Socket-Shield Technique for Immediate Implant Placement: A Literature Review.

Abstract

Background: Immediate implant placement in the esthetic zone can be challenging because tooth extraction initiates physiological remodeling of the alveolar ridge, which may compromise the facial bone plate and peri-implant soft-tissue architecture. The socket-shield technique (SST) has been introduced as a partial extraction therapy intended to minimize these dimensional changes by retaining the buccal portion of the tooth root.

Objective: This literature review evaluates the biological rationale, surgical principles, clinical outcomes, complications, and current evidence regarding the socket-shield technique for immediate implant placement, with particular emphasis on esthetic-zone applications.

Review: The technique involves sectioning the root and retaining a carefully prepared buccal root fragment while removing the remaining root structure. An implant is placed palatal to the retained fragment. Preservation of the periodontal ligament and its relationship with the facial bundle bone is intended to reduce post-extraction remodeling. Clinical studies and systematic reviews have reported favorable outcomes in buccal bone preservation, marginal bone stability, and esthetic parameters. However, complications such as shield exposure, mobility, infection, and inflammatory reactions have also been documented. Recent meta-analyses suggest potential advantages over conventional immediate implant placement, although heterogeneity among studies and limited long-term evidence remain important limitations.

Conclusion: SST is a promising but technique-sensitive approach for immediate implant placement in carefully selected cases. Although current evidence supports its potential to preserve peri-implant hard and soft tissues, further well-designed clinical trials with standardized protocols and long-term follow-up are necessary to establish its predictability and clinical indications.

Keywords: Socket-shield technique; partial extraction therapy; immediate implant placement; periodontal ligament; buccal bone preservation; esthetic zone; dental implants.

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1. Introduction

Immediate implant placement is an established treatment option for replacing non-restorable teeth, particularly in the anterior esthetic zone. It can reduce treatment time and preserve the existing soft-tissue architecture when appropriate clinical conditions are present. However, extraction initiates a physiological remodeling process that can result in horizontal and vertical

dimensional changes of the alveolar ridge. These changes are particularly relevant in the anterior maxilla, where the facial bone plate is frequently thin and may be vulnerable to resorption following tooth extraction.[1,2]

The conventional immediate implant protocol does not completely prevent post-extraction remodeling because the periodontal ligament and its associated bundle bone are removed with the tooth. Consequently, even when an implant is placed immediately, the facial bone and soft tissues may undergo dimensional changes that can affect the final esthetic outcome.[3]

The socket-shield technique (SST), introduced by Hürzeler and colleagues in 2010, is a partial extraction therapy developed to address this biological limitation.[4] The technique involves retaining the buccal portion of the tooth root while removing the remaining root structure and placing an implant palatal to the retained fragment. The underlying principle is to preserve the periodontal ligament attached to the retained root segment and maintain its relationship with the facial bundle bone.[4]

By preserving this anatomical complex, SST aims to reduce the remodeling associated with conventional extraction and immediate implant placement. Since its introduction, the technique has attracted considerable interest, and several clinical studies, systematic reviews, and meta-analyses have evaluated its effectiveness.[5–8,11,12]

This review discusses the biological rationale, surgical principles, clinical and radiographic outcomes, complications, limitations, and current evidence supporting SST for immediate implant placement, particularly in the esthetic zone.

2. Biological Basis of the Socket-Shield Technique

2.1 Post-extraction alveolar remodeling

Following tooth extraction, the alveolar ridge undergoes physiological remodeling involving changes in both the bundle bone and the surrounding alveolar bone. The periodontal ligament provides the functional attachment between the root and the alveolar socket. The bundle bone, which receives the periodontal ligament fibers, is dependent on this relationship and undergoes remodeling following loss of the tooth and its periodontal ligament.[1]

The resulting dimensional changes may include horizontal reduction in ridge width and vertical reduction in the facial bone crest. These changes can be particularly pronounced in the facial aspect of the anterior maxilla, where the bone plate may be thin.[2]

Although immediate implant placement may help maintain the original treatment timeline and support the existing soft-tissue architecture, it does not eliminate the biological remodeling process associated with extraction.[3]

2.2 Preservation of the periodontal ligament–bundle bone complex

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The biological rationale of SST is based on retaining a portion of the natural root and its associated periodontal ligament. The retained buccal root fragment maintains the periodontal ligament attachment on its external surface, potentially preserving the functional relationship between the root and the adjacent bundle bone.[4]

In the original proof-of-principle study, Hürzeler and colleagues demonstrated histological evidence of periodontal ligament preservation and new cementum formation following immediate implant placement adjacent to a retained root fragment. The study was conducted in a beagle dog model and involved four implants; therefore, its findings provide experimental biological support rather than direct evidence of long-term human clinical effectiveness.[4]

The retained root fragment is intended to act as a biological barrier between the implant site and the facial alveolar tissues. By maintaining the periodontal ligament–bundle bone complex, SST may reduce the extent of facial bone remodeling and help maintain the overlying soft-tissue contour.

