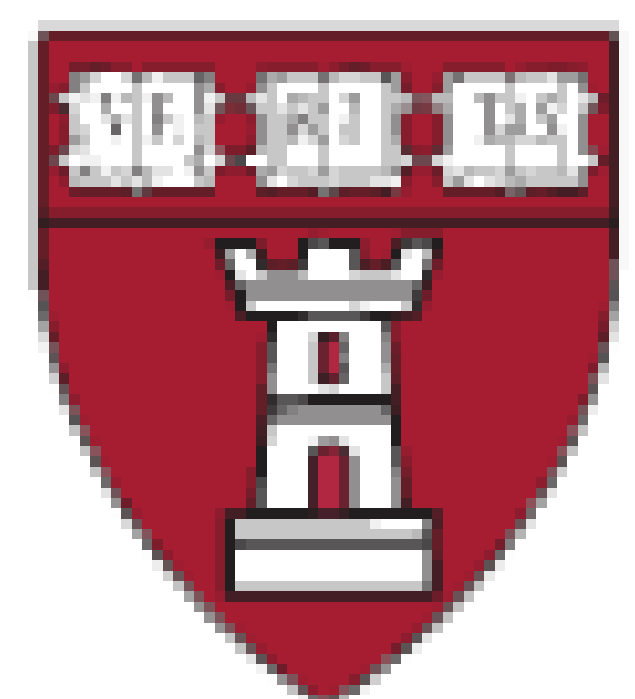


A Novel Technique for Analyzing Bone Gain: A Retrospective CBCT Study of Resorbable Versus Non-resorbable Membranes in Lateral Ridge Augmentation

Jennifer Wong BDS, Andrew Hsieh BS, Chia-Yu Chen DDS DMSc, Stacy Y. Cho DMD

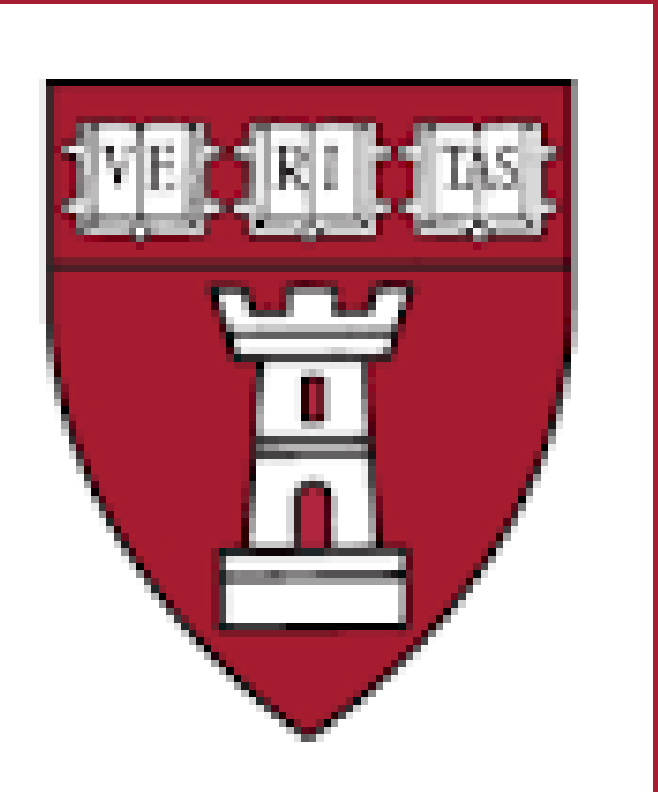
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Background

- Lateral ridge augmentation is used to increase the width of bone before dental implant placement.
- There are many different surgical modalities available for lateral ridge augmentation.
- To compare the effectiveness of lateral ridge augmentation between surgical modalities, we present a novel method for analyzing CBCT scan data using a programming computer platform (MATLAB, MathWorks).

Aim

- To assess the effectiveness of resorbable membranes versus non-resorbable membranes for lateral ridge augmentation utilizing the software MATLAB.

