IS BONE GRAFT OR MEMBRANE NECESSARY FOR RIDGE PRESERVATION?

A Three-Arm CBCT-Based Comparative Analysis of Linear and Volumetric Ridge Changes

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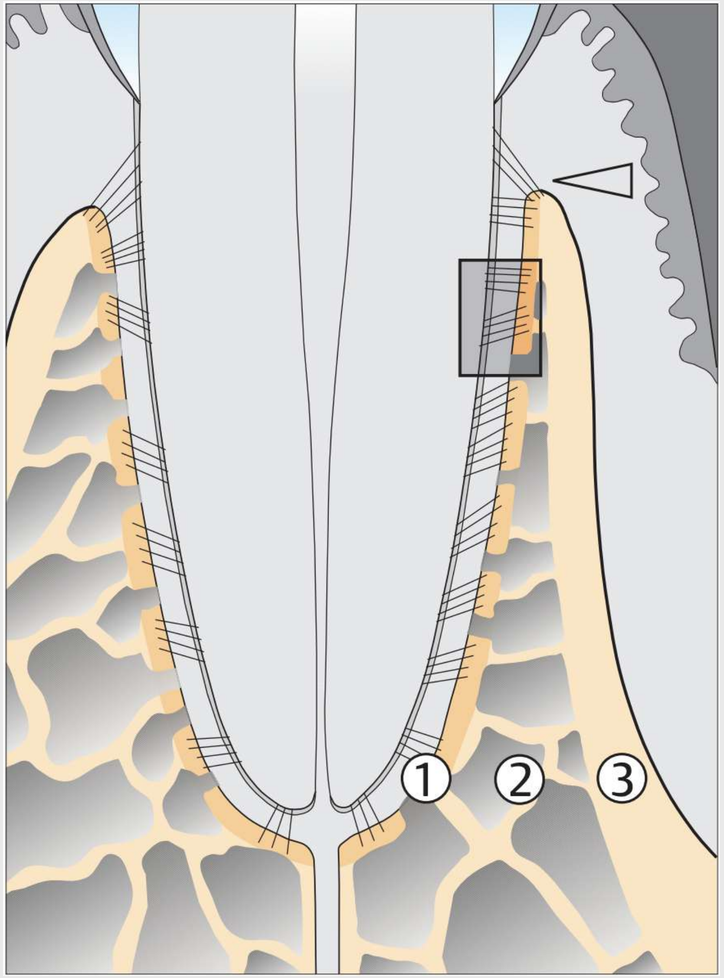
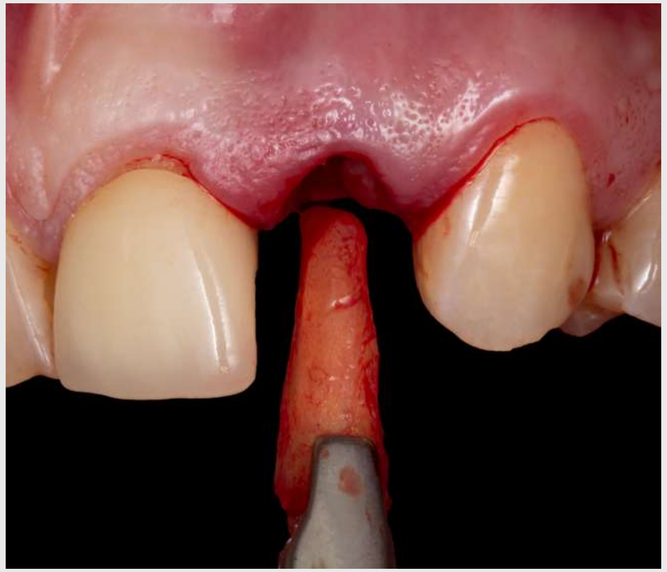
Not every tooth can be saved

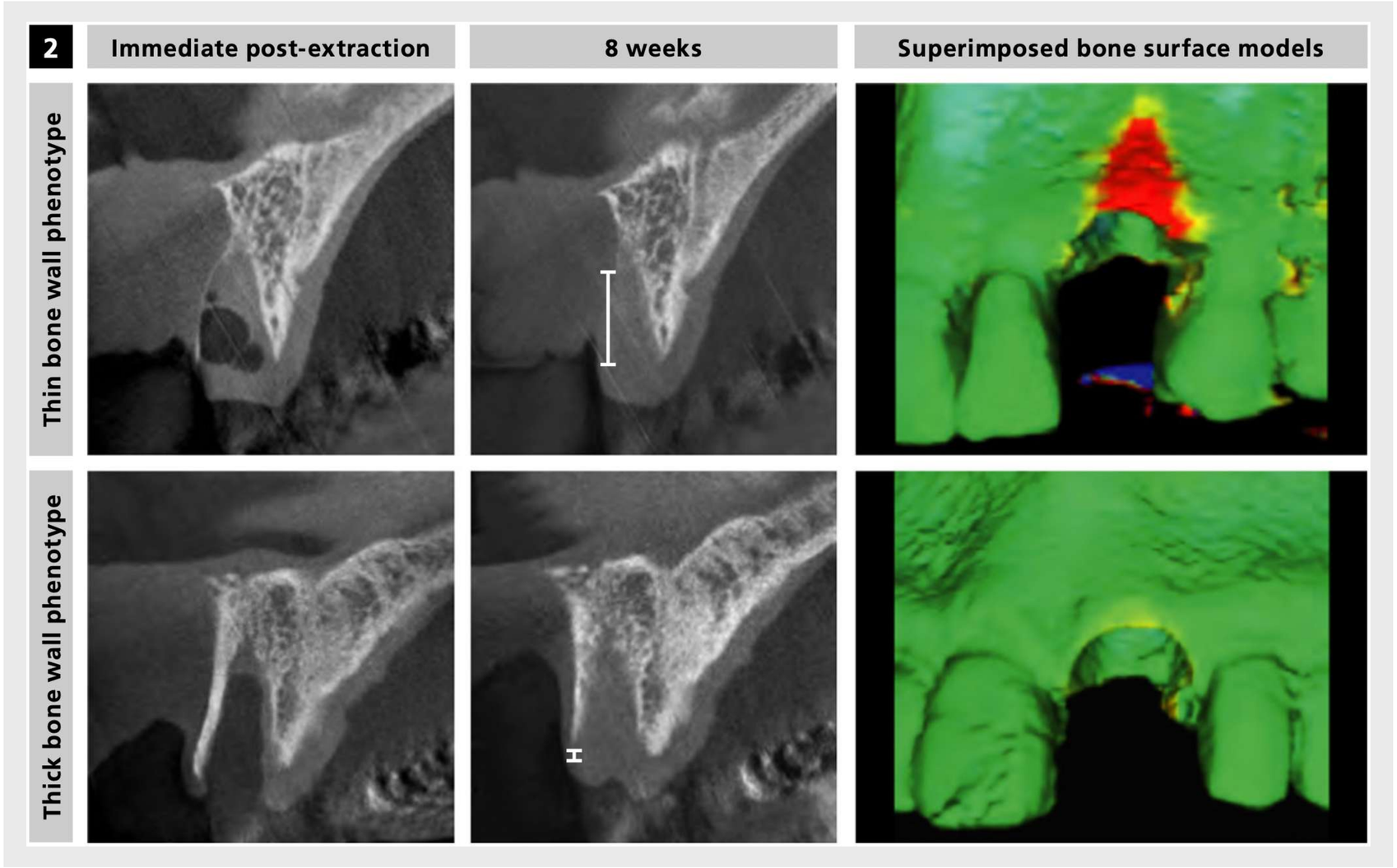
How does the bone respond to tooth extraction?



Wolf, HF. Color Atlas of Dental Medicine: Periodontology



What is the influence of buccal bone thickness?