2.3 Preservation of peri-implant soft tissues

The facial bone plate provides structural support for the overlying gingival tissues. Loss of facial bone height or thickness may contribute to midfacial recession, alteration of the gingival margin, and changes in the peri-implant mucosal contour.[2]

By attempting to preserve the facial root-periodontal ligament complex, SST may help maintain the underlying bony support and peri-implant soft-tissue architecture. Clinical studies have reported favorable pink esthetic scores and soft-tissue outcomes following SST, although the magnitude and long-term stability of these benefits require further investigation.[6–8,11,12]

3. Surgical Technique and Clinical Protocol

The socket-shield technique requires careful preoperative assessment, controlled root sectioning, preservation of an appropriate buccal root fragment, and precise implant positioning. The following describes the general principles of the technique; clinical execution should be adapted to the individual anatomy and treatment plan.

3.1 Patient selection and preoperative assessment

Appropriate case selection is essential for predictable outcomes. The tooth should be evaluated clinically and radiographically to determine whether the buccal root portion can be retained without compromising periodontal or peri-implant health.

Preoperative assessment should include:

- Evaluation of the tooth's restorability and endodontic and periodontal status.
- Assessment of root morphology, curvature, and root dimensions.
- Evaluation of the facial bone plate and surrounding alveolar anatomy.

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- Assessment of periapical and periodontal pathology.
- Evaluation of the available bone for appropriate implant positioning and primary stability.
- Assessment of soft-tissue thickness, gingival architecture, and esthetic expectations.

Cone-beam computed tomography (CBCT) may be useful when indicated to evaluate root anatomy, facial bone dimensions, and the three-dimensional relationship between the root and surrounding structures.

The presence of active infection, extensive root fracture, severe periodontal destruction, or an inability to retain a stable and healthy buccal root fragment may make the technique unsuitable. Patient selection should be based on clinical findings rather than the desire to use SST in every immediate implant case.[5,6]

3.2 Root sectioning and preparation of the shield

After appropriate anesthesia and access, the tooth is sectioned longitudinally, generally in a mesiodistal direction, to separate the buccal and palatal root portions. The palatal and remaining root segments are carefully removed while preserving the intended buccal fragment.

The retained fragment is reduced and contoured to create a smooth internal surface and an appropriate coronal profile. The preparation should avoid damaging the external periodontal ligament attachment or the adjacent facial bone. Sharp edges and irregularities should be eliminated to reduce the risk of soft-tissue irritation or exposure.

The final dimensions and contour of the shield must be determined according to the individual root anatomy and clinical situation. A uniform shield dimension should not be applied to every case.

3.3 Implant placement

Following preparation of the buccal shield, the implant osteotomy is prepared in the remaining socket. The implant is positioned palatal to the retained root fragment, with attention to three-dimensional implant positioning and adequate restorative space.

The implant should not be positioned excessively facially, and the retained shield should not interfere with the planned implant trajectory or restorative emergence profile. Primary stability must be achieved through appropriate engagement of the available apical and palatal bone.

The relationship between the implant and the shield may vary according to the clinical protocol. The implant may be placed close to the retained fragment or with a small intervening space, depending on the anatomy and the selected technique.[4,5]

3.4 Gap management and provisionalization

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The implant-socket gap should be assessed after implant placement. Management may involve spontaneous healing or the use of grafting materials according to the defect morphology and clinical indication. The decision should be based on the available evidence and the individual treatment plan rather than an assumption that grafting is mandatory in every SST case.

Provisionalization may be performed when adequate primary stability and appropriate occlusal conditions are achieved. The provisional restoration should be designed to support the peri-implant soft-tissue contour without exerting excessive pressure on the surgical site or retained shield.