Materials and Methods

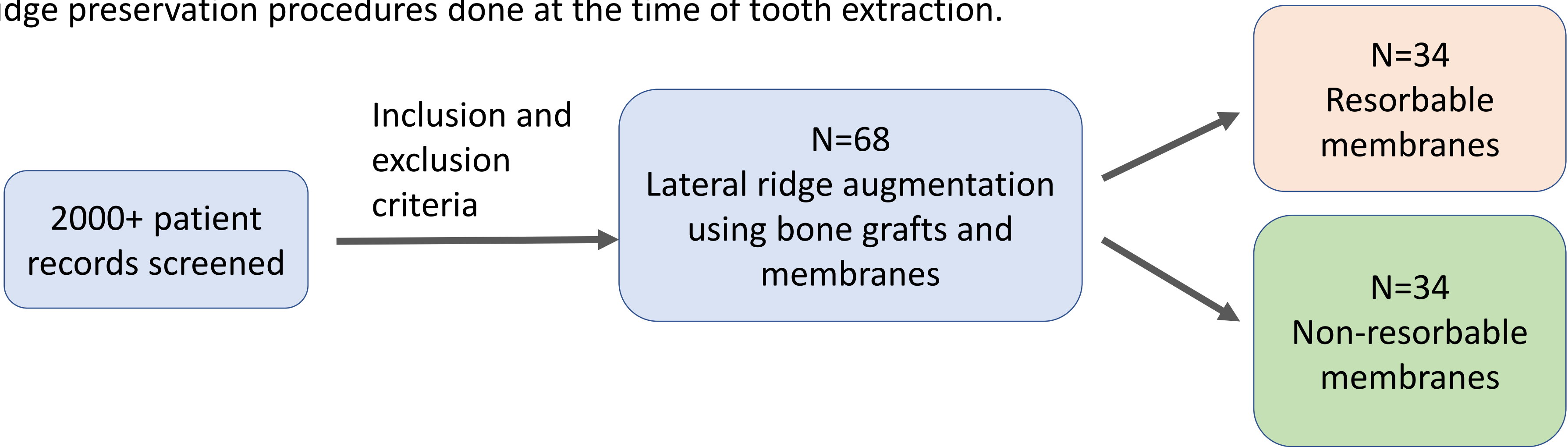
The study protocol was approved by the Institutional Review Boards at the Harvard Medical School (IRB19-1860). All electronic records from January 2009 to February 2023 at Harvard Dental Center were screened. Patients were included if they met the following inclusion and exclusion criteria:

Inclusion criteria:

1. Pre-operative CBCT scan prior to lateral ridge augmentation and implant placement
2. Patient had lateral ridge augmentation after pre-op CBCT scan
3. Post-operative CBCT scan taken no less than 4 months after surgery
4. Resorbable or non-resorbable membranes and bone grafting substitutes were used.

Exclusion criteria:

1. Patient did not have pre-operative and post-operative CBCT scans.
2. Concomitant dental implant placement with lateral ridge augmentation.
3. Post-operative CBCT scan taken less than 4 months after procedure.
4. If the CBCT scans had a limited field of view.
5. Ridge preservation procedures done at the time of tooth extraction.



Measurement of bone width on CBCT scans using MATLAB

MATLAB is a programming platform with robust image processing support including DICOM files. The tools used in this project were developed on top of MATLAB.

- 1) Either the maxilla or the mandible was selected on the pre-op and post-op CBCT scan (Figure 1)
- 2) MATLAB superimposed the pre-op and post-op scans (Figure 2).
- 3) The region of interest (ROI) corresponding to the future implant position was chosen (blue line) (Figure 3).
- 4) The edge of the bone was selected by using pixel threshold or edge selection. For the purposes of the study, the width of bone at 2mm, 5mm, and 8mm from the alveolar crest was calculated (Figure 4).
- 5) The ROI appeared in the same position on the post-op scan and step 4 was repeated.
- 6) The difference between the pre-op and post-op measurements was calculated.