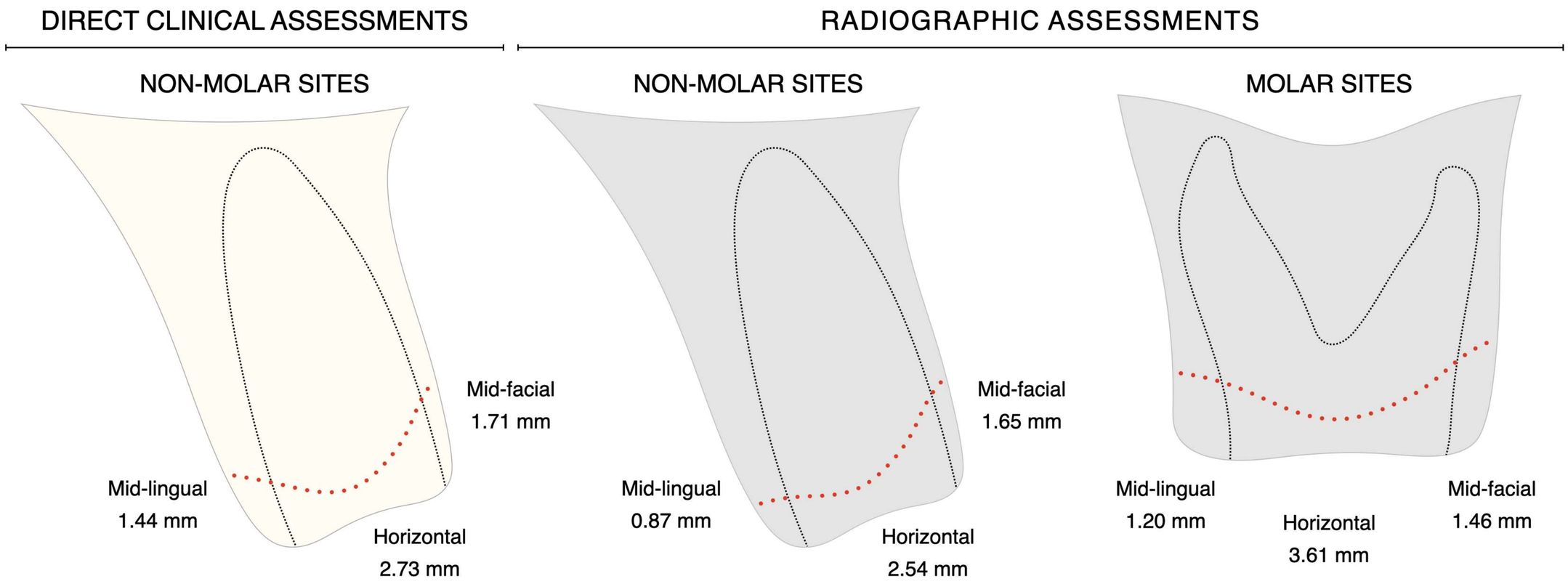


- Median vertical bone resorption = 7.5 mm or 62.3%
- Median horizontal bone resorption = 0.8 mm or 10.5%

- Median vertical bone resorption = 1.1 mm or 9.1%
- Median horizontal bone resorption = 0 mm or 0%

Chappuis et al. 2013

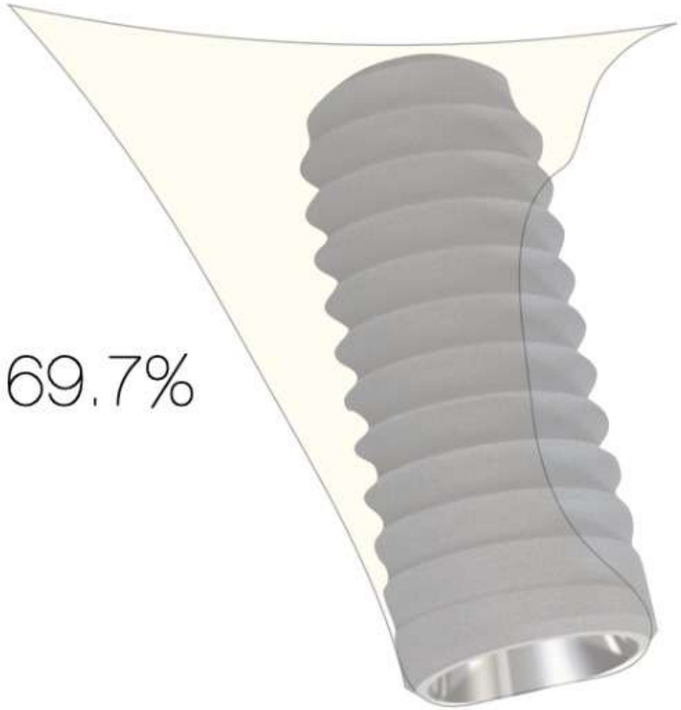
What is the dimensional change of the bone?



Couso-Queiruga et al. 2021

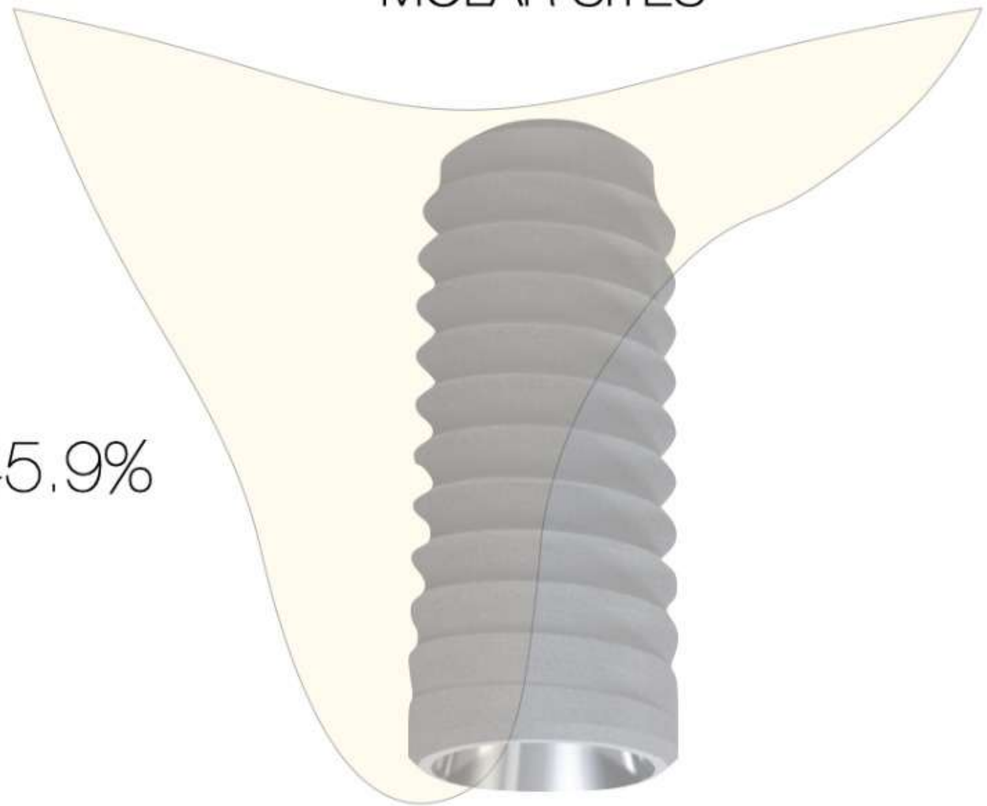
How does this impact implant placement?

