



A Randomized Controlled Trial to Compare the Histomorphometric and Clinical Outcomes of Soft Tissue Augmentation at the Time of Lateral Ridge Augmentation Procedures

Hussein Basma*, Ramzi Abou-Arraj*, Kenneth Liu*, Sarah Startley* , Nico Geurs*

*Department of Periodontology, University of Alabama at Birmingham



Introduction : Soft tissue augmentation is performed to correct muco-gingival deformities resulting from lateral ridge augmentation (LRA). The aim of this study is to clinically and histologically evaluate the quality and quantity of soft tissue when LRA is combined with soft tissue augmentation using autogenous connective tissue grafts (CTG) or acellular dermal matrix (ADM) at the time of the GBR procedure..

Study Objectives

1. To evaluate the quality of soft tissue regenerated with the use of the two available soft tissue grafts via histological analysis.
2. To evaluate whether CTG or ADM influences the outcomes of GBR procedures.
3. To quantify the soft tissue augmentation achieved by the two available soft tissue grafts by direct clinical measurements after healing.

Outcomes will be measured by evaluation of the following

1. The quality of soft tissue regenerated with the use of the two available grafts via histological analysis (attachment to bone and keratinization).
2. Keratinized tissue width (in mm) measured clinically with a periodontal probe from the implant collar to the muco-gingival junction.
3. Vertical thickness of soft tissue (in mm) measured clinically with a periodontal probe around the implant collar from soft tissue surface to bone contact.
4. Volumetric change of soft tissue dimensions around the implant collar evaluated by superimposition of pre- and post-grafting digital intra-oral scans.

Inclusion Criteria	Exclusion Criteria
--------------------	--------------------

Patient related criteria	
--------------------------	--

- | | |
|---|---|
| <ul style="list-style-type: none">• English speaking and able to read and understand informed consent document• At least 18 years old• Planned for implant(s) to replace missing tooth or teeth in at least one quadrant of the mouth• Willing and able to comply with the preoperative and postoperative instructions | <ul style="list-style-type: none">• Patients with systemic pathologies or conditions contraindicating oral surgical procedures or adversely affecting wound healing.• Significant medical conditions or habits expected to interfere with bone healing.• Smoking ≥ 10 cigarettes/day• Presence of active periodontal disease• Patient is a poor compliance risk (e.g., poor oral hygiene, history of alcohol/drug use). |
|---|---|

Site related criteria	
-----------------------	--

- | | |
|--|--|
| <ul style="list-style-type: none">• Insufficient alveolar ridge width for endosseous implant placement defined as < 5 mm as determined by cone beam computed tomography (CBCT) scan. | <ul style="list-style-type: none">• Bone dehiscence of > 4 mm following tooth extraction or vertical loss of bone at the edentulous ridge. |
|--|--|

Surgical Steps:

