International Journal of Dental Research and Allied Sciences
2022, Volume 2, Issue 2, Page No: 32-44

Available online at: www.tsdp.net

ISSN: 3062-3502

Original Article

A New Method for Immediate Implants: The CastleWall Surgical Approach

Marina Guseva[1], Denis Pavlov[1], Viktoria Chernyshova[2]*

[1]Department of Oral Surgery of the Institute of Dentistry, I.M. Sechenov First Moscow State Medical University (Sechenov University), 119048 Moscow, Russia.
[2]Department of Pharmacology, Nelyubin Institute of Pharmacy, I.M. Sechenov First Moscow State Medical University (Sechenov University), 119991 Moscow, Russia.

***E-mail** ✉ viktoria.chernyshova2025@gmail.com

Received: 22 August 2022; **Revised:** 17 November 2022; **Accepted:** 18 November 2022

ABSTRACT

This study evaluated how maintaining a complete 360-degree socket-shield using the CastleWall Surgical Technique (CWST) affects the volumetric stability around immediate dental implants. In this retrospective study, 25 patients received a total of 31 immediate implants with the CWST. Pre-extraction and follow-up silicone impressions were digitized into STL files for volumetric analysis. The median follow-up duration was 14.2 ± 5.5 months. Measurements included tissue volume changes and gingival recession on both buccal and lingual sides, as well as alterations in papilla height from clinical photographs. Patients reported post-operative discomfort and overall satisfaction using a Visual Analogue Scale (VAS).

All implants healed successfully without complications. Average tissue reduction was 0.30 ± 0.32 mm buccally and 0.17 ± 0.27 mm lingually. Mid-buccal and mid-lingual gingival recession averaged 0.66 ± 0.64 mm and 0.87 ± 0.84 mm, while mesial and distal papillae showed 0.26 ± 0.55 mm and 0.29 ± 0.52 mm recession, respectively. Patients expressed high satisfaction, with a mean VAS score of 97.74 ± 5.60%, and reported minimal discomfort. The CWST appears to maintain excellent soft tissue volume and aesthetic outcomes with low post-operative pain. Preserving a full 360-degree socket-shield also provides greater surface area for implant stabilization, reducing the risk of shield displacement over time.

Keywords: Immediate implant, Socket-shield, CastleWall, Partial extraction therapy

How to Cite This Article: Guseva M, Pavlov D, Chernyshova V. A New Method for Immediate Implants: The CastleWall Surgical Approach. Int J Dent Res Allied Sci. 2022;2(2):32-44. https://doi.org/10.51847/Dd2HqRlxg0

Introduction

Removing a tooth root entirely before placing an implant initiates a series of inevitable biological changes, including rapid bone loss and soft tissue recession [1, 2]. Despite numerous interventions—such as grafting with bone substitutes, guided implant placement, platform switching, and immediate implantation—complete prevention of post-extraction bone resorption remains elusive [3–11].

In 2010, Hürzeler and colleagues introduced the "Socket-Shield" approach, which involves retaining a segment of the buccal root during implant placement to reduce bone loss [12]. The literature, however, does not provide a clear guideline regarding how far the retained root segment should extend interproximally. To preserve adjacent papillae, Kan *et al*. proposed the "Proximal Socket-Shield" in 2013, and similar methods were described by Cherel *et al*. [13, 14]. Conversely, a case report by Aslan highlighted significant palatal tissue loss when only a buccal shield was used [15].

These observations suggest that areas not protected by the shield remain prone to atrophy. Expanding the shield to a full 360-degree design could potentially stabilize soft tissues more effectively, both interproximally and palatally. Troiano *et al*. reported promising clinical outcomes using such a 360-degree shield, termed the "Root-T-Belt," where the implant osteotomy passes directly through the root [16].

Supporting evidence from animal studies also confirms the biological feasibility of a full-circumference shield [17].

However, creating an osteotomy through the root poses technical challenges, particularly in removing the apex completely. Drill bits are cylindrical and straight, while roots are often curved or elliptical, leading to potential deviations into surrounding bone—a concern in regions like the thin anterior maxilla [18, 19]. The CastleWall Surgical Technique (CWST) was developed as an alternative approach to address these limitations and allow safe preparation of a 360-degree shield [16].

A further challenge with socket-shield procedures is the risk of "shield migration" over time, which may expose the root segment and require removal [3, 20, 21]. Such removal can compromise both tissue integrity and aesthetics. By creating a larger-diameter shield, the implant has more surface area to engage the shield, reducing the likelihood of displacement and enhancing long-term stability.

This study aimed to assess the effects of CWST on soft tissue stability and patient-reported outcomes.

Materials and Methods

This retrospective study reviewed all patients who received immediate implants using CWST over a 24-month period at a private practice. A total of 31 implants were placed consecutively in 25 patients (11 males, 14 females), with a median age of 64 ± 9.35 years. Follow-up assessments were conducted at a median of 14.2 ± 5.5 months post-treatment.

Eligibility for inclusion followed the criteria outlined in **Table 1**. All participants were informed of alternative treatment options, along with associated benefits and risks, before consenting to the procedure.

Table 1. Patient selection criteria.

Patient Selection Criteria	Details
Inclusion Criteria	- Adult patients with overall good health - Vertical fractures, including buccal involvement - Horizontal fractures at or below bone level - Acute or chronic apical infections - Active periodontal disease - Signed informed consent - Eligible for immediate implant via CastleWall Surgical Technique
Exclusion Criteria	- Primary implant stability less than 25 Ncm - Unable to attend final follow-up - Pre-treatment models not obtained - Models unclear or incomplete around the treatment site

Surgical technique

All surgical procedures were carried out by the author. Local anesthesia was administered using Articaine (Septanest 1:100,000, Septodont, Saint-Maur-des-Fossés, France) after photographic and radiographic records were obtained **(Figures 1–3)**. The tooth crown was removed, and the coronal portion was hollowed out following the natural root contour. The apical segment of the root was then amputated and fully extracted **(Figures 4–7)**. For teeth with multiple roots, this procedure was applied to each root individually. In cases of acute or chronic apical infection, the socket was thoroughly debrided using a curette and irrigated with abundant saline. All interventions were performed without raising a flap.