NON-MOLAR SITES



69.7%

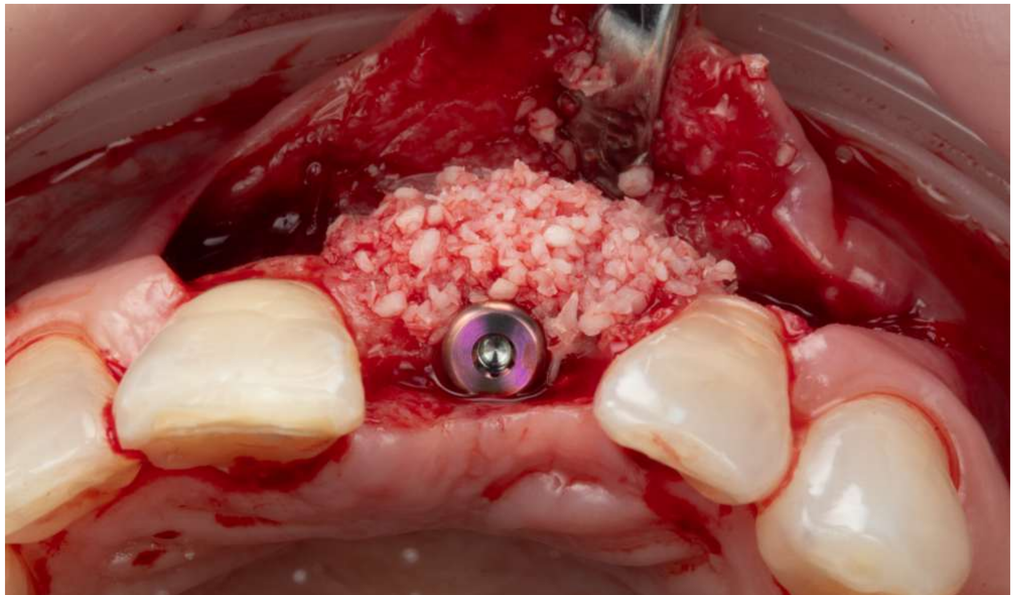
MOLAR SITES



45.9%

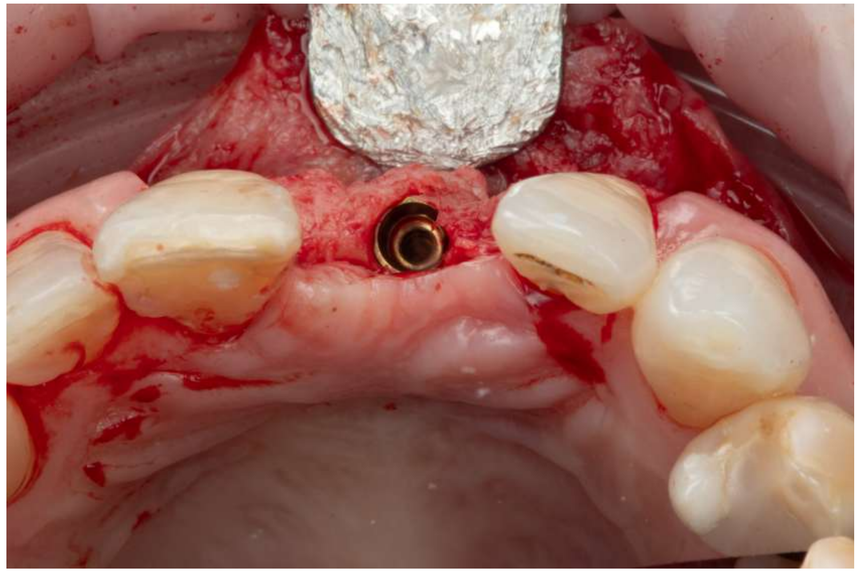
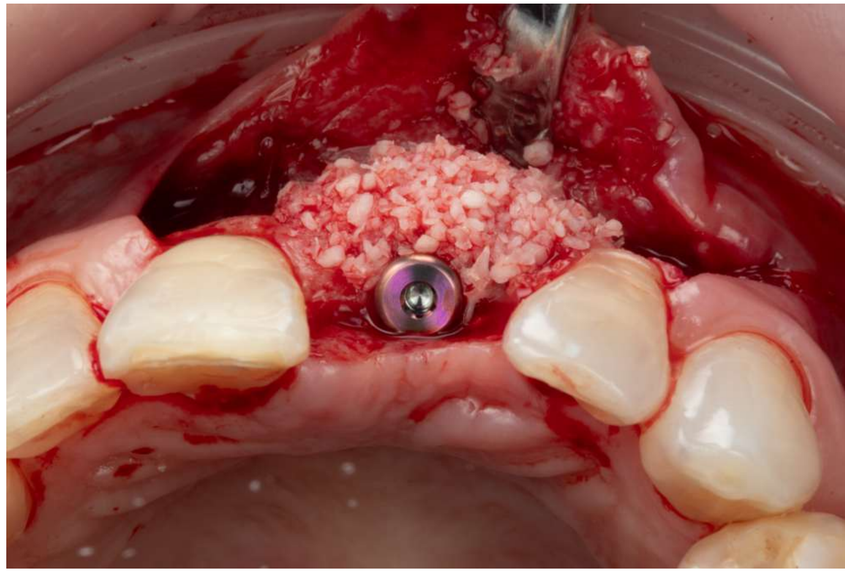
Couso-Queiruga et al. 2021

How does this impact implant placement?



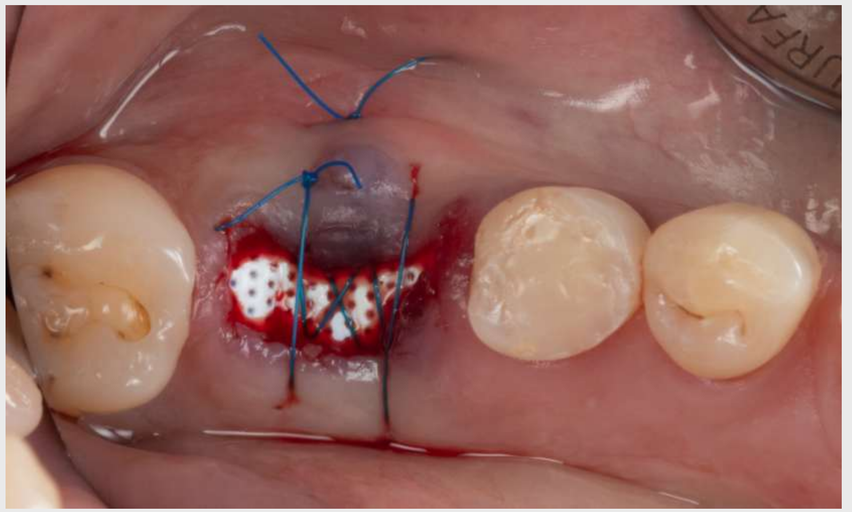
- Increased cost
- Increased morbidity
- Increased invasiveness
- Less predictability

How does this impact implant placement?

Alveolar ridge preservation



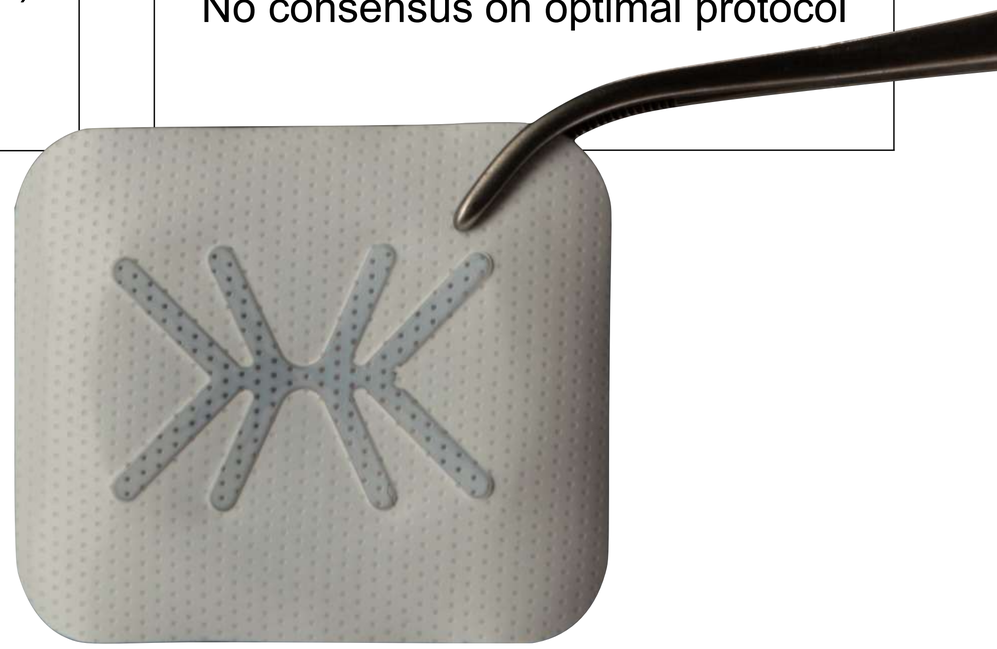


- Intervention immediately after tooth extraction
- Aims to preserve the contour of the alveolar ridge
- Provide maximum bone for future implant placement