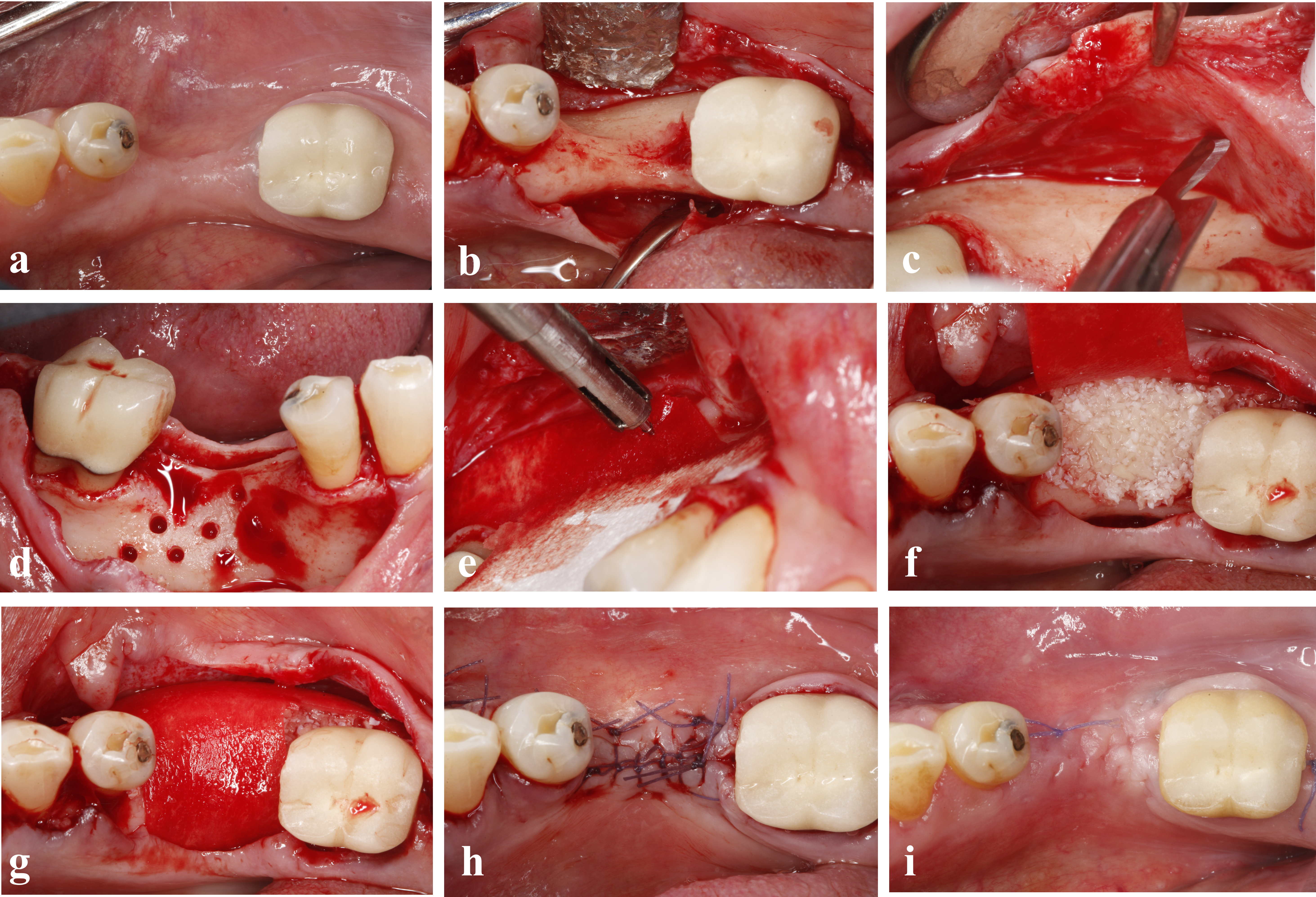
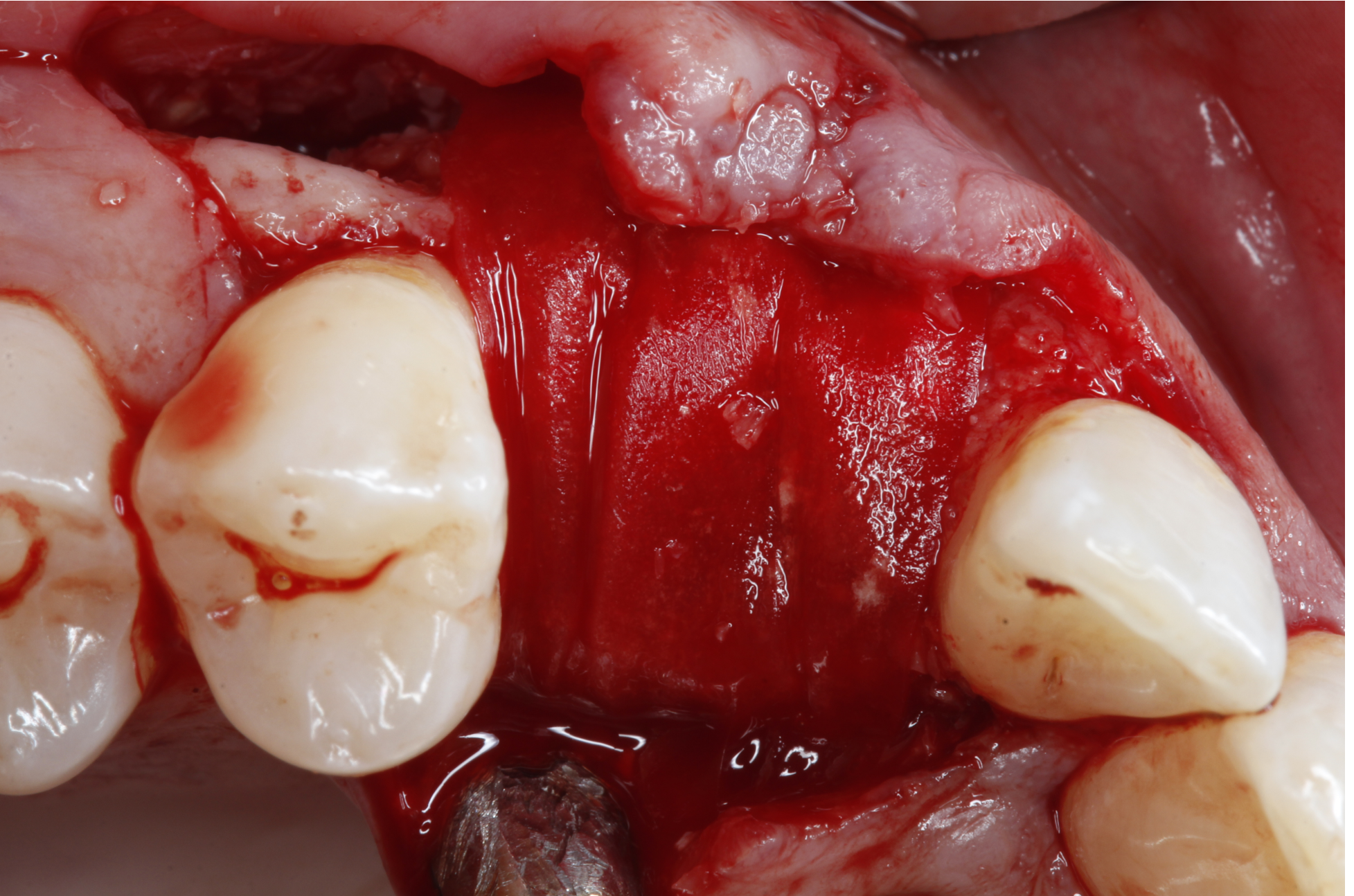


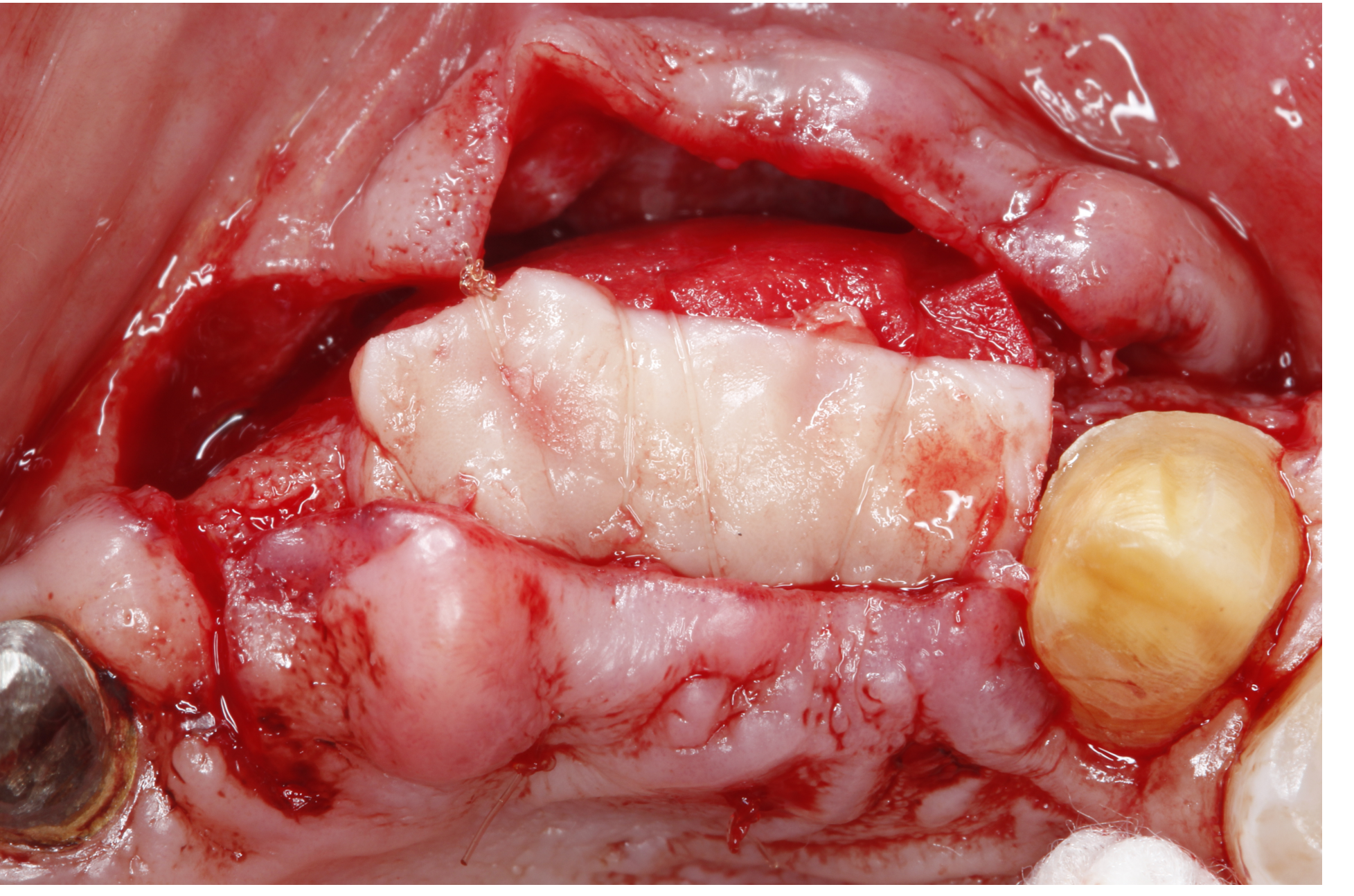
Fig. 1 Surgical steps: (a) Clinical appearance of horizontal ridge defect; (b) Visualization of alveolar ridge after incisions and full thickness mucoperiosteal flap reflection; (c) Periosteal releasing incision; (d) Bone decortication; (e) Placement and fixation of membrane; (f) Placement of particulate graft; (g) Secured membrane in place (If patient is randomized into group A or B, a CTG or ADM will be sutured on top of the membrane; (h) Suturing. (i) 2 weeks follow up.