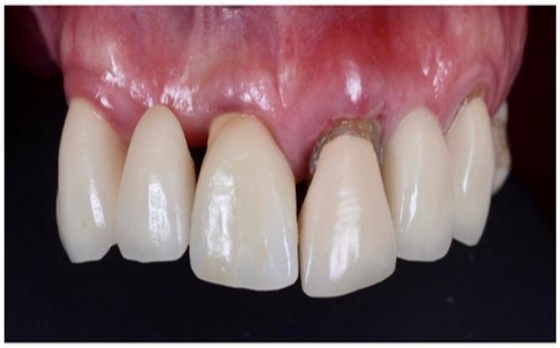


Figure 1. Preoperative image showing a PFM post-core crown on tooth 21, accompanied by a buccal root fracture.

Figure 2. Images of tooth 21 with the post-core crown, showing the fractured segment of the buccal root still securely in place.

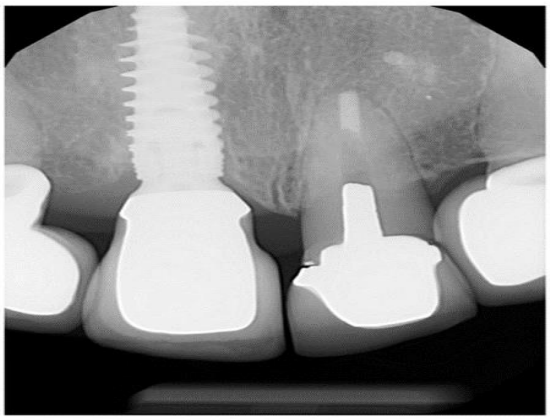


Figure 3. Preoperative radiograph of tooth 21 before the shield preparation.

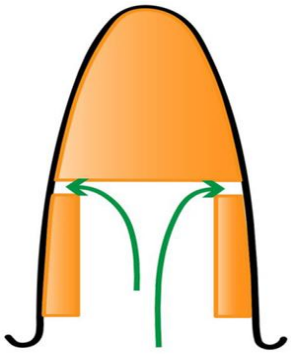


Figure 4. The apical portion has been fully removed following coronal preparation.

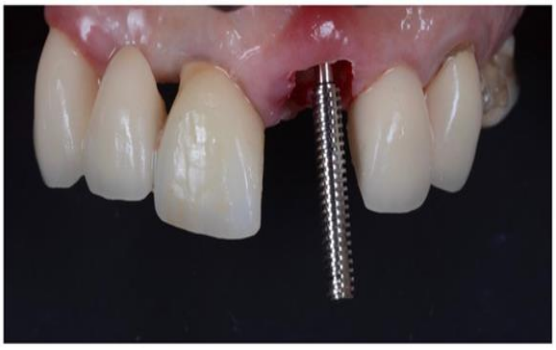


Figure 5. Placement of a root screw into the apex of the sectioned root.

Figure 6. Mobilization of the root apex using a root extractor.

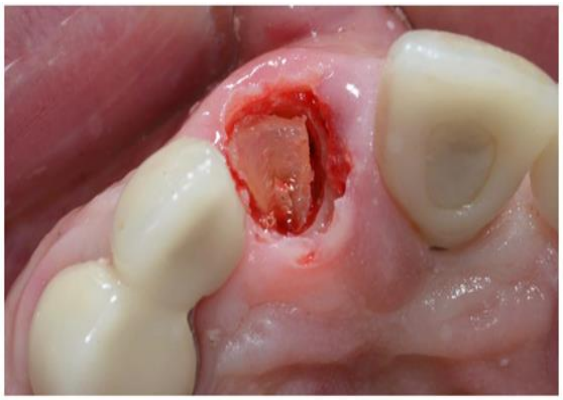


Figure 7. The root apex was removed through the central channel of the 360-degree socket-shield.

The final shield had an average thickness of about 1 ± 0.5 mm. The osteotomy was performed freehand, without any guiding templates. Subsequently, the implant was positioned through the 360-degree shield into the alveolar bone at a depth of 3–4 mm beneath the mid-buccal gingival margin **(Figures 8 and 9)**.

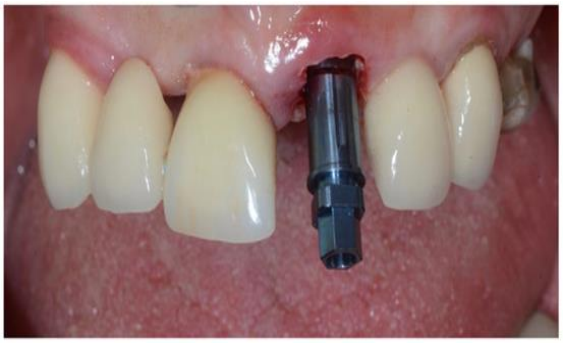


Figure 8. Placement of the implant at a depth of 3–4 mm beneath the mid-buccal gingival margin.

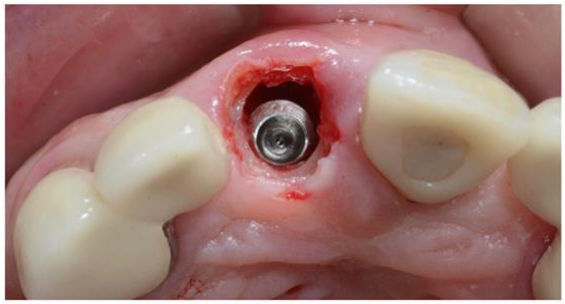


Figure 9. Occlusal perspective showing the implant closely aligned with the 360-degree socket-shield.