Avila-Ortiz et al. 2019

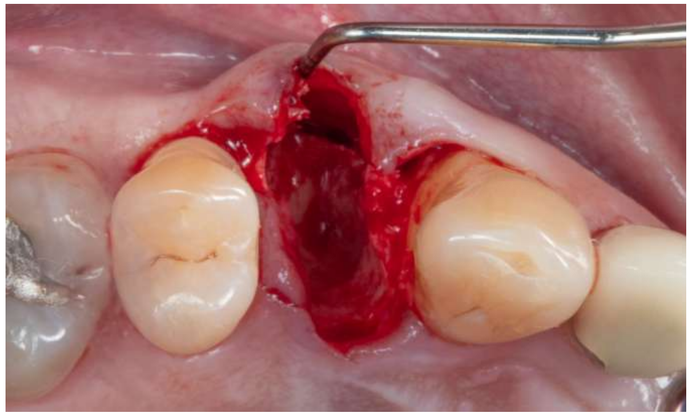
dPTFE Membranes in ARP

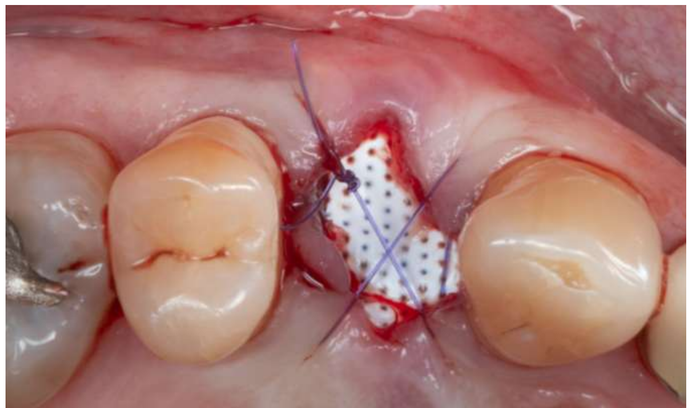
Unique characteristics	Clinical evidence	Open questions
Pore size < 1 micron prevents bacterial infiltration	Attenuates ridge dimensional changes	Is bone grafting necessary?
Maintains barrier function while exposed	Cost effective	Cost effectiveness analyses suggest membrane may drive efficacy
Allows healing without primary intention closure	Reduced morbidity vs conventional GBR procedures	Graft adds cost and technique sensitivity
Stiff handling	(Avila-Ortiz 2020; Barootchi 2022)	No consensus on optimal protocol



MATERIAL AND METHODS

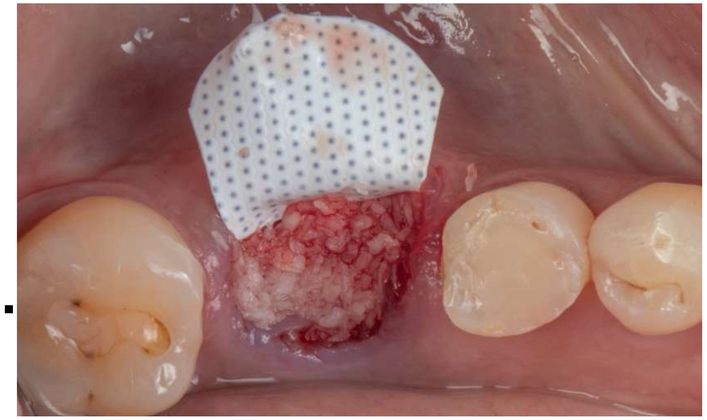
dPTFE alone

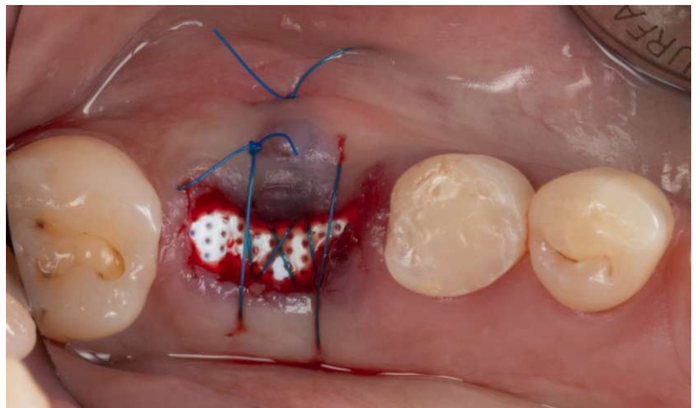




vs.

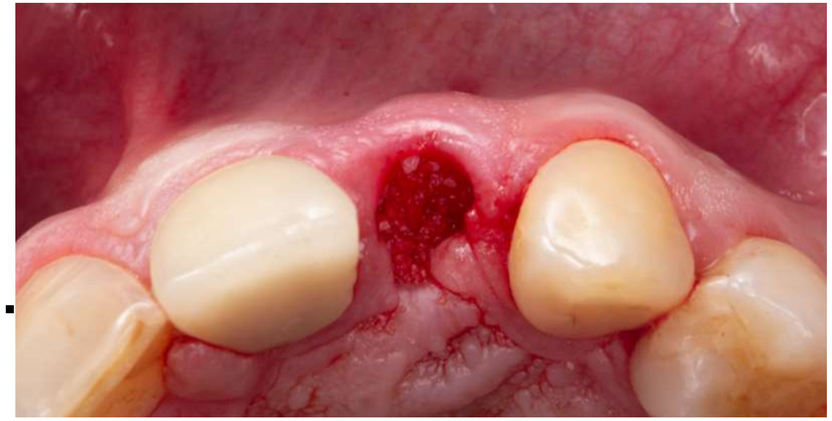
Bone graft + dPTFE

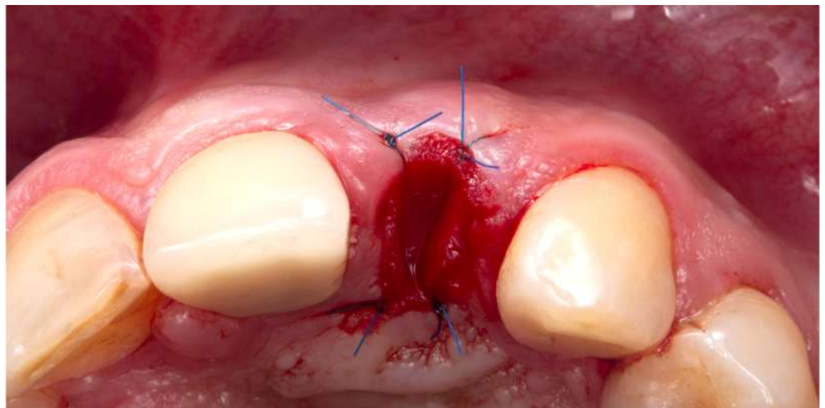




vs.

Bone graft + collagen dressing





Materials & Methods

Retrospective re-analysis of a previously conducted randomized controlled trial (RCT)

	Original RCT	This Re-analysis	
Scan Alignment	✗ Pre- and post-op CBCT scans analyzed independently — no superimposition performed in the original trial	✓ Pre- and post-op scans superimposed using stable anatomical landmarks via Planmeca Romexis software	NEW
Linear Measure-ments	— Ridge width measured at a single cross-section: 2 mm apical to the bone crest only	✓ Ridge width measured at three levels: 1 mm, 3 mm, AND 5 mm apical to the bone crest	NEW
Volumetric Analysis	✗ Not performed in the original RCT —	✓ Full volumetric change (cm^3) measured within a defined volume of interest for all 27 extraction sites	NEW

Unchanged from original RCT: 27 sites · 3 randomized treatment arms · CBCT pre-op & 3–4 mo post-op · Buccal plate stratification added in re-analysis