24 systemically and periodontally healthy patients

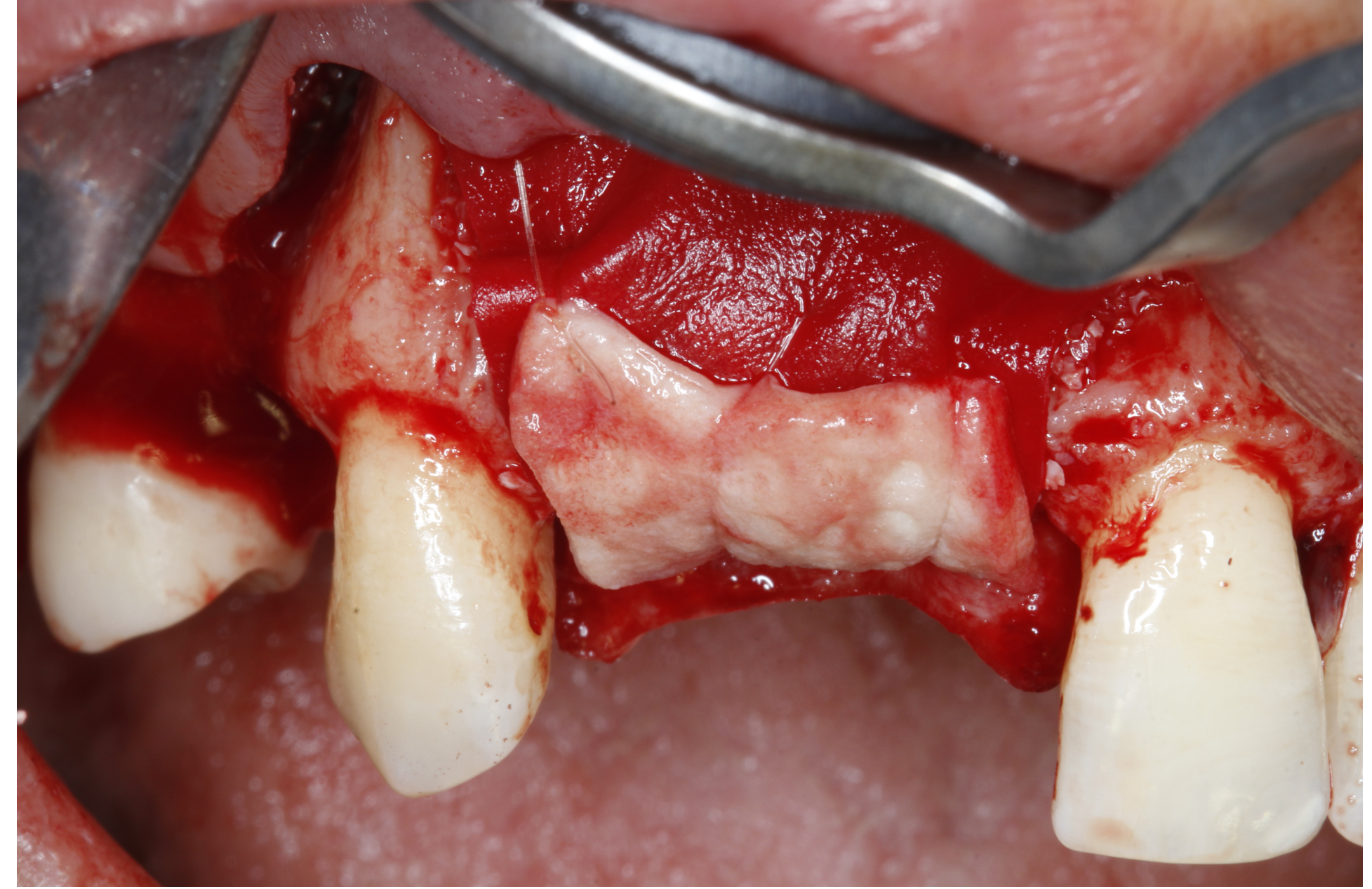
→ *Group 1: (Control Group)*
LRA with no soft tissue augmentation
(8 Patients)



→ *Group 2: (Test Group 1)*
LRA + CTG
(8 Patients)



→ *Group 3: (Test Group 2)*
LRA + ADM
(8 Patients)