Careful occlusal management and follow-up are important during healing. The definitive restoration should be provided after adequate clinical healing and assessment of implant and peri-implant tissue stability. (Fig. 1)

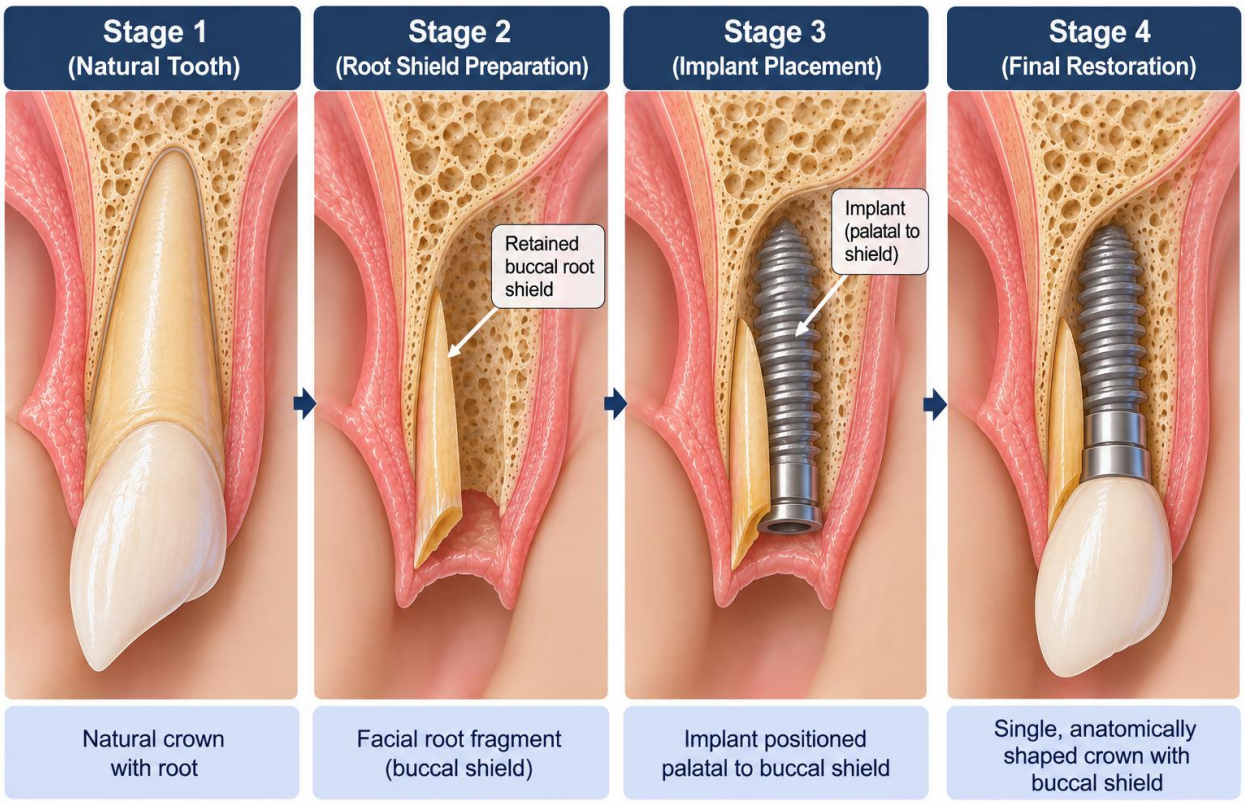


Fig. 1: Clinical stages in the Socket-Shield technique

4. Clinical and Radiographic Outcomes

4.1 Buccal bone preservation

Preservation of the facial alveolar bone is one of the primary objectives of SST. By retaining the buccal root fragment and its periodontal ligament attachment, the technique aims to reduce the remodeling associated with conventional extraction and immediate implant placement.

Systematic reviews of human studies have reported lower horizontal and vertical alveolar bone resorption and better maintenance of the buccal plate following SST compared with conventional immediate implant placement.[6,8]

A 2021 systematic review and meta-analysis of randomized controlled trials reported favorable differences in buccal plate dimensions and pink esthetic scores in the SST group.[7] A subsequent 2022 meta-analysis also reported statistically favorable outcomes for buccal plate height, buccal plate width, and esthetic scores.[8]

These findings support the potential of SST to preserve facial bone dimensions. However, differences in surgical protocols, measurement methods, follow-up periods, and study populations should be considered when interpreting the results.