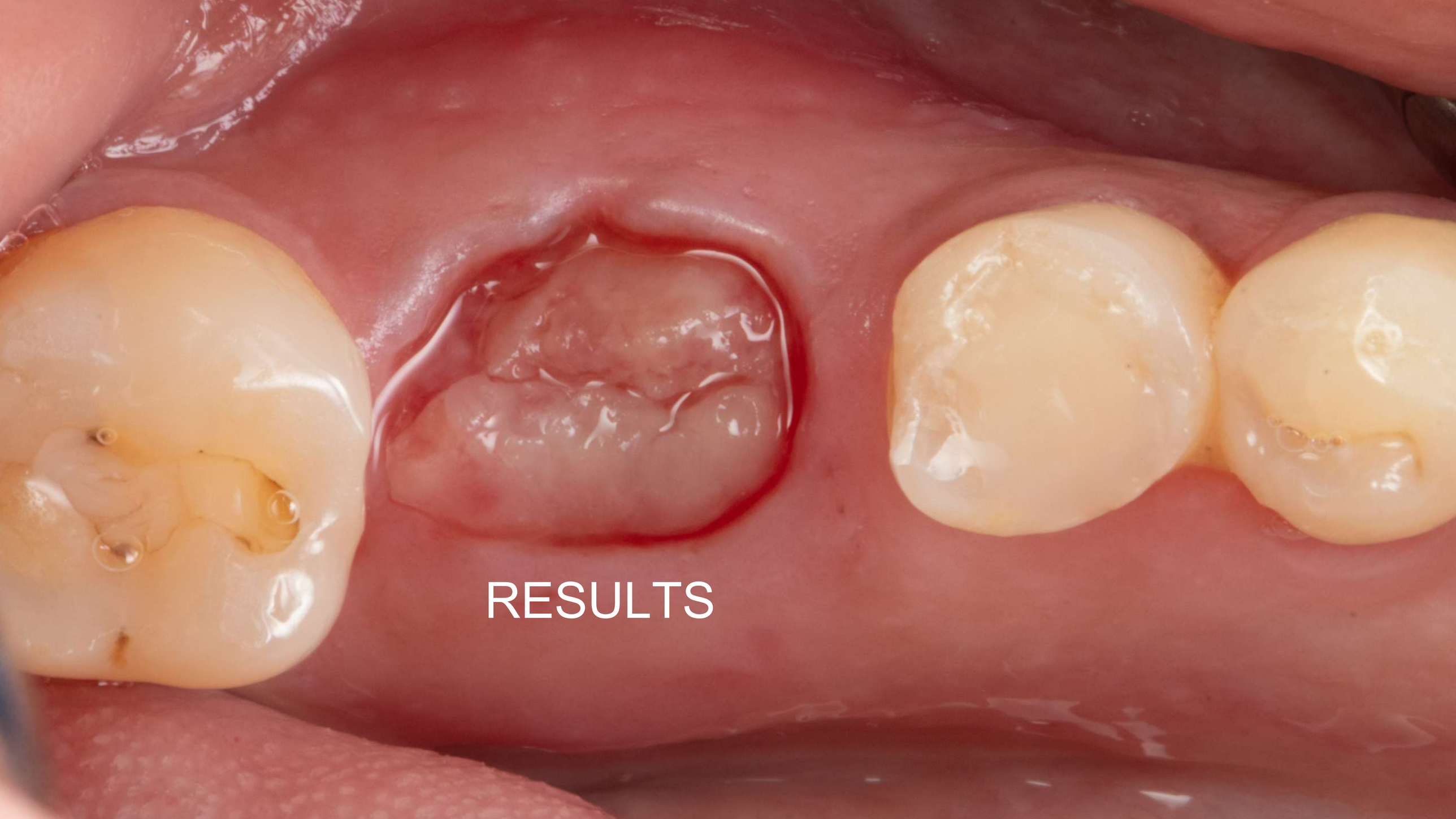
Study Objective

Compare linear and volumetric post-extraction ridge changes across three treatment modalities — dPTFE membrane alone, dPTFE with particulate bone graft, and collagen dressing with bone graft — and evaluate the modifying effect of pre-existing buccal plate thickness on outcomes.

Primary Hypothesis:

Both grafted protocols will outperform membrane-alone for linear ridge preservation, with the two grafted groups performing similarly to each other.

Aim 1	Pairwise comparisons of all three groups across linear and volumetric outcomes
Aim 2	Assess buccal plate thickness (<1 mm vs ≥1 mm) as a modifying variable within each group
Aim 3	Responder analysis — proportion of sites achieving ≤2 mm crestal width loss per group


RESULTS

Baseline Characteristics

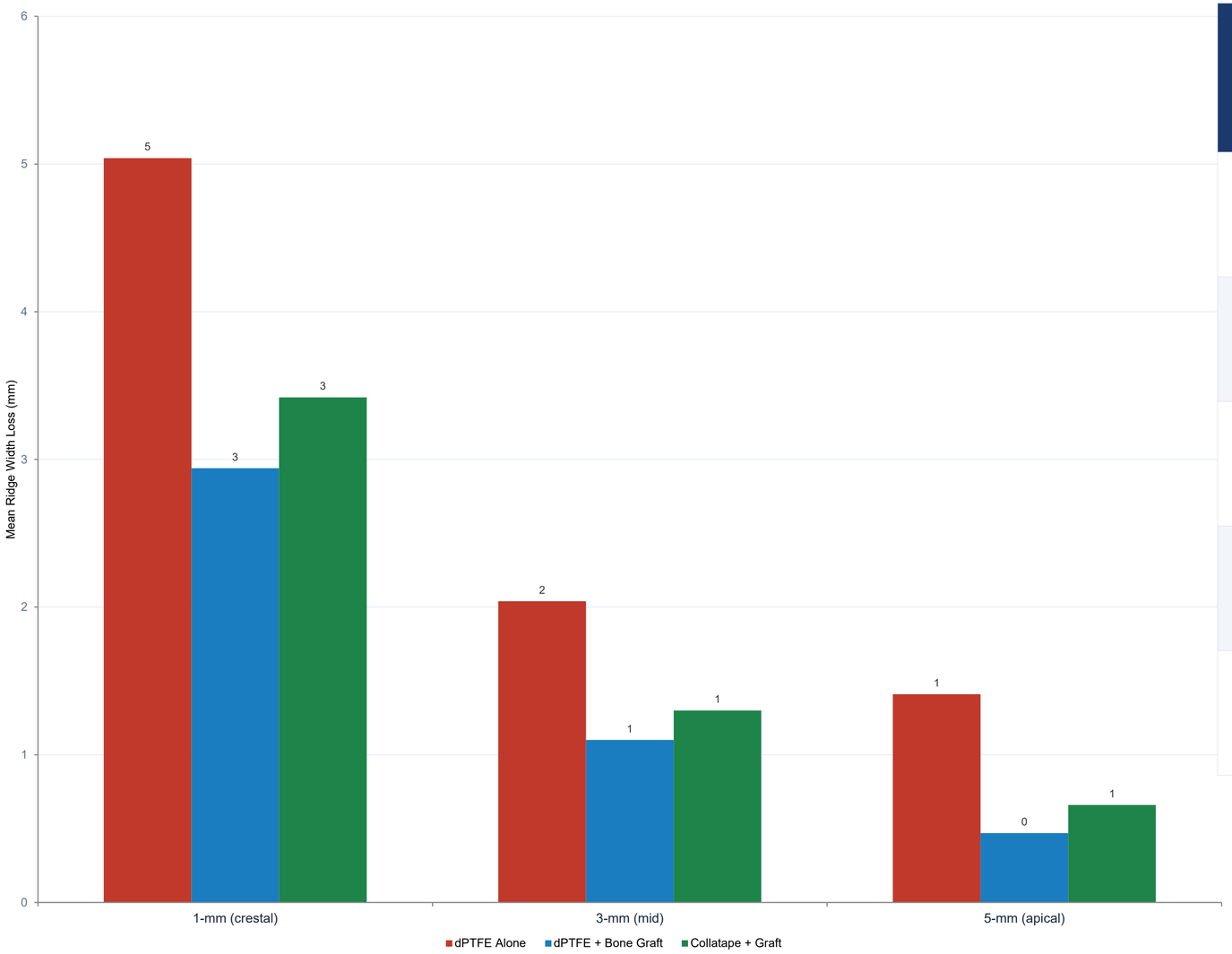
Kruskal-Wallis omnibus — all p > 0.40; groups were well-matched at baseline

Characteristic	dPTFE Alone (n = 10)	dPTFE + Graft (n = 10)	Collatape + Graft (n = 7)	KW p-value
Pre-op Ridge Volume (cm^3)	1.87 ± 0.48	1.88 ± 0.61	2.35 ± 1.26	0.83
Width at 1-mm pre-op (mm)	9.10 ± 1.55	9.12 ± 2.21	9.67 ± 2.09	0.84
Width at 3-mm pre-op (mm)	9.89 ± 1.67	9.41 ± 2.03	10.19 ± 2.51	0.77
Width at 5-mm pre-op (mm)	10.70 ± 1.62	9.39 ± 1.86	10.37 ± 2.65	0.45
Buccal plate thickness (mm)	1.04 ± 0.54	1.12 ± 0.66	1.13 ± 0.44	0.92
Thin buccal plate (<1 mm)	5 / 10 (50%)	4 / 10 (40%)	2 / 7 (29%)	—
Dehiscence/defect present	4 / 10 (40%)	2 / 10 (20%)	2 / 7 (29%)	—

KW: Kruskal-Wallis omnibus test. Mean ± SD. No significant baseline differences across any characteristic.

Ridge Width Changes

Higher values = more bone loss. Both grafted protocols outperform membrane alone.