Histological Analysis

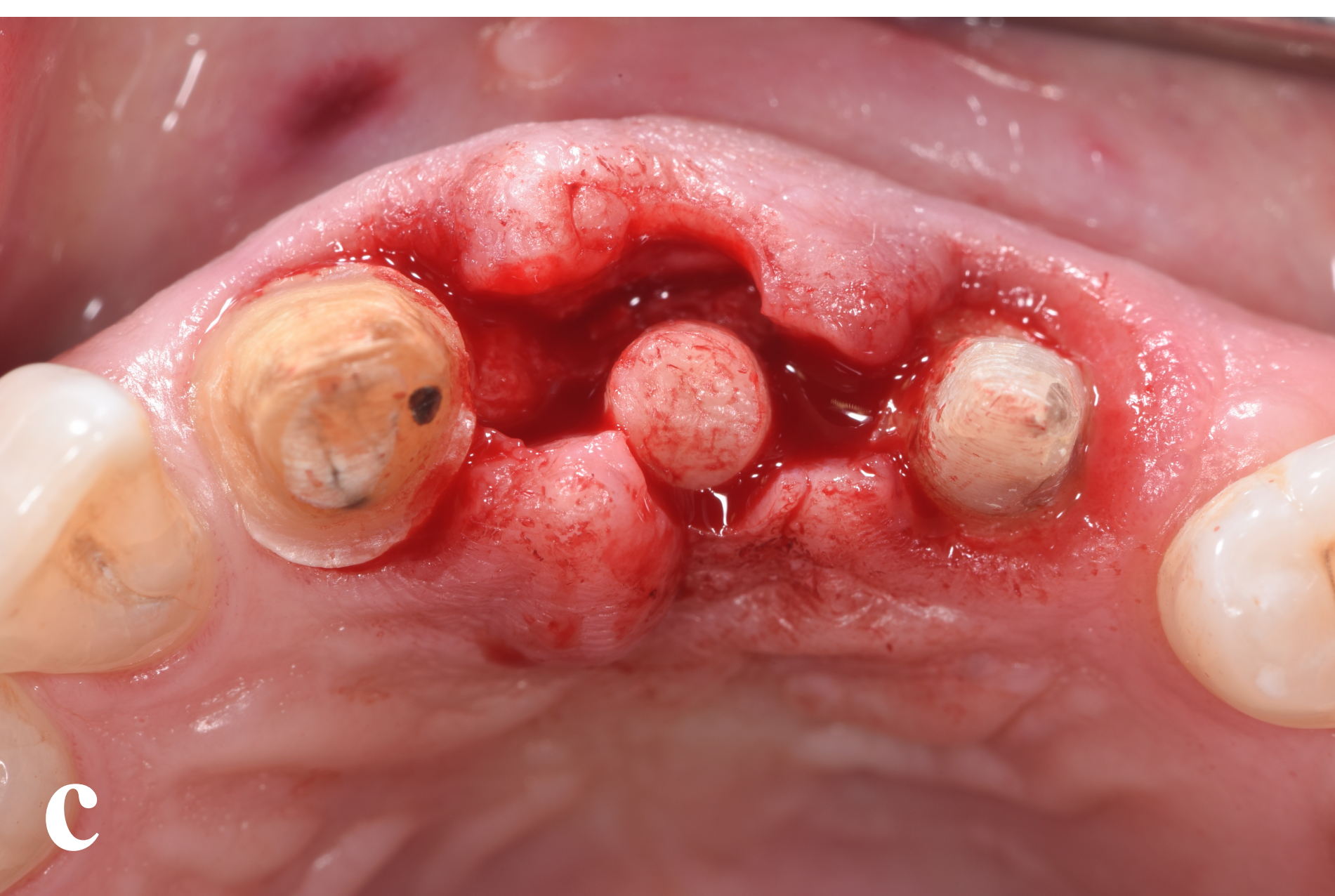
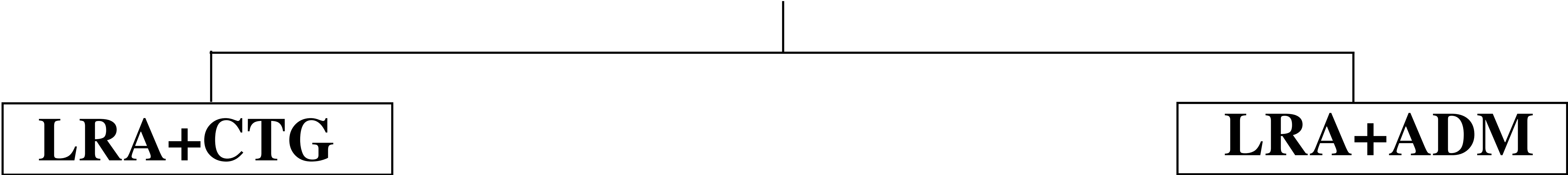