For teeth exhibiting vertical root fractures, the fracture lines were carefully cleaned using a long diamond fissure bur to remove any residual biofilm. Any mobile sections of the shield were stabilized by tightly packing xenograft particles (Bio-Oss, Geistlich, Wolhusen, Switzerland) between the implant and shield. Buccal

fenestrations were internally managed with a resorbable membrane (Bio-Gide, Geistlich), followed by placement of Bio-Oss. In patients with active periodontal disease, the shield was trimmed below the visibly contaminated root surface at the bone level.

A temporary abutment was attached to the implant at the time of surgery, and flowable resin (Filtek Supreme XTE, 3M ESPE, Maplewood, MN, USA) was molded around it to cover the shield. For posterior teeth (25 cases), the temporary cylinder was kept close to the gingival margin, whereas for anterior teeth (6 cases), it was extended and used to support a provisional crown (Integrity, Dentsply, York, PA, USA) fabricated with a putty index (Elite HD+, Zhermack, Badia Polesine, Italy). All provisional crowns were slightly shortened to infra-occlusion to avoid occlusal contacts during centric and eccentric movements **(Figure 10)**.

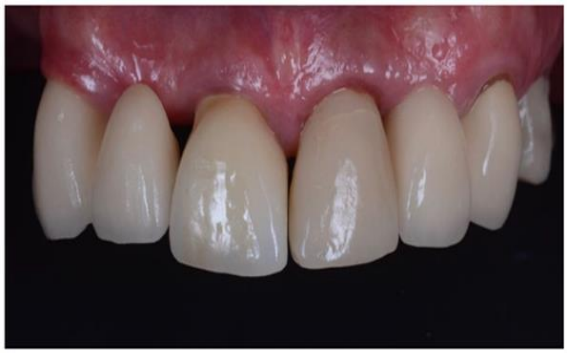


Figure 10. One-week follow-up showing the temporary crown.

Following surgery, patients were administered a single dose of 400 mg Ibuprofen (Apo-Ibuprofen 400, Apotex, Toronto, ON, Canada) along with 2 g Amoxicillin (Apo-Amoxycillin, Apotex, Toronto, ON, Canada). They were instructed to avoid chewing on the treated area for six weeks and complete a full course of Amoxicillin, taking Ibuprofen every 6–8 hours as needed. The first postoperative review was conducted one week after the procedure.

Temporary prostheses were removed between 6 and 12 weeks post-implant placement **(Figure 11)**, and impressions were obtained for the final crowns. All implants successfully integrated, as confirmed by resonance frequency analysis (Osstell, W&H, Bürmoos, Austria). Three anterior crowns were cemented, while the remaining 28 crowns were screw-retained. Anterior restorations consisted of lithium disilicate with custom zirconia over titanium bases, and posterior crowns were monolithic zirconia over titanium. A follow-up check was performed one week after placement of the final crowns **(Figure 12)**.

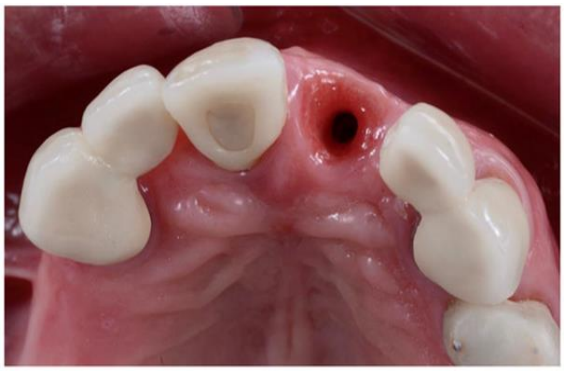


Figure 11. View of the occlusal surface during the crown impression visit following the removal of the temporary crown.

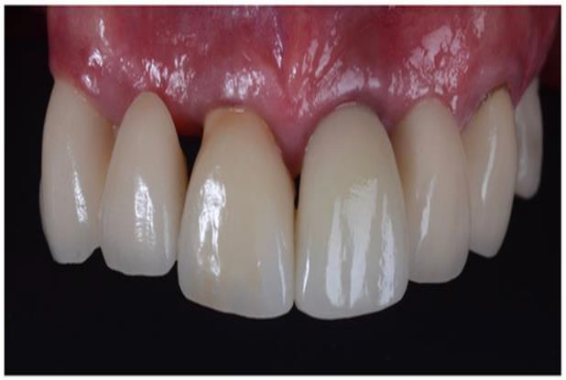


Figure 12. One week after placement, the final crown of tooth 21 is shown. This case featured symmetry, with cantilever bridges on both canines supporting a lateral pontic. Tooth 11 also received an implant crown via a conventional approach, using bovine bone to fill the jumping gap. After replacing 11, notable gingival recession was observed around the adjacent pontic 12. Before the complete extraction of 11, the pontic on 12 was contoured to the gingiva similarly to tooth 22.

Complications

Two instances of shield exposure occurred, both involving posterior teeth upon removal of the provisional crown. In each case, the exposed shield was reduced using a round diamond bur, followed by insertion of a healing abutment to promote gingival coverage. Two weeks later, patients returned for uneventful final crown placement.

Data collection

A final review visit was scheduled for all study participants, during which post-operative silicone impressions (Imprint 4, 3M ESPE), clinical photographs, and radiographs were obtained **(Figures 13 and 14)**. Each patient completed a questionnaire administered by a staff member, which included a Visual Analogue Scale (VAS) assessing pain, bleeding,

swelling, and overall satisfaction, as well as recording the duration of post-operative pain and swelling.

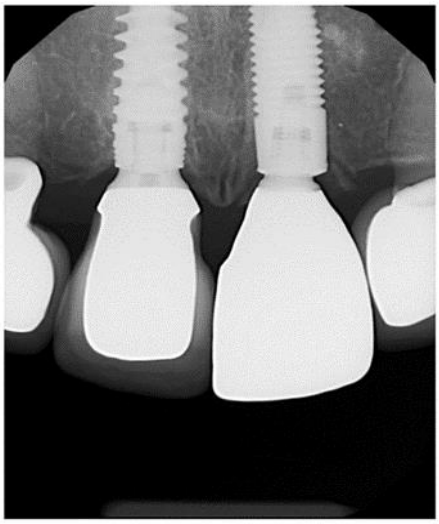


Figure 13. Radiograph of the final crown demonstrating proper seating and absence of contact with the shield.