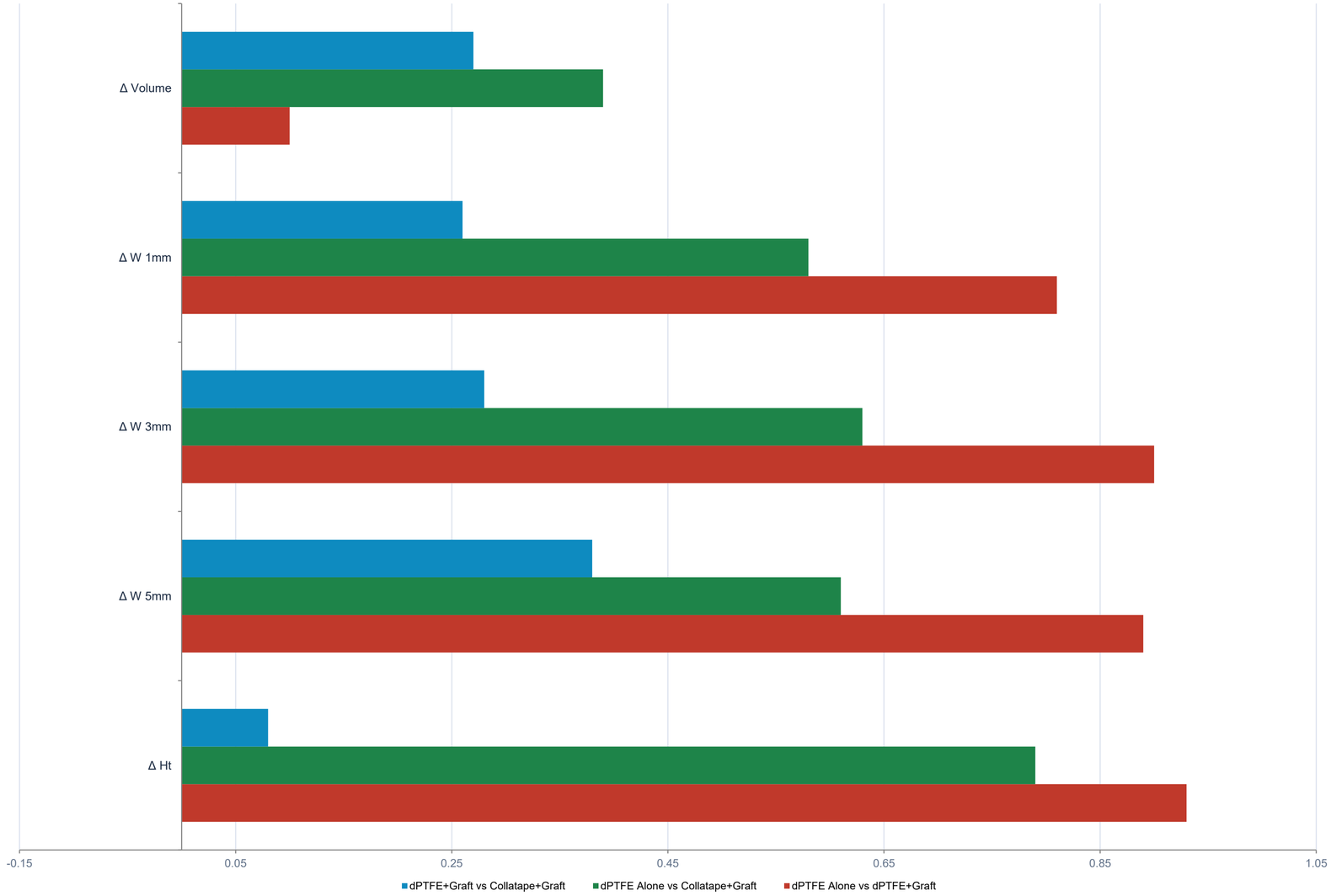


Outcome	dPTFE Alone	dPTFE + Graft	Collatape + Graft	KW p-value
Δ Width 1-mm	5.04±3.18	2.94±1.81	3.42±1.99	0.20
Δ Width 3-mm	2.04±1.34	1.10±0.61	1.30±0.87	0.19
Δ Width 5-mm	1.41±1.46	0.47±0.32	0.66±0.72	0.20
Δ Ht (mm)	1.48±1.10	0.69±0.46	0.74±0.60	0.19
Δ Vol (cm^3)	0.34±0.15	0.32±0.15	0.28±0.14	0.60

All Kruskal-Wallis omnibus p > 0.05. Both grafted groups consistently outperform dPTFE-alone. KW = Kruskal-Wallis.

Effect Size Analysis: Pairwise Comparisons

Cohen's d: small <0.5 · medium 0.5–0.8 · large >0.8 (favoring lower ridge loss)



PTFE Alone vs Both Grafted

LARGE effect (d=0.58–0.93)

for all linear & height outcomes

dPTFE+Graft vs Collatape

SMALL effect (d=0.08–0.38)

Two grafted groups perform similarly

Key Interpretation

The major treatment distinction is between graft vs. no graft — not between graft carrier type. Both grafted protocols consistently outperform membrane alone, and neither grafted protocol is superior to the other.

All p > 0.05. All between-group differences underpowered (n=10 or 7 per group). Effect sizes reflect practical/clinical magnitude.

Volumetric Changes

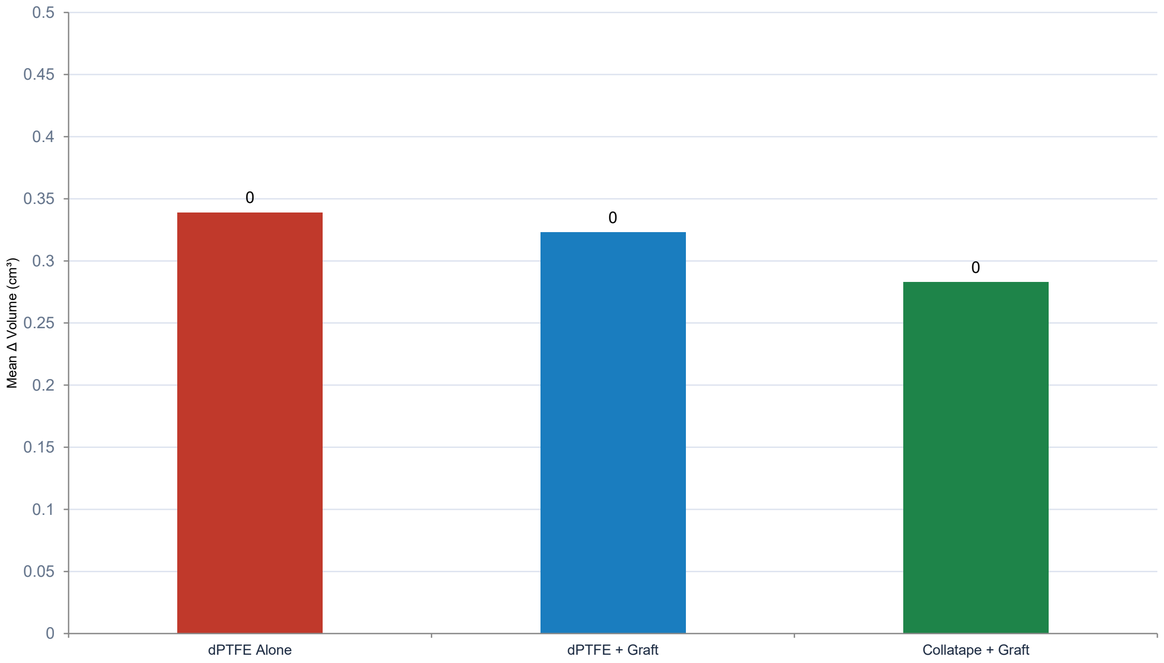
All groups lost significant volume · Collatape group shows numerically less reduction

18.5%
Volume reduction
dPTFE Alone (p<0.001)

17.6%
Volume reduction
dPTFE + Graft (p<0.001)

12.8%
Volume reduction
Collatape + Graft (p=0.001)