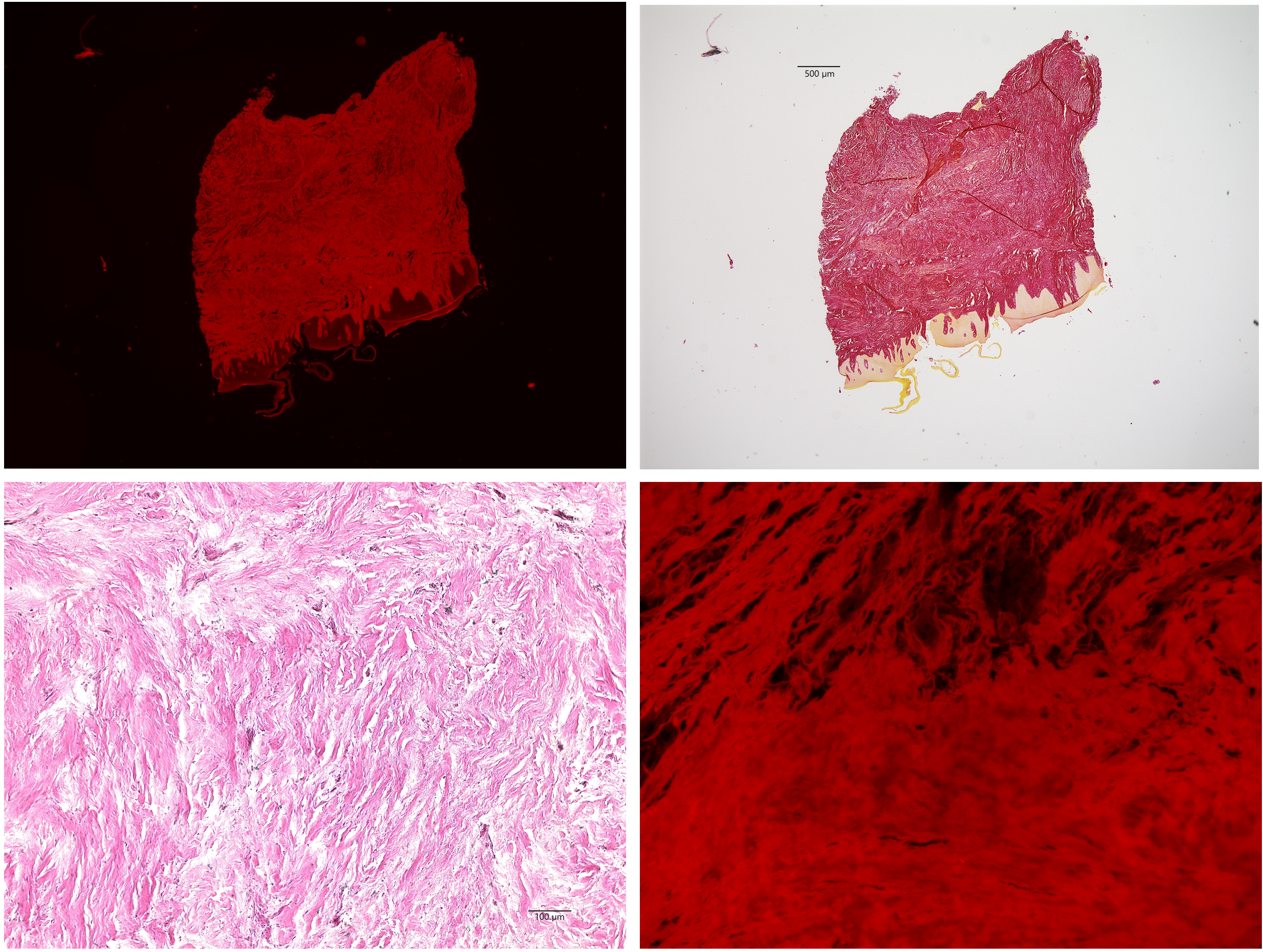
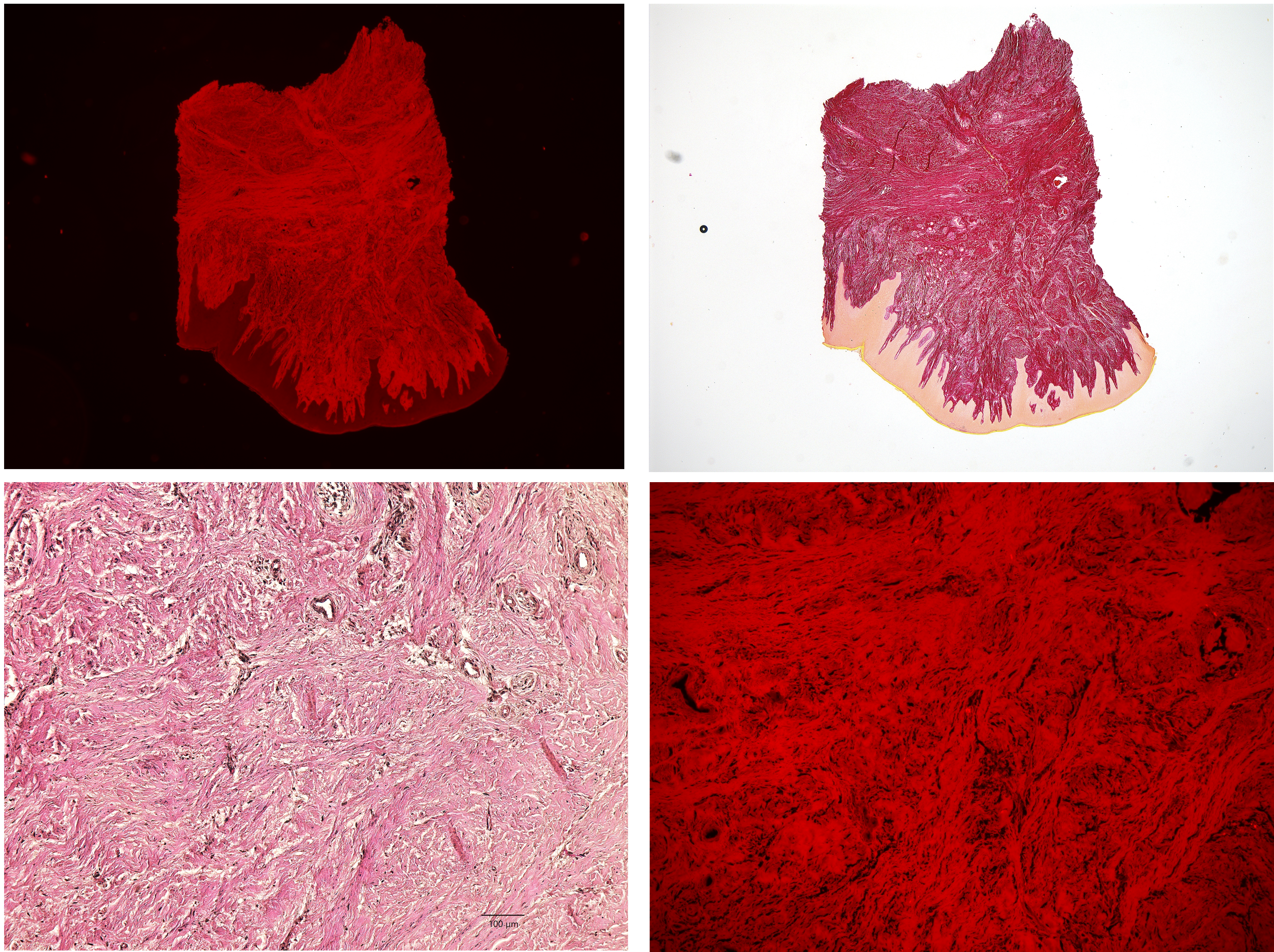