4.2 Marginal bone stability

Marginal bone changes are important parameters in evaluating implant success and long-term peri-implant tissue stability. The retained buccal root fragment may contribute to preservation of the facial tissues, while the implant itself remains dependent on appropriate positioning, osseointegration, and maintenance of peri-implant health.

Systematic reviews and meta-analyses have reported favorable marginal bone outcomes with SST compared with conventional immediate implant placement.[6,7,11,12] Nevertheless, the available evidence does not establish that the technique prevents all peri-implant bone remodeling. Long-term comparative studies using standardized radiographic measurements are required.

4.3 Soft-tissue and esthetic outcomes

The esthetic outcome of an anterior implant depends on the stability of the facial gingival margin, papillae, mucosal contour, and surrounding hard tissues. Midfacial recession can compromise the appearance of the definitive restoration, particularly in patients with a high smile line or thin periodontal phenotype.

SST aims to preserve the facial tissue architecture by maintaining the buccal root-periodontal ligament complex. Clinical studies have reported favorable pink esthetic scores and reduced changes in peri-implant soft-tissue contours.[7,8]

The 2025 meta-analysis by Lu and colleagues also reported favorable esthetic outcomes with SST compared with conventional immediate implant placement.[11] A 2026 systematic review similarly reported better esthetic outcomes and reduced midfacial recession in the SST group.[12] Although these results are encouraging, esthetic outcomes are influenced by multiple factors,

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including implant position, tissue phenotype, provisional restoration design, and surgical execution.

4.4 Implant survival and stability

Implant survival is an essential outcome when evaluating any implant placement technique. The available evidence indicates that SST can achieve high implant survival rates in appropriately selected cases. However, improved tissue preservation should not be interpreted as evidence of superior implant survival.

A 2021 systematic review and meta-analysis found no statistically significant difference in implant failure between SST and conventional immediate implant placement.[7] A retrospective evaluation of 128 socket-shield cases reported 123 surviving implants, corresponding to a survival rate of 96.1%, although the study also documented a notable complication burden.[9]

The 2026 systematic review reported implant survival rates exceeding 95% in both SST and conventional post-extraction implant placement groups.[12] These findings suggest that implant survival can be favorable with either approach, while the potential advantages of SST relate primarily to tissue preservation and esthetic outcomes.

5. Complications and Limitations

Although SST has demonstrated promising clinical outcomes, it is technique-sensitive and associated with complications that may affect implant and peri-implant tissue health.

5.1 Shield exposure

Exposure of the retained root fragment into the oral cavity may occur during healing or after restoration. Exposure can result from inadequate shield preparation, unfavorable soft-tissue conditions, or changes in the surrounding tissues. Depending on the clinical presentation, management may involve smoothing or reduction of the exposed fragment, surgical correction, or removal of the shield.

5.2 Shield mobility

Mobility of the retained root fragment is a potential complication because the stability of the shield is important for maintaining the intended biological relationship with the surrounding tissues. An unstable fragment may require clinical intervention and, in some cases, removal.

5.3 Infection and inflammatory complications

Residual infection, contamination, or inflammatory changes involving the retained root fragment may compromise healing. Careful preoperative assessment and appropriate case selection are

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therefore essential. The retained fragment should not be considered suitable when its condition or surrounding tissues raise concerns about persistent pathology.

5.4 Internal shield exposure

Internal shield exposure refers to exposure of the retained root fragment toward the implant or peri-implant space. This complication may be difficult to detect clinically and can require additional treatment. A multicenter case series has specifically described the management of internal shield exposure, highlighting the importance of recognizing and addressing this complication.[10]

5.5 Root resorption and ankylosis-related concerns

Changes in the retained root fragment, including resorptive processes and possible ankylosis-related responses, have been discussed in the literature. These biological responses require further investigation, particularly with respect to their long-term clinical significance and effect on implant stability.

5.6 Complication rates and clinical predictability

A retrospective evaluation of 128 socket-shield cases reported a 96.1% implant survival rate, with a combined complication rate of 19.5%.[9] This finding illustrates that favorable implant survival does not necessarily indicate an uncomplicated clinical course.

Early systematic reviews also identified limitations in the quality and consistency of the available evidence and emphasized the need for more robust clinical studies.[5,6] The technique should therefore be performed only after careful assessment of the root anatomy, periodontal condition, facial bone, and restorative requirements.