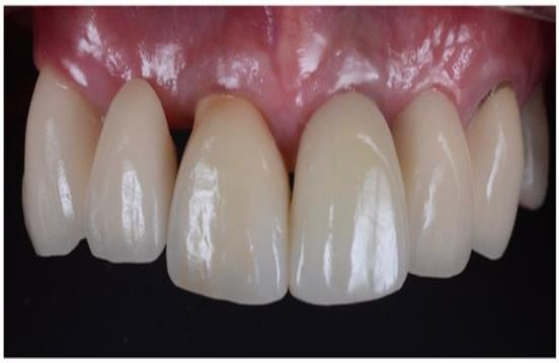


Figure 14. Follow-up examination demonstrated complete resolution of inflammation surrounding crown 21, with only minor gingival recession noted adjacent to pontic 22.

All impressions obtained before treatment and at the final review were cast in type IV die stone (Fujirock EP, GC, Tokyo, Japan) and scanned using an optical scanner (Emerald 2, Planmeca, Helsinki, Finland). The resulting STL files were imported into SMOP Volume Compare software (Swissmeda, Baar, Switzerland), and datasets from pre-extraction and post-treatment models were aligned for comparison. Volumetric changes were analyzed on buccal and lingual surfaces, with measurements taken parallel to the tooth axis and referenced from the pre-extraction gingival zenith. Tissue changes were expressed as mean distance loss (Δd [mm] = Δvol [mm^3]/area [mm^2]) in line with established methods [22, 23]. Models that were incomplete or unclear were excluded. Both SB and HA performed the volumetric assessments collaboratively.

Recession of the soft tissue was quantified by measuring vertical shifts at mid-buccal and mid-lingual gingival margins on the superimposed models. Papillary height alterations were determined using available photographs taken before treatment and at the final review. Measurements were aligned with the tooth's long axis using a digital caliper and calibrated with reference points from the stone models. Cases in which the papilla was not clearly visible or where photograph angles differed significantly were excluded. All papillary height assessments were conducted by a single operator (CC).

Statistical analysis

Six outcome measures were evaluated: Buccal Mean Distance (MD), Lingual MD, Mid-Buccal Recession, Mid-Lingual Recession, Mesial Papillary Recession, and Distal Papillary Recession. The null hypothesis proposed no volumetric difference between baseline and follow-up measurements. Statistical significance was determined at $\alpha < 0.05$ using the Wilcoxon signed-rank test, comparing observed medians to a hypothesized value of zero. Analyses were also stratified by tooth location. STATA V16 (Dallas, TX, USA) was used for all statistical analyses. Patient-reported outcomes were summarized descriptively.

Results and Discussion

Figure 15 illustrates the distribution of treatment sites. The average loss of tissue was -0.30 ± 0.32 mm on the buccal aspect and -0.17 ± 0.27 mm on the lingual aspect **(Table 2)**. Buccal tissue loss reached statistical significance ($p < 0.001$), whereas lingual tissue loss did not show a significant difference ($p = 0.664$).

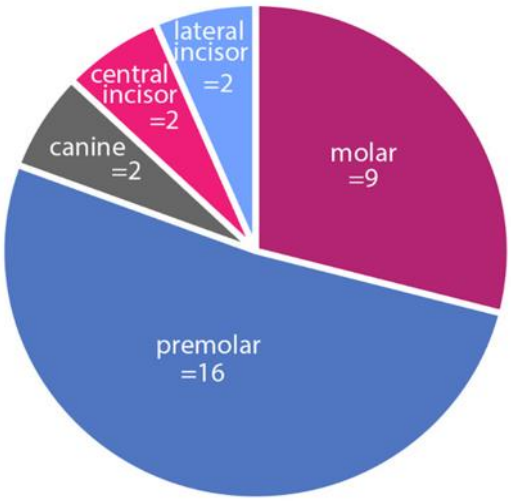


Figure 15. Distribution of immediate implant sites.

Table 2. Volumetric analyses measured as the mean distance (MD) change in both the buccal and lingual directions. Recession at both the mid-buccal and mid-lingual gingival margins was also reported.

Case No	Site (FDI)	MD Buccal (mm)	MD Lingual (mm)	Mid-Buccal Recession (mm)	Mid-Lingual Recession (mm)
1	17	−0.77	−0.69	−1.40	−1.00
2	22	0	n.a	−0.76	n.a.
3	24	−0.22	0.21	0.32	−0.34
4	22	−0.43	0.02	−1.27	−0.89
5	24	−0.29	−0.37	−0.36	−0.48
6	16	0.08	n.a.	−0.28	n.a.
7	14	−0.10	0.03	−1.61	−0.25
8	35	0.18	−0.26	−0.51	−0.52
9	11	−0.24	0.02	0.31	0.57
10	33	−0.18	n.a.	−0.92	−0.02
11	26	n.a.	n.a.	n.a.	n.a.
12	44	−0.15	0.04	−0.87	−0.70
13	26	−0.78	n.a.	−0.94	−1.22
14	25	0.10	−0.21	−1.71	−1.48
15	24	0.20	−0.03	−1.48	−0.66
16	26	−0.98	n.a.	−0.93	−2.99
17	26	−0.20	−0.68	0.58	−1.75
18	23	−0.09	−0.18	−0.77	−0.48
19	26	−0.62	n.a.	−1.57	−2.02
20	24	−0.32	−0.07	0.24	−0.85
21	21	−0.87	−0.30	−1.13	−2.43
22	25	−0.44	0.01	−1.29	−0.54
23	35	−0.28	n.a.	−0.51	−0.74
24	16	−0.32	0.04	−0.35	−0.02
25	36	−0.12	−0.56	0.26	−0.93
26	44	−0.51	n.a.	−0.18	n.a.
27	35	−0.61	−0.64	−0.90	−1.69
28	14	−0.87	0.07	−1.01	−1.72
29	14	−0.13	0.06	−0.80	0.39
30	45	0.02	−0.06	0.07	0
31	25	−0.15	n.a.	−0.14	−0.66

n.a. = not applicable as data not available.