Fig. 2. Surgical steps: (a) Clinical appearance of augmented site; (b) Soft tissue sample obtained from planned implant site; (c) Full thickness reflection of buccal flap to facilitate intact harvesting of tissue sample

The sections were stained in hematoxylin and eosin (H&E) according to Mayer’s protocol and the most intact specimens were also stained with picosirius red (PSR) staining which helps in identifying collagen networks in tissues with high specificity and sensitivity



- For both the CTG and ADM groups, the intensity of the stain was similar throughout the specimen, correlating to the similar densities of collagen in both the host’s overlying connective tissue and the graft’s connective tissue.
- Under increased magnification, the collagen fiber orientations were apparent, and the boundaries of the graft could be visualized.

Digital and Radiographic measurements

The pre-operative and post-operative intra-oral scans were superimposed in Geomagic Control X software using the teeth only as reference points. Various measurements were made to compare the pre-operative and post-operative intra-oral scans. In addition, the pre-operative CBCT and intraoral scans were superimposed, and the post-operative CBCT and intra-oral scans were superimposed using BlueSkyPlan 4 software, and various measurements were obtained.

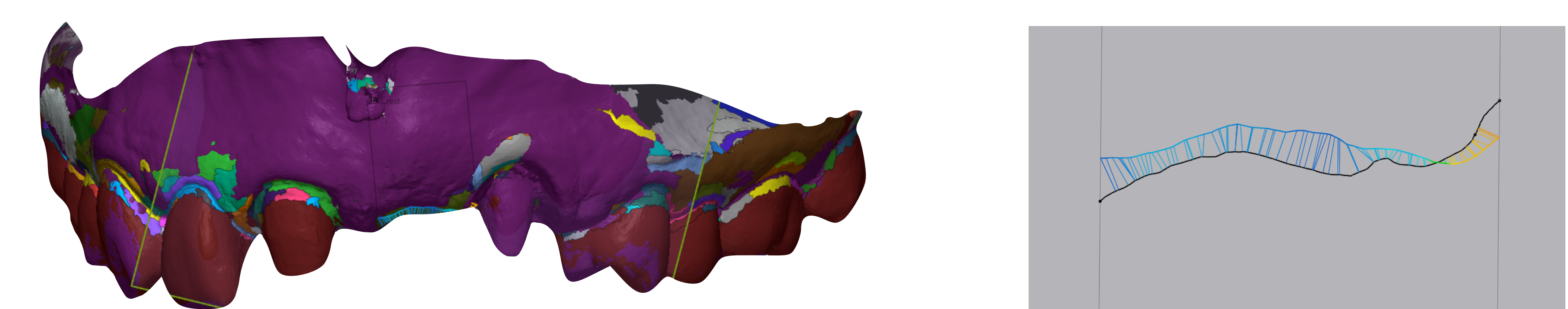


Figure 3. The plane “2D Crest.” (a) Orthogonal view of the plane. (b) 2D Comparison of pre-operative and post-operative intraoral scans within the plane.



Figure 4. The plane “2D 4mm.” (a) Orthogonal view of the plane. (b) 2D Comparison of pre-operative and post-operative intraoral scans within the plane.

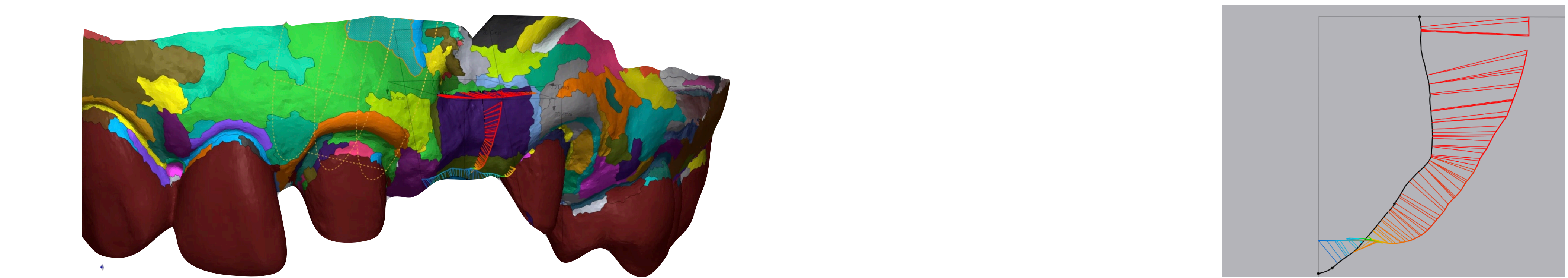


Figure 5. The plane “2D Longitudinal” or “2D Long.” (a) Orthogonal view of the plane. (b) 2D Comparison of pre-operative and post-operative intraoral scans within the plane.

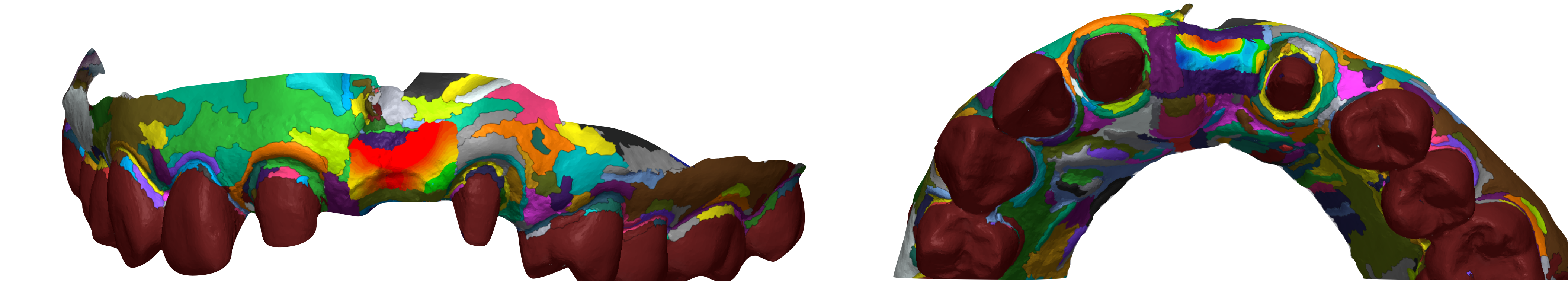


Figure 6. Graphical depictions of gain and loss at both regions of interest using the 3D Comparison tool on the region bounded by the buccal aspect of the crest and 4 mm apical from the buccal aspect of the crest.