6. Comparison with Conventional Immediate Implant Placement

Conventional immediate implant placement involves removal of the entire tooth followed by implant placement into the extraction socket. Although this approach can reduce treatment time and may preserve the existing soft-tissue architecture, it does not prevent the physiological remodeling associated with removal of the periodontal ligament and bundle bone.[1–3]

In contrast, SST retains the buccal root fragment to preserve the periodontal ligament–bundle bone relationship. The intended advantage is improved maintenance of the facial alveolar bone and peri-implant soft tissues.[4]

Comparative clinical studies and meta-analyses have reported favorable outcomes for SST in terms of buccal bone dimensions, marginal bone levels, and esthetic parameters.[7,8,11,12]

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However, the available evidence does not consistently demonstrate a significant difference in implant failure or complication rates.[7]

Parameter	Conventional immediate implant placement	Socket-shield technique
Root management	Complete extraction of the tooth	Buccal root fragment retained
Periodontal ligament	Removed with the tooth	Preserved on the external surface of the retained fragment
Facial bundle bone	Subject to post-extraction remodeling	Intended to be supported by preservation of the root-periodontal ligament complex
Implant positioning	Within the extraction socket according to restorative and anatomical requirements	Palatal to the retained buccal root fragment
Buccal tissue preservation	May be affected by post-extraction remodeling	Potentially improved through partial root retention
Surgical complexity	Established immediate implant protocol	More technique-sensitive root sectioning and shield preparation
Complications	Conventional implant-related complications	Conventional implant-related complications plus shield-specific complications
Evidence	Established clinical protocol with extensive literature	Promising comparative findings, but long-term evidence remains limited

The choice between the two approaches should be based on clinical anatomy, periodontal and endodontic status, esthetic requirements, operator experience, and the available evidence. SST should not be considered automatically superior or suitable for every immediate implant case.

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7. Recent Evidence and Future Directions

The evidence base for SST has expanded from the original experimental proof-of-principle report to human clinical studies, randomized controlled trials, systematic reviews, and meta-analyses.[4–8]

The 2017 systematic review by Gharpure and Bhatavadekar identified promising clinical findings but emphasized limitations in the quality and duration of the available evidence.[5] The 2021 systematic review by Sáez-Alcaide and colleagues included six human studies and reported favorable outcomes for alveolar bone preservation and esthetics. However, the authors concluded that the evidence was insufficient to recommend SST as an alternative with the same long-term predictability as conventional immediate implant placement.[6]

A 2021 systematic review and meta-analysis by Atieh and colleagues included seven randomized controlled trials involving 206 implants in 191 participants. The analysis reported favorable outcomes for buccal plate dimensions, marginal bone levels, and pink esthetic scores, but did not identify statistically significant differences in implant stability, complication rates, or implant failure.[7]

Similarly, the 2022 meta-analysis by Gao and colleagues included four randomized controlled trials and reported favorable outcomes for buccal plate height, buccal plate width, and pink esthetic scores in the SST group.[8] The findings from these reviews should be interpreted with consideration of overlap among the included primary studies; they should not be treated as entirely independent bodies of clinical evidence.

A retrospective study by Gluckman and colleagues evaluated 128 socket-shield cases in esthetic and posterior sites, reporting a 96.1% implant survival rate and a combined complication rate of 19.5%.[9] This study provides useful clinical information but, because of its retrospective design and absence of a control group, cannot establish comparative effectiveness.

In 2024, Gluckman, Pohl, and Chen reported a multicenter case series describing the management of internal shield exposure.[10] This report highlights the importance of recognizing shield-specific complications and developing appropriate management strategies.

A 2025 meta-analysis by Lu and colleagues included 27 studies, comprising 22 randomized controlled trials and five non-randomized studies, with a total of 1,307 implants. The authors reported favorable outcomes for buccal bone preservation, pink esthetic scores, and implant stability with SST compared with conventional immediate implant placement.[11] However, substantial heterogeneity was reported across several outcomes, limiting the certainty of the pooled estimates and emphasizing the need for cautious interpretation.