KW p=0.60
No significant
3-group difference



Key Insights

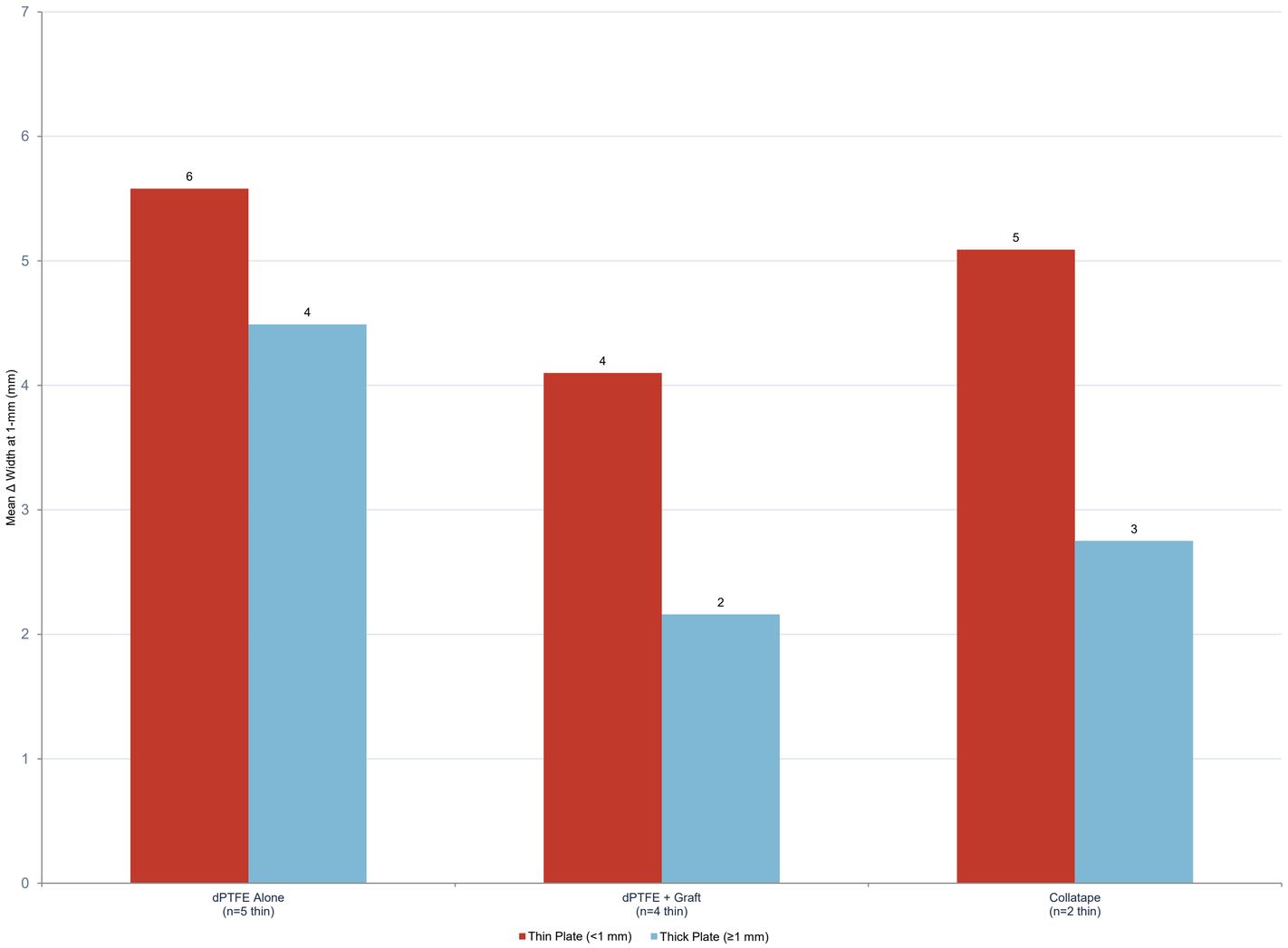
All three groups demonstrate statistically significant volumetric reduction, confirming that even active ARP cannot fully prevent post-extraction bone loss.

The Collatape + graft group shows numerically less volume loss (12.8% vs ~18%), though this difference is not statistically significant (KW p=0.60), likely due to the small sample size.

As in the two-group analysis, volumetric and linear outcomes dissociate: bone graft preservation of buccal width is not

Buccal Plate Thickness: Stratified Analysis

Thin (<1 mm) vs. Thick (≥1 mm) within each treatment group · Δ Width at 1-mm shown



Thin: 5.58 mm | Thick: 4.49 mm

dPTFE Alone

r = −0.39, p = 0.27 (1mm)

r = −0.62, p = 0.055 (3mm)

Trend toward plate-dependence (approaching sig. at 3mm)

Thin: 4.10 mm | Thick: 2.16 mm

dPTFE + Graft

r = −0.30, p = 0.40 (1mm)

r = −0.43, p = 0.21 (3mm)

Attenuation of plate-dependence with bone graft

Thin: 5.09 mm | Thick: 2.75 mm

Collatape + Graft

r = −0.02, p = 0.97 (1mm)

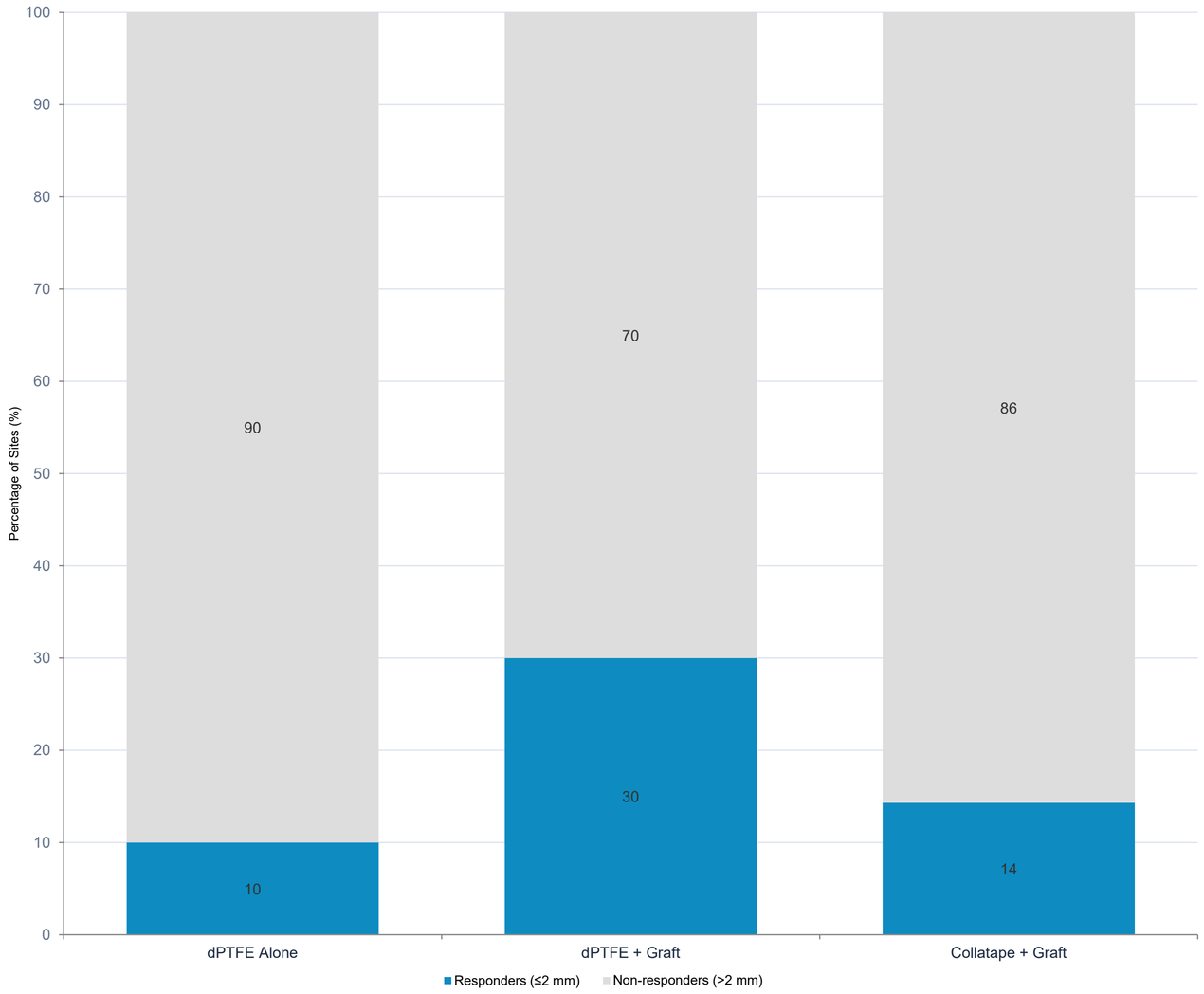
r = +0.71, p = 0.07 (3mm)*

*Interpret with caution: Only n=2 thin-plate sites

No within-group thin vs. thick comparisons reached statistical significance (all p > 0.05). Collatape thin-plate result unreliable (n=2).