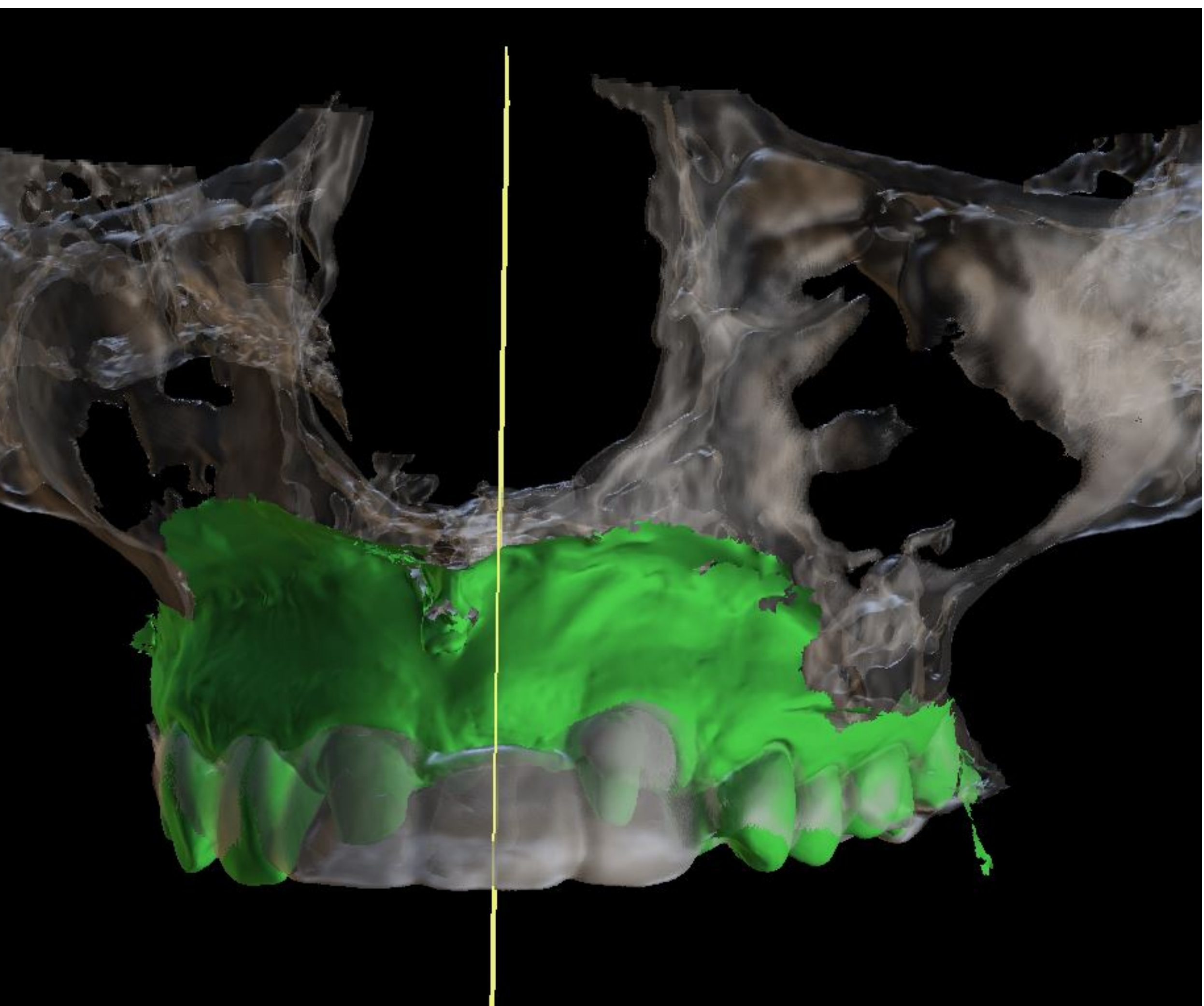
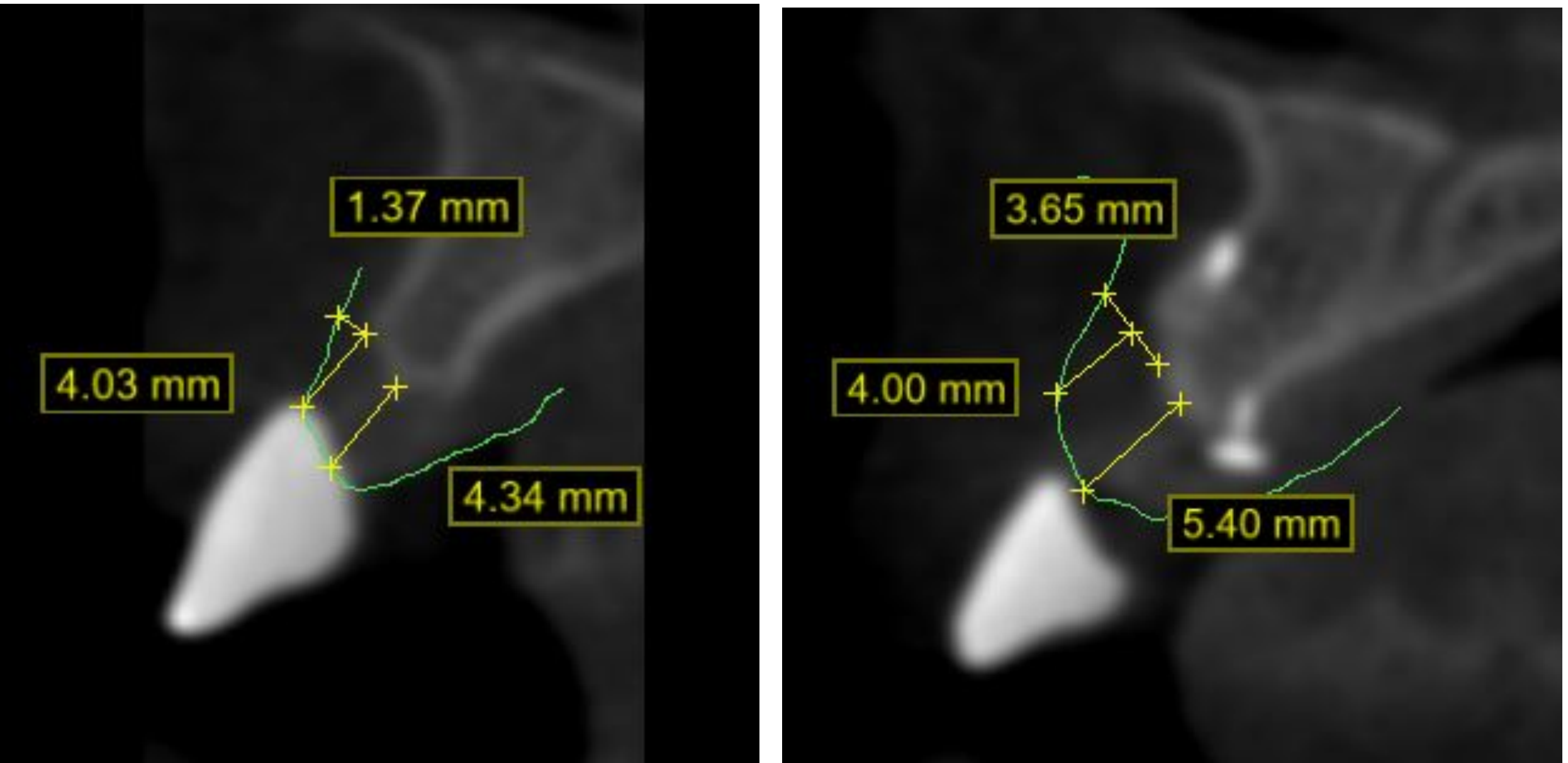


Figure 7. Superimpositions of a CBCT and an intraoral scan. (a) A simulated model showing an intraoral scan (green) superimposed on a CBCT. (b) Measurements taken at the crest and at 4 mm apical from the buccal aspect of the crest for pre-operative superimposition. (c) The same measurements taken for post-operative superimposition.