Recession at the mid-buccal and mid-lingual gingival margins averaged −0.66 ± 0.64 mm and −0.87 ± 0.84 mm, respectively, whereas the mesial and distal papillae exhibited mean reductions of −0.26 ± 0.55 mm and −0.29 ± 0.52 mm, respectively **(Table 3)**. **Table 4** presents a comprehensive overview of these measurements according to each tooth site.

Table 3. Changes to the mesial and distal papilla height.

Case No	Site (FDI)	Pre-op Mesial (mm)	Post-op Mesial (mm)	Mesial Recession (mm)	Pre-op Distal (mm)	Post-op Distal (mm)	Distal Recession (mm)

1	17	n.a.	n.a.		n.a.	n.a.	
2	22	4.25	4.22	−0.03	2.99	2.92	−0.24
3	24	3.92	3.91	−0.01	3.43	2.92	−0.51
4	22	5.85	4.50	−1.35	4.34	3.15	−1.19
5	24	4.92	5.03	0.11	3.41	3.31	−0.10
6	16	2.60	2.22	−0.38	3.17	2.46	−0.71
7	14	3.13	3.42	0.29	1.35	1.91	0.56
8	35	2.94	2.93	−0.01	2.84	2.97	0.13
9	11	4.27	3.74	−0.53	3.46	2.38	−1.08
10	33	2.81	2.52	−0.29	1.29	1.64	0.35
11	26	n.a.	n.a.		n.a.	n.a.	
12	44	n.a.	n.a.		n.a.	n.a.	
13	26	n.a.	n.a.		n.a.	n.a.	
14	25	n.a.	n.a.		n.a.	n.a.	
15	24	n.a.	n.a.		n.a.	n.a.	
16	26	3.00	2.80	−0.20	2.09	2.43	0.34
17	26	n.a.	n.a.		n.a.	n.a.	
18	23	3.26	2.97	−0.29	2.36	2.29	−0.07
19	26	n.a.	n.a.		n.a.	n.a.	
20	24	4.87	4.07	−0.80	2.62	2.65	0.03
21	21	5.96	6.56	0.60	5.48	5.29	−0.19
22	25	n.a.	n.a.		n.a.	n.a.	
23	35	n.a.	n.a.		n.a.	n.a.	
24	16	n.a.	n.a.		n.a.	n.a.	
25	36	n.a.	n.a.		n.a.	n.a.	
26	44	n.a.	n.a.		n.a.	n.a.	
27	35	n.a.	n.a.		n.a.	n.a.	
28	14	5.53	4.01	−1.52	4.09	3.04	−1.05
29	14	4.73	4.88	0.15	3.09	2.80	−0.29
30	45	4.22	3.98	−0.24	3.64	3.35	−0.29
31	25	0.99	1.03	0.04	1.86	1.22	−0.64

n.a. = not applicable as data not available.

Table 4. Summary of volumetric gingival margin and papillary changes from pre-treatment to final review.

Variable	n	Mean ± SD	Median (IQR)	p-Value *
MD Buccal	**30**	**−0.30 ± 0.32**	**−0.23 (0.41)**	**<0.001**
Molar	8	−0.46 ± 0.38	−0.47 (0.62)	
Premolar	16	−0.22 ± 0.29	−0.19 (0.34)	
Incisor	6	−0.30 ± 0.31	−0.21 (0.34)	
MD Lingual	**21**	**−0.17 ± 0.27**	**−0.06 (0.33)**	**0.664**
Molar	4	−0.47 ± 0.35	−0.62 (0.43)	
Premolar	13	−0.09 ± 0.23	−0.03 (0.25)	
Incisor	4	−0.11 ± 0.16	−0.80 (0.26)	

Mid-buccal Recession	**30**	**−0.66 ± 0.64**	**−0.79 (0.95)**	**0.001**
Molar	8	−0.58 ± 0.77	−0.64 (1.16)	
Premolar	16	−0.67 ± 0.65	−0.66 (0.99)	
Incisor	6	−0.76 ± 0.56	−0.85 (0.37)	
Mid-lingual Recession	**27**	**−0.87 ± 0.84**	**−0.70 (1.14)**	**<0.001**
Molar	7	−1.42 ± 0.94	−1.22 (1.09)	
Premolar	15	−0.68 ± 0.58	−0.66 (0.51)	
Incisor	5	−0.65 ± 1.13	−0.48 (0.87)	
Mesial Papillary Recession	**17**	**−0.26 ± 0.55**	**−0.20 (0.42)**	**0.144**
Molar	2	−0.29 ± 0.13	−0.29 (0.18)	
Premolar	9	−0.22 ± 0.58	−0.01 (0.35)	
Incisor	6	−0.32 ± 0.64	−0.30 (0.31)	
Distal Papillary Recession	**17**	**−0.29 ± 0.52**	**−0.24 (0.67)**	**0.144**
Molar	2	−0.19 ± 0.74	−0.19 (1.05)	
Premolar	9	−0.24 ± 0.47	−0.29 (0.54)	
Incisor	6	−0.40 ± 0.60	−0.22 (1.01)	

MD = Mean Distance; SD = Standard deviation; IQR = inter quartile range; * = Wilcoxon sign test.

Patients reported very high satisfaction with the procedure, with an average score of 97.74 ± 5.60 percent. No instances of post-operative bleeding were noted, and ibuprofen use was minimal, averaging 0.55 ± 0.68 days. Swelling after the procedure was rated highly, with a mean satisfaction of 98.71 ± 4.99% on the Visual Analogue Scale (VAS) and an average duration of 0.13 ± 0.5 days. Post-operative pain received a slightly lower satisfaction score of 91.13 ± 8.14% on the VAS, lasting on average 0.82 ± 0.82 days **(Table 5)**.