A 2026 systematic review by Cosola and colleagues included 11 comparative studies involving 423 implants. Implant survival exceeded 95% in both SST and conventional immediate implant placement groups. The review reported favorable buccal and crestal bone outcomes, higher

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pink esthetic scores, and improved soft-tissue contours with SST. The authors also emphasized the technique's sensitivity and the need for further high-quality long-term studies.[12]

Future research should focus on standardized surgical protocols, appropriate patient selection criteria, long-term implant and shield survival, and consistent reporting of complications. Comparative studies should also evaluate patient-reported outcomes, esthetic satisfaction, and the cost-effectiveness of SST. Further investigation of digital planning and guided shield preparation may help improve surgical precision and reproducibility, although their clinical benefits require validation.

8. Discussion

The socket-shield technique has emerged as a biologically oriented approach to immediate implant placement. It involves retaining a portion of the buccal root to preserve the periodontal ligament–bundle bone complex and potentially limit post-extraction dimensional changes. This rationale is supported by evidence demonstrating that extraction-related remodeling can result in substantial alterations in the facial alveolar ridge, particularly in esthetic sites.[1,2] The retained buccal root fragment may help maintain periodontal ligament attachment and support the surrounding facial tissues, potentially reducing buccal bone resorption and midfacial soft-tissue recession.[4]

Clinical evidence suggests that SST may offer favorable hard- and soft-tissue outcomes compared with conventional immediate implant placement. Systematic reviews and meta-analyses have reported improved preservation of buccal bone dimensions, marginal bone levels, and pink esthetic scores in selected cases.[6–8] A 2021 meta-analysis of randomized controlled trials reported significant advantages in buccal plate dimensions, marginal bone levels, and esthetic outcomes. However, it found no statistically significant differences in implant stability, complication rates, or implant failure.[7] These findings suggest that the principal potential advantage of SST may be improved tissue preservation rather than increased implant survival.

More recent evidence has further evaluated the clinical effectiveness of this approach. A 2025 meta-analysis reported favorable outcomes for buccal bone preservation, pink esthetic scores, and implant stability compared with conventional immediate implant placement.[11] However, substantial heterogeneity among the included studies limits the certainty and generalizability of these findings. A 2026 systematic review also reported favorable clinical, radiographic, and esthetic outcomes, with implant survival exceeding 95% in both treatment groups. Nevertheless, the authors emphasized the need for further long-term clinical evidence.[12]

Despite these promising findings, SST is associated with potential complications, including shield exposure, mobility, infection, and inflammatory reactions.[5,9] Internal shield exposure may also occur and can require additional surgical or restorative management.[10] A retrospective evaluation of 128 cases reported an implant survival rate of 96.1%, but also documented a

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combined complication rate of 19.5%.[9] These findings demonstrate that favorable implant survival does not necessarily indicate an absence of postoperative complications.

The technique is operator-dependent and requires a thorough understanding of root anatomy, alveolar bone morphology, implant positioning, and soft-tissue management. Retention of the buccal root fragment should not compromise appropriate implant positioning or primary stability. The retained fragment must also remain stable and free from infection or other pathological changes. Careful patient selection, precise shield preparation, appropriate implant positioning, and regular postoperative monitoring are therefore essential.[5,9,10]

An important limitation of the current literature is the variation in surgical protocols, outcome measurements, follow-up periods, and study designs. Although randomized controlled trials and systematic reviews have expanded the evidence base, differences in methodology and substantial heterogeneity limit direct comparisons between studies.[6–8,11,12] Furthermore, the available evidence does not yet establish SST as a universally predictable replacement for conventional immediate implant placement. Future research should focus on standardized surgical protocols, clearly defined complication criteria, patient-reported outcomes, and well-designed randomized controlled trials with longer follow-up periods.

9. Conclusion

The socket-shield technique represents a promising approach to immediate implant placement in carefully selected patients, particularly in the esthetic zone. By retaining the buccal portion of the tooth root and its associated periodontal ligament, the technique aims to reduce post-extraction remodeling and preserve the facial alveolar bone and soft-tissue architecture.[4,6]

Current evidence suggests potential advantages in buccal bone preservation, marginal bone stability, and esthetic outcomes compared with conventional immediate implant placement.[7,8,11,12] However, these findings should be interpreted cautiously because of methodological heterogeneity, limited long-term follow-up, and the possibility of technique-related complications.[5,9,10]

SST should therefore be considered a technique-sensitive treatment option for appropriately selected cases rather than a routine replacement for conventional implant protocols. Further high-quality randomized controlled trials and long-term comparative studies are necessary to establish its predictability, safety, and long-term clinical relevance.[6,11,12]

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