Variable	Group	Mean (mm)	Std Dev	p-value†
Change at Crest (2D Comparison)	CTG	0.0862	0.5572	0.8936
	ADM	-0.0613	0.4153	
	Control	0.2894	1.3303	
Change at 4 mm Apical (2D Comparison)	CTG	2.4985	1.8803	0.5098
	ADM	2.5956	0.8985	
	Control	1.8117	1.0072	
Longitudinal Change (2D Comparison)	CTG	1.4921	1.5160	0.9073
	ADM	1.3263	0.8762	
	Control	1.4963	0.8996	
Change at Buccal Aspect (3D Comparison)	CTG	1.0826	0.6510	0.6570
	ADM	0.8715	0.6471	
	Control	1.1620	0.6671	
Change at Crest (3D Comparison)	CTG	0.3797	0.7820	0.7109
	ADM	0.2629	0.4718	
	Control	0.6410	0.8899	
Change at Crest (CBCT-intraoral scan)	CTG	1.6400	1.0930	0.0133*
	ADM	0.6158	1.0511	
	Control	-0.1880	0.6272	
Change at 4mm Apical (CBCT-intraoral scan)	CTG	1.7830	0.9677	0.0778
	ADM	1.1725	0.8031	
	Control	0.7278	0.6449	

† Type 3 GEE Analysis

Table 1. Comparison between groups for various parameters measured digitally.

Summary of Outcomes

- Clinically, vertical soft thickness gain occurred as follows: 1.90mm in CTG, 1.60mm in ADM, and 0.33 mm in control (*P*=0.0168).
- While the differences were statistically significant between CTG and control (*P*=0.0008) and between ADM and control (*P*=0.004), no similar findings could be found between CTG and ADM.
- Digitally, vertical thickness gain was greatest with CTG (1.64mm) followed by ADM (0.62mm), while a slight loss was noted in the control group (-0.2mm) (*P*=0.0133) with statistical significance only between CTG and control (*P*<0.0001).
- The control group had a reduction in TT (-0.1880 ± 0.6272 mm) while both CTG and ADM had increase in TT (1.64mm and 0.61mm respectively).
- All groups resulted in KT decrease.

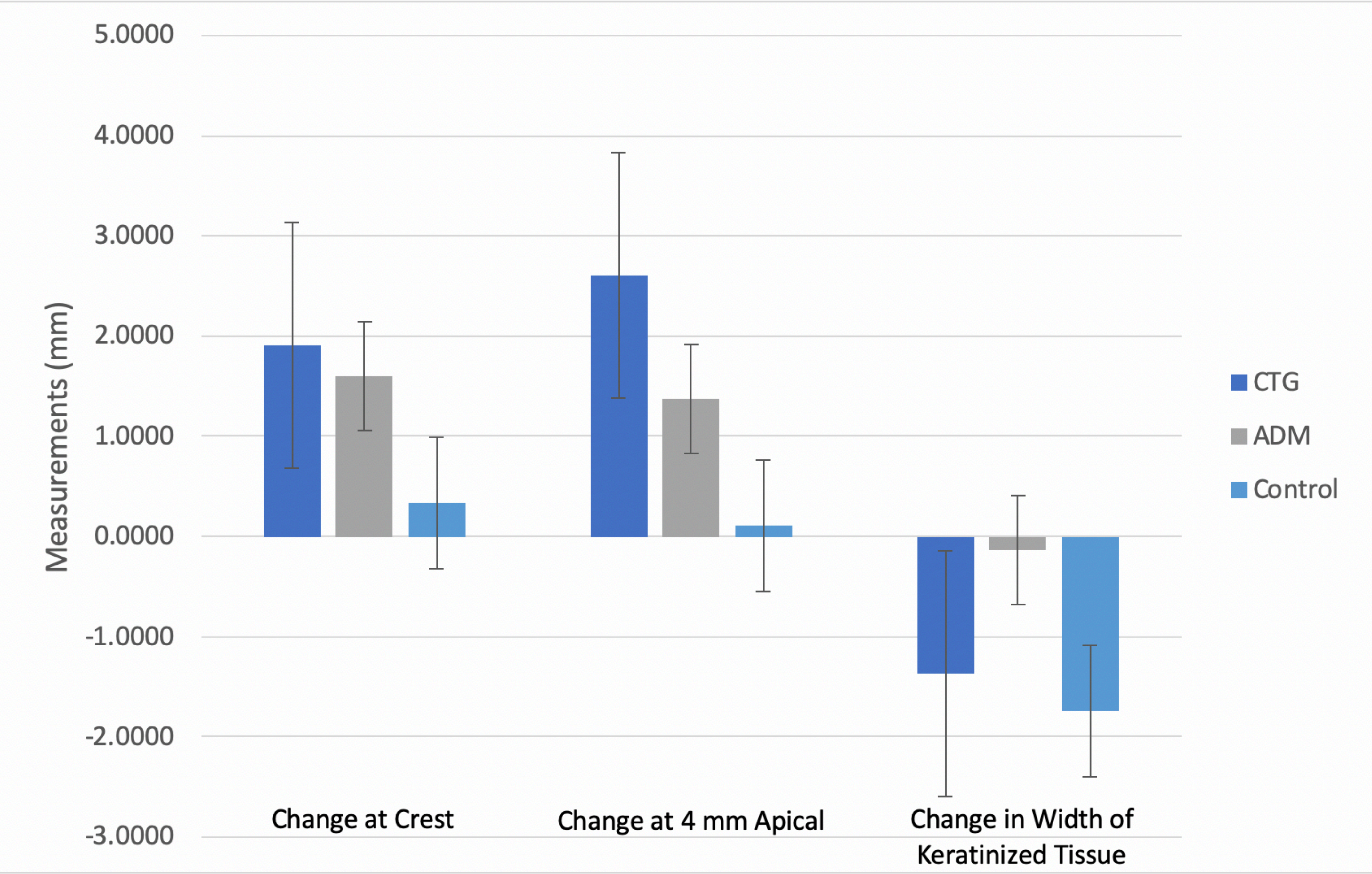


Figure 8. Graph of dimensional changes measured clinically for the CTG, ADM, and control groups.

Conclusions:

- The clinical and radiographic results showed that gains in alveolar ridge width and vertical soft tissue thickness can be both achieved in one procedure.
- A second procedure may still be required due to the potential need for vestibular deepening and increasing the width of keratinized tissue.
- ADM should be used at the time of GBR for vertical thickness, whereas autogenous tissue should be reserved for Keratinized Tissue increase.