painuly H, Shukla A, et al. Socket shield: an esthetic success? J Indian Soc Periodontol 2020;24(3):289–294. DOI: 10.4103/jisp.jisp_557_19.
27. Stangl DK, Berry DA. Meta-analysis in medicine and health policy. New York, NY: 2000. DOI: 10.1201/9780203909935.
28. Higgins JP, Thompson SG, Deeks JJ, et al. Measuring inconsistency in meta-analyses. BMJ 2003;327(7414):557–560. DOI: 10.1136/bmj.327.7414.557.
29. Staehler P, Abraha SM, Bastos J, et al. The socket-shield technique: a step-by-step protocol after 12 years of experience. Int J Esthet Dent 2020;15(3):288–305. PMID: 32760924.
30. Melsen WG, Bootsma MC, Rovers MM, et al. The effects of clinical and statistical heterogeneity on the predictive values of results from meta-analyses. Clin Microbiol Infect 2014;20(2):123–129. DOI: 10.1111/1469-0691.12494.
31. Lin X, Gao Y, Ding X, et al. Socket shield technique: a systemic review and meta-analysis. J Prosthodont Res 2022;66(2):226–235. DOI: 10.2186/jpr.JPR_D_20_00262.
32. Zhang A, Liu Y, Liu X, et al. Could the socket shield technique be better than conventional immediate implantation? A meta-analysis. Clin Oral Investig 2022;26(2):1173–1182. DOI: 10.1007/s00784-021-04266-z.
33. Gao B, Lai X, Dong Y, et al. Clinical efficacy of the socket shield technique used in the aesthetic zone: a systematic review and meta-analysis. Int J Oral Implantol (Berl) 2022;15(1):45–55. PMID: 35266668.
34. Ogawa T, Sitalaksmi RM, Miyashita M, et al. Effectiveness of the socket shield technique in dental implant: a systematic review. J Prosthodont Res 2022;66(1):12–18. DOI: 10.2186/jpr.JPR_D_20_00054.
35. Atieh MA, Shah M, Abdulkareem M, et al. The socket shield technique for immediate implant placement: a systematic review and meta-analysis. J Esthet Restor Dent 2021;33(8):1186–1200. DOI: 10.1111/jerd.12812.
36. Dobrescu AI, Nussbaumer-Streit B, Klerings I, et al. Restricting evidence syntheses of interventions to English-language publications is a viable methodological shortcut for most medical topics: a systematic review. J Clin Epidemiol 2021;137:209–217. DOI: 10.1016/j.jclinepi.2021.04.012.