Table 5. Patient-reported outcomes using a questionnaire which included a Visual Analogue Scale (VAS).

Case No.	Tooth No	Bleeding * (%)	Swelling * (%)	Pain * (%)	Satisfaction (%)	Swelling (Days)	Pain (Days)	Analgesics (Days)
1	17	100	100	90	100	0	1	0
2	22	100	100	100	100	0	0	0
3	24	100	80	90	100	2	1	1
4	22	100	100	80	100	0	2	1
5	24	100	100	80	100	0	2	1
6	16	100	100	90	100	0	1	1
7	14	100	100	100	100	0	0	0
8	35	100	100	90	100	0	2	0
9	11	100	100	100	100	0	0	2
10	33	100	100	80	90	0	2	0
11	26	100	100	80	90	0	2	0
12	44	100	100	90	90	0	1	1
13	26	100	100	90	100	0	0	0
14	25	100	100	80	80	0	2	1
15	24	100	100	80	80	0	2	1
16	26	100	100	100	100	0	0	0
17	26	100	100	90	100	0	1	1

18	23	100	100	100	100	0	0	0
19	26	100	100	100	100	0	0	0
20	24	100	80	90	100	2	1	2
21	21	100	100	90	100	0	0.5	0
22	25	100	100	80	100	0	1	1
23	35	100	100	100	100	0	0	0
24	16	100	100	90	100	0	2	2
25	36	100	100	100	100	0	0	0
26	44	100	100	100	100	0	0	0
27	25	100	100	80	100	0	1	1
28	14	100	100	100	100	0	0	0
29	14	100	100	100	100	0	0	0
30	45	100	100	85	100	0	1	1
31	25	100	100	100	100	0	0	0
Mean	100	98.71	91.13	97.74	0.13	0.82	0.55	
Median	100	100	90	100	0	1	0	
SD	0	4.99	8.14	5.60	0.50	0.82	0.68	

SD = standard deviation; * = values obtained from the Visual Analogue Scale (VAS), where 0% indicates complete dissatisfaction and 100% represents full satisfaction.

Volumetric measurements indicated that buccal tissue changes were minimal, with an average loss of only −0.30 mm. The literature contains few studies assessing volumetric outcomes with conventional implant protocols, and a comparison of socket-shield approaches to these limited data is provided in **Table 6**.

Lingual tissue alterations in the present study were negligible, averaging just 0.17 mm. By comparison, Aslan [15] documented considerable palatal tissue reduction of −1.21 mm, measured 1 mm below the gingival margin, when using solely a buccal shield. The improved stability observed with a complete 360-degree shield suggests a potential biological benefit over partial shields, though additional research is necessary to confirm this advantage.

Mid-buccal gingival recession averaged −0.66 mm, exceeding the −0.33 mm reported by Bäumer *et al*. [5]. Several factors may account for this difference. One important factor is the shield's depth in relation to the underlying bone, which can markedly influence the final gingival contour [3]. Both this study and Bäumer *et al*.'s employed a flapless approach, making it challenging to determine the precise position of the shield relative to the bone, with an estimated tolerance of up to 1 mm. Carnevale *et al*. reported that preparing the shield to bone level can lead to approximately 1 mm of buccal bone resorption [24].

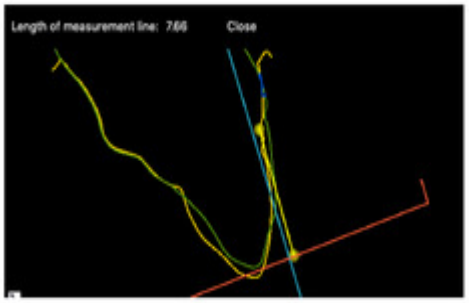
Table 6. Immediate implants comparing socket-shield techniques to traditional techniques.

Technique		Author	Length of Study (Years)	Mesial Papillary Recession (mm)	Distal Papillary Recession (mm)	MD Buccal Recession	Mid-Buccal Recession (mm)	MD Buccal Bone Loss (mm)
Socket-Shield	360-degree socket shield	Cameron Castle 2022	2	−0.26 ± 0.55	−0.29 ± 0.52	−0.30 ± 0.32	−0.66 ± 0.64	n.a.
	Buccal socket shield	Bäumer *et al*., 2017 [5]	5	n.a.	n.a.	−0.37 ± 0.30	−0.33 ± 0.23	n.a.
Traditional	No graft	Gavilán R 2017 [25]	1	−0.89 ± 0.41	−0.84 ± 0.50	−0.71 ± 0.35	−1.10 ± 0.64	n.a.
	Bovine bone in gap	Gavilán R 2017 [25]	1	−0.95 ± 0.62	−0.84 ± 0.46	−0.79 ± 0.44	−0.82 ± 0.53	n.a.

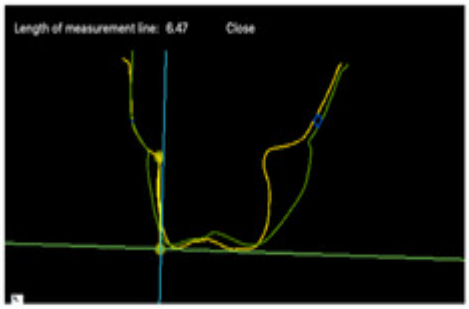
Bovine bone in gap	Van Nimwegen *et al*., 2018 [26]	1	n.a.	n.a.	−0.49 ± 0.54	−0.48 ± 1.13	−0.47 ± 0.55
Bovine in gap + CTG on buccal	Zuiderveld *et al*., 2020 [27]	1	n.a.	n.a.	−0.68 ± 0.59	0.20 ± 0.70	−0.81 ± 0.66

MD = Mean Distance; n.a. = data not reported on.