Responder Analysis

Acceptable crestal preservation defined as Δ width at 1-mm ≤ 2 mm



10%
dPTFE alone
(1/10)

30%
dPTFE + Graft
(3/10)

14.3%
Collatape+Graft
(1/7)

3.86×
PTFE vs Graft
Odds Ratio

Fisher's Exact p (all pairwise): p = 0.58–1.00 (n too small)

Clinical Takeaway

dPTFE + graft sites were ~3.9× more likely to achieve acceptable crestal preservation than membrane alone. The Collatape + graft group performed similarly to PTFE alone in this metric — potentially reflecting its smaller sample size and case mix.

Discussion

01

All Treatments Attenuate But Don't Eliminate Ridge Loss

All three groups showed statistically significant within-group bone loss ($p<0.05$). ARP with any modality reduces loss compared to natural healing, but cannot fully prevent it — underscoring the clinical importance of implant timing and patient counseling.

02

Graft vs. No Graft: A Consistent Pattern

Both grafted groups (dPTFE+graft and Collatape+graft) demonstrated less ridge loss across all linear and height measures compared to membrane alone, with medium-to-large effect sizes. The two grafted protocols performed similarly to each other ($d < 0.40$ for all outcomes), suggesting graft material type — not carrier — may drive the benefit.

03

Buccal Plate Thickness as Modifier

The approaching-significant correlation in the PTFE-alone group (Spearman $r=-0.62$, $p=0.055$ at 3mm) was attenuated in both grafted groups. The Collatape group trend must be interpreted cautiously (n=2 thin-plate sites). Buccal plate thickness is most clinically relevant when no graft is used.

Limitations & Statistical Power

Sample sizes:

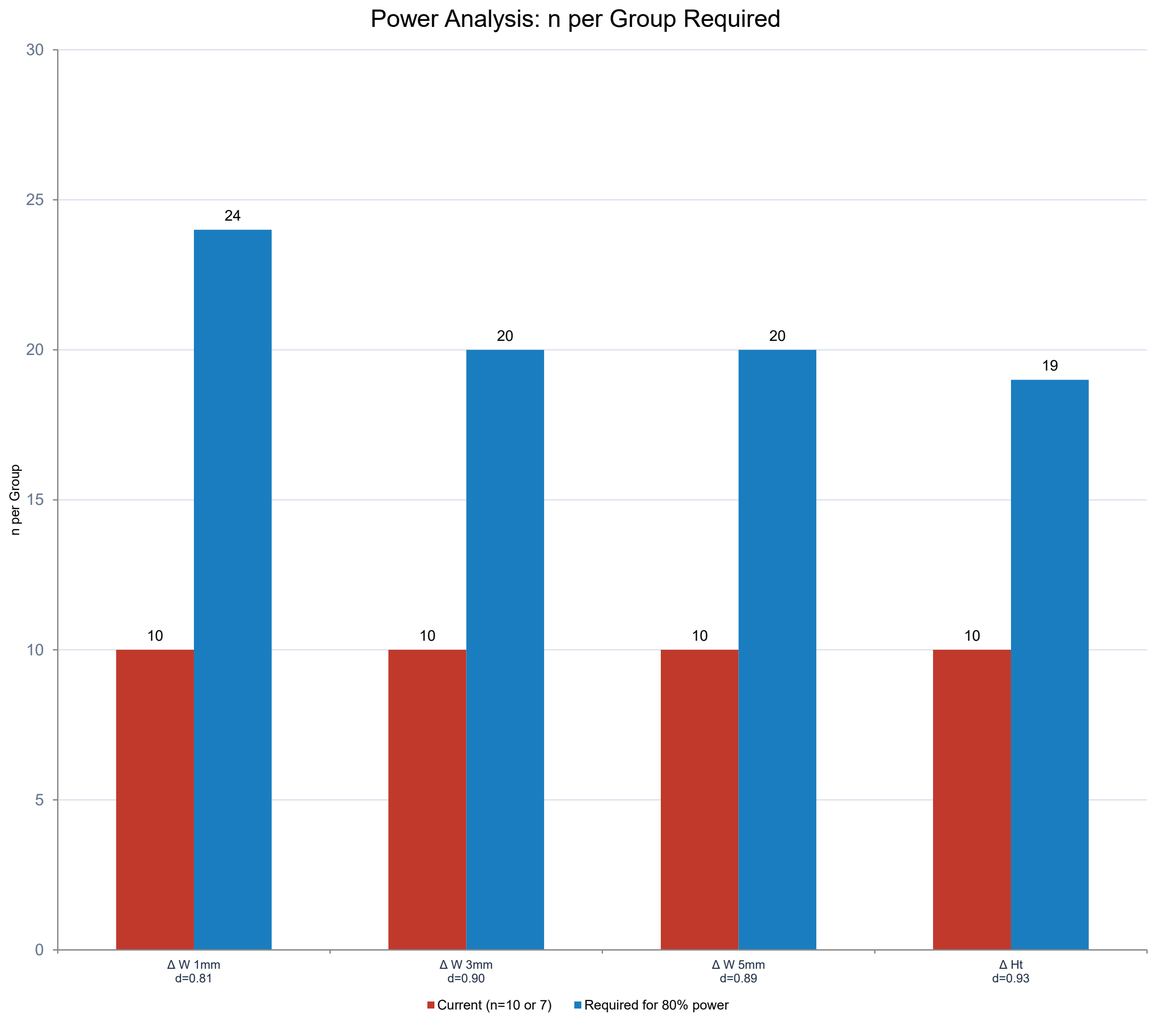
n=10 (dPTFE groups) and n=7 (Collatape) — substantially underpowered for observed effect sizes

Unequal group sizes:

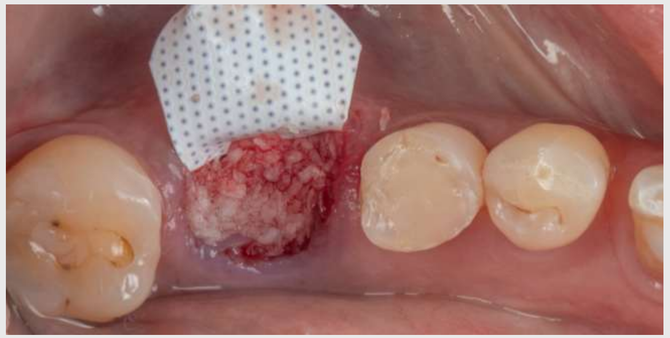
Collatape group (n=7) limits statistical power and reduces reliability of subgroup analyses

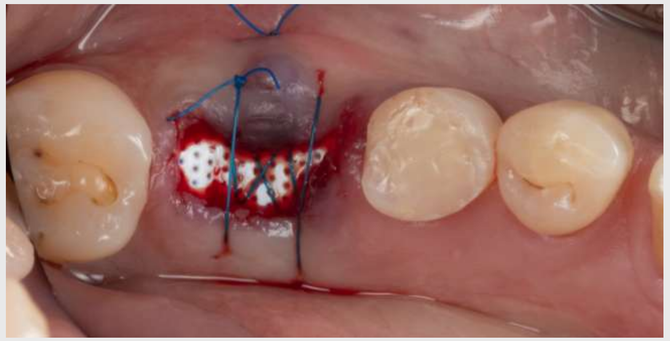
Single center:

Outcomes may not generalize across different providers or techniques



~19–24 sites/group needed. All three groups require enrollment before meaningful three-way testing.





Conclusions

- Bone grafting demonstrated consistently more preservation of ridge width and height than dPTFE alone with medium-to-large effect (d=0.58-0.93) sizes across linear outcomes.

- The bone grafted groups performed equivalently (d<0.40), suggesting the beneficial effect is driven by the presence of bone graft rather than the choice of a barrier/dressing material.

- Sample sizes 19-24/group are required to confirm statistical significance.

QUESTIONS

Key Finding: Bone grafting is the primary determinant of improved linear ridge preservation. Prospective studies with ≥20 sites per group are needed to confirm these findings