A further factor impacting the buccal gingival margin is the shape of the prosthetic restoration. Excessive contouring of crowns near the gingival margin can lower the apparent gingival level **(Figure 16)**, while a bulky emergence profile may displace the gingiva downward, leading to recession **(Figure 17)**.

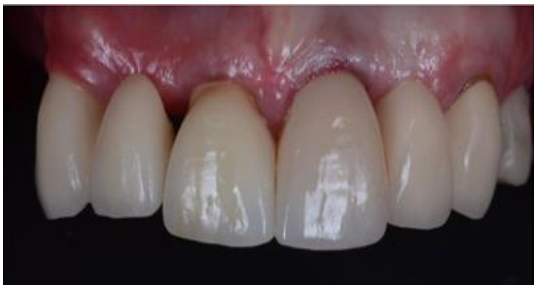


a)

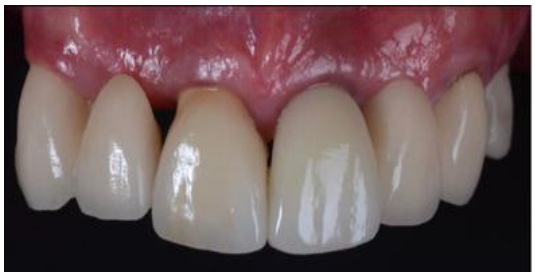


b)

Figure 16. Overlay of digital scans illustrating that the final implant crown (green) has a broader emergence profile compared to the original tooth (yellow).



a)



b)

Figure 17. (Top) Image depicting the crown prior to adjustments in color and emergence profile. (Bottom) Image showing reduced gingival recession after the crown's emergence profile was significantly minimized.

In this study, 39% of cases presented with apical lesions, yet no post-operative issues related to unresolved infections were observed **(Figure 18)**. Final intraoral radiographs confirmed complete healing of all lesions. This modified approach may offer greater predictability in fully removing the apex compared to traditional socket-shield methods. In contrast, Siormpas *et al*. reported that incomplete apex removal in one case led to gradual resorption over time [28].

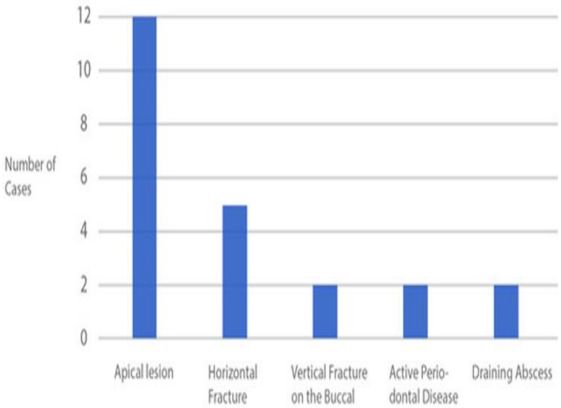


Figure 18. Frequency of more severe conditions observed in some cases within this study.

Two of the 31 cases involved teeth with periodontal involvement. In these instances, the shields were reduced to the level of the bone, theoretically positioning them below areas prone to biofilm accumulation. If the shields remain fully submerged, they should avoid bacterial exposure that could trigger

periodontal disease [29]. Long-term follow-up is necessary to determine whether these cases maintain stability and remain infection-free over time.

A key question is whether reducing a shield to bone level, as proposed by Gluckman *et al*., reliably prevents future migration [20]. Zuhr *et al*. have suggested that shield migration may be more complex, potentially influenced by the ongoing anterior-to-posterior growth of the maxilla [21, 30]. Other factors, such as genetic predisposition, may also play a role, where certain individuals experience natural migration of the shield to the gingival surface. Zuhr *et al*. documented a case of shield migration requiring removal, recommending that the implant be "locked" to the shield. A 360-degree socket-shield provides a larger surface area to achieve this locking, representing a significant advantage.

Locking the implant to the coronal portion of the shield is relatively straightforward for anterior teeth and premolars using the CWST. Molars are more challenging, as implant contact with the shield typically requires asymmetrical placement or the use of a wider diameter implant.

Previous studies, including Bäumer *et al*., have considered buccal vertical root fractures as a contraindication for socket-shield procedures [5, 20, 22, 31], likely because the fractured shield is inherently unstable even if disinfection is possible. In contrast, this study did not consider such fractures a contraindication. Preparing a 360-degree socket-shield in fractured roots increases the likelihood that rigid and viable portions of the shield are retained, providing a clear advantage if part of the shield migrates over time. This technique should be performed only by clinicians experienced with immediate implant placement. With sufficient practice, the CWST enables efficient and predictable preparation of a 360-degree socket-shield, particularly in anterior teeth. This approach can reduce or eliminate the need for costly and invasive grafting procedures, while preserving aesthetics. Adequate illumination and magnification are critical, and single-rooted anterior teeth are easier to prepare than multi-rooted teeth.

The study's findings are derived from volumetric analysis, which, although precise, may still be influenced by procedural variability, as noted by Hinze *et al*. [22].

Future directions

A limitation of this study was the absence of detailed bone level data, due to discrepancies in the angulation of available pre- and post-treatment radiographs. Nevertheless, intraoral periapical radiographs demonstrated bone formation around all implants, and successful integration was confirmed using resonance frequency analysis. Future studies using CBCT would provide more precise evaluation.

Conclusion

The study demonstrated that the CWST can achieve excellent soft tissue stability and aesthetics with minimal post-operative discomfort. A key benefit of retaining a 360-degree socket-shield is the increased surface area available to secure the implant to the shield, which helps prevent shield migration over time.

Acknowledgments: None

Conflict of Interest: None

Financial Support: None

Ethics Statement: None

References

1. Chappuis V, Araújo M, Buser D. Clinical relevance of dimensional bone and soft tissue alterations post-extraction in esthetic sites. Periodontol 2000. 2017;73(1):73–83.
2. Schropp L, Wenzel A, Kostopoulos L, Karring T. Bone healing and soft tissue contour changes following single-tooth extraction: a clinical and radiographic 12-month prospective study. Int J Periodontics Restor Dent. 2003;23(4):313–23.
3. Staehler P, Abraha S, Bastos J, Zuhr O, Hürzeler M. The socket-shield technique: a step-by-step protocol after 12 years of experience. Int J Esthet Dent. 2020;15(3):288–305.
4. Chen S, Buser D. Esthetic outcomes following immediate and early implant placement in the anterior maxilla—A systematic review. Int J Oral Maxillofac Implants. 2014;29(1):186–215.
5. Bäumer D, Zuhr O, Rebele S, Hürzeler M. Socket shield technique for immediate implant placement—clinical, radiographic and volumetric data after 5 years. Clin Oral Implants Res. 2017;28(12):1450–8.
6. Esposito M, Maghaireh HGrusovin MG, Ziounas I, Worthington HV. Soft tissue management for dental implants: what are the most effective techniques? A Cochrane systematic review. Eur J Oral Implant. 2012;5(3):221–38.
7. Lin GH, Chan HL, Wang HL. Effects of currently available surgical and restorative interventions on reducing midfacial mucosal recession of immediately placed single-tooth implants: a

systematic review. J Periodontol. 2014;85(1):92–102.
8. Hsu Y, Lin G, Wang H. Effects of platform-switching on peri-implant soft and hard tissue outcomes: a systematic review and meta-analysis. Int J Oral Maxillofac Implants. 2017;32(1):9–24.
9. Cosyn J, De Rouck T. Aesthetic outcome of single-tooth implant restorations following early implant placement and guided bone regeneration: crown and soft tissue dimensions compared with contralateral teeth. Clin Oral Implants Res. 2009;20(10):1063–9.
10. Cosyn J, De Bruyn H, Cleymaet R. Soft tissue preservation and pink aesthetics around single immediate implant restorations: a 1-year prospective study. Clin Implant Dent Relat Res. 2013;15(6):847–57.
11. Jung R, Philipp A, Annen B, Signorelli L, Thoma D, Hammerle C, et al. Radiographic evaluation of different techniques for ridge preservation after tooth extraction: a randomized controlled clinical trial. J Clin Periodontol. 2012;40(1):90–8.
12. Hürzeler MB, Zuhr O, Schupbach P, Rebele SF, Emannouilidis N, Fickl S. The socket-shield technique: a proof-of-principle report. J Clin Periodontol. 2010;37(9):855–62.
13. Kan J, Rungcharassaeng K. Proximal socket shield for interimplant papilla preservation in the esthetic zone. Int J Periodontics Restor Dent. 2013;33(3):e24–31.
14. 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.
15. Aslan S. Improved volume and contour stability with thin socket-shield preparation in immediate implant placement and provisionalization in the esthetic zone. Int J Esthet Dent. 2018;13(2):172–83.
16. Troiano M, Benincasa M, Sanchez P, Calvo-Guirado JL. Bundle bone preservation with Root-T-Belt: case study. Ann Oral Maxillofac Surg. 2014;2(1):7.
17. Calvo-Guirado JL. Different configuration of socket-shield technique in peri-implant bone preservation: an experimental study in dog mandible. Ann Anat. 2016;208:109–15.
18. Braut V, Bornstein MM, Belser U, Buser D. Thickness of the anterior maxillary facial bone wall—a retrospective radiographic study using cone beam computed tomography. Int J Periodontics Restor Dent. 2011;31(2):125–31.
19. Januário AL, Duarte WR, Barriviera M. Dimension of the facial bone wall in the anterior maxilla: a cone-beam computed tomography study. Clin Oral Implants Res. 2011;22(10):1168–71.
20. 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. 2017;20(1):122–9.
21. Zuhr O, Staehler P, Hürzeler M. Complication management of a socket-shield case after 6 years of function. Int J Periodontics Restor Dent. 2020;40(3):408–15.
22. Hinze M, Janousch R, Goldhahn S, Schlee M. Volumetric alterations around single-tooth implants using the socket-shield technique: preliminary results of a prospective case series. Int J Esthet Dent. 2018;13(2):146–70.
23. Schneider D, Grunder U, Ender A, Hammerle CH, Jung RE. Volume gain and stability of per-implant tissue following bone and soft tissue augmentation: 1-year results from a prospective cohort study. Clin Oral Implants Res. 2011;22(1):28–37.
24. Carnevale G, Sterrantino S, Di Febo G. Soft and hard tissue wound healing following tooth preparation to the alveolar crest. Int J Periodontics Restor Dent. 1983;3(1):36–53.
25. Gavilán RC. 3D volumetric changes of tissue contour after immediate implant placement with and without xenograft in the horizontal gap: a randomized controlled clinical trial. Ph.D. Thesis, University of Southern California, ProQuest Dissertations Publishing, Los Angeles, CA, USA; 2017.
26. van Nimwegen WG, Raghoebar GM, Zuiderveld EG, Jung RE, Meijer HJA, Mühlemann S. Immediate placement and provisionalization of implants in the aesthetic zone with or without a connective tissue graft: a 1-year randomized controlled trial and volumetric study. Clin Oral Implants Res. 2018;29(6):671–8.
27. Zuiderveld EG, van Nimwegen WG, Meijer HJA, Jung RE, Muehlemann S, Vissink A, Raghoebar GM. Effect of connective tissue grafting on buccal bone changes based on cone beam computed tomography scans in the aesthetic zone of single immediate implants: a 1-year randomized controlled trial. J Periodontol. 2020;92(4):553–61.
28. Siormpas K, Miltiadis 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.

29. Wolff L, Dahlen G, Aeppli D. Bacteria as risk marker for periodontitis. J Periodontol. 1994;64(5):498–510.
30. Björk A. Facial growth in man, studied with the aid of metallic implants. Acta Odontol Scand. 1955;13(1):9–34.
31. Gluckman H, Du Toit J, Salama M, Nagy K, Dard M. A decade of the socket-shield technique: a step-by-step partial extraction therapy protocol. Int J Esthet Dent. 2020;15(3):212–25.