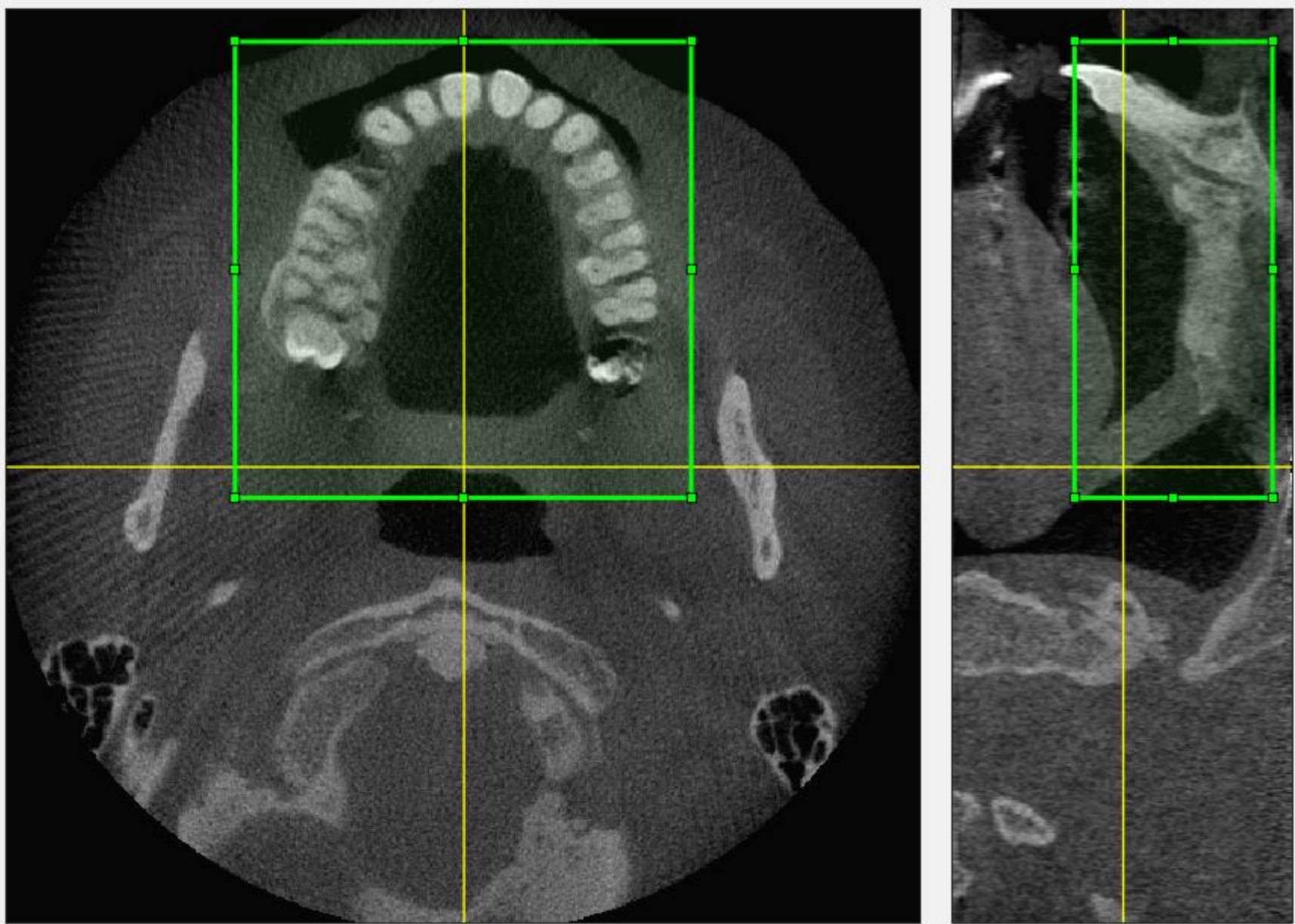


Figure 1- choose area of interest

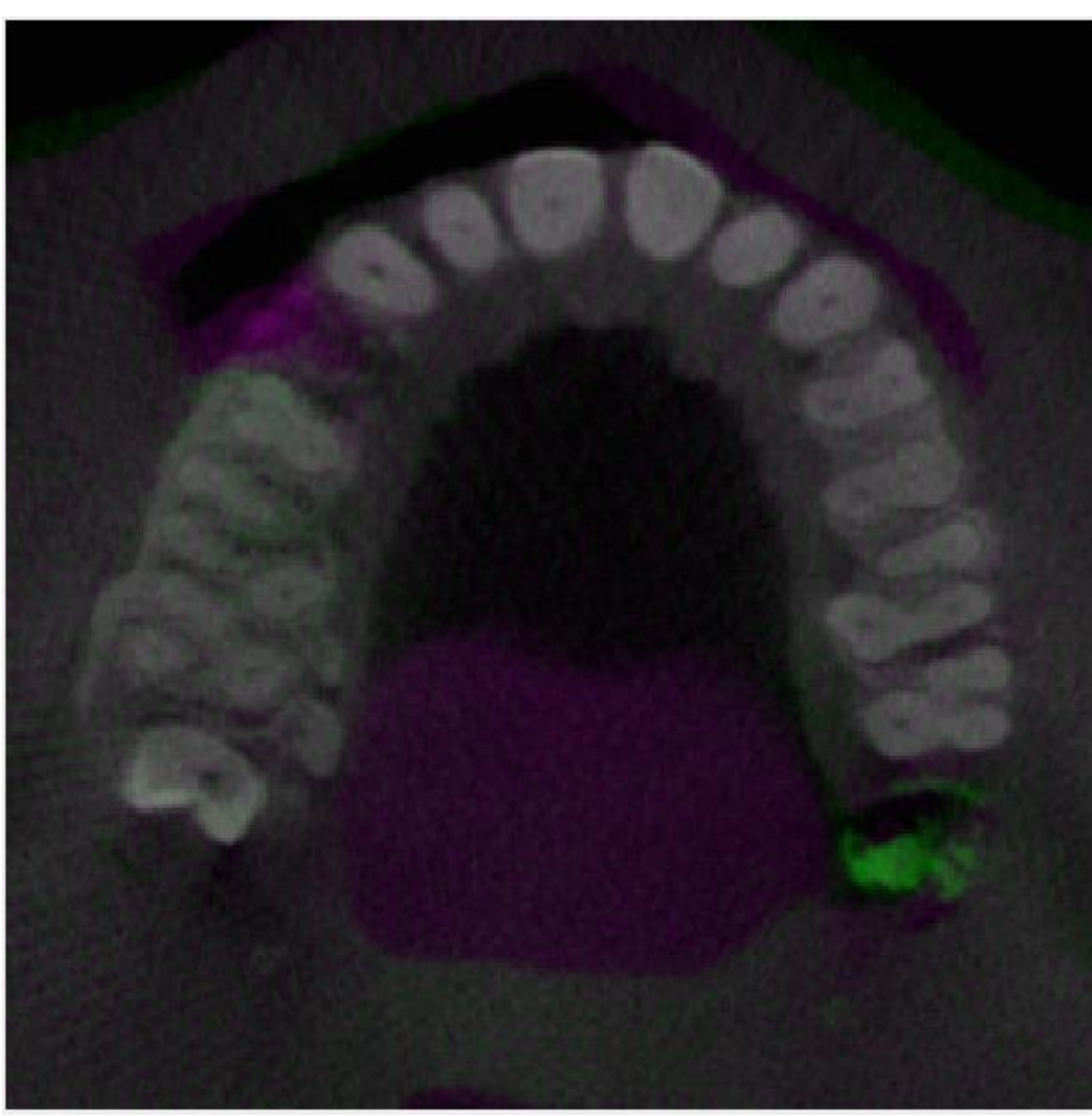


Figure 2- check superimposition



Figure 3- select the cross section to be measured using the blue line



Figure 4- measure the width of bone at 2mm, 5mm, and 8mm on pre-op and post-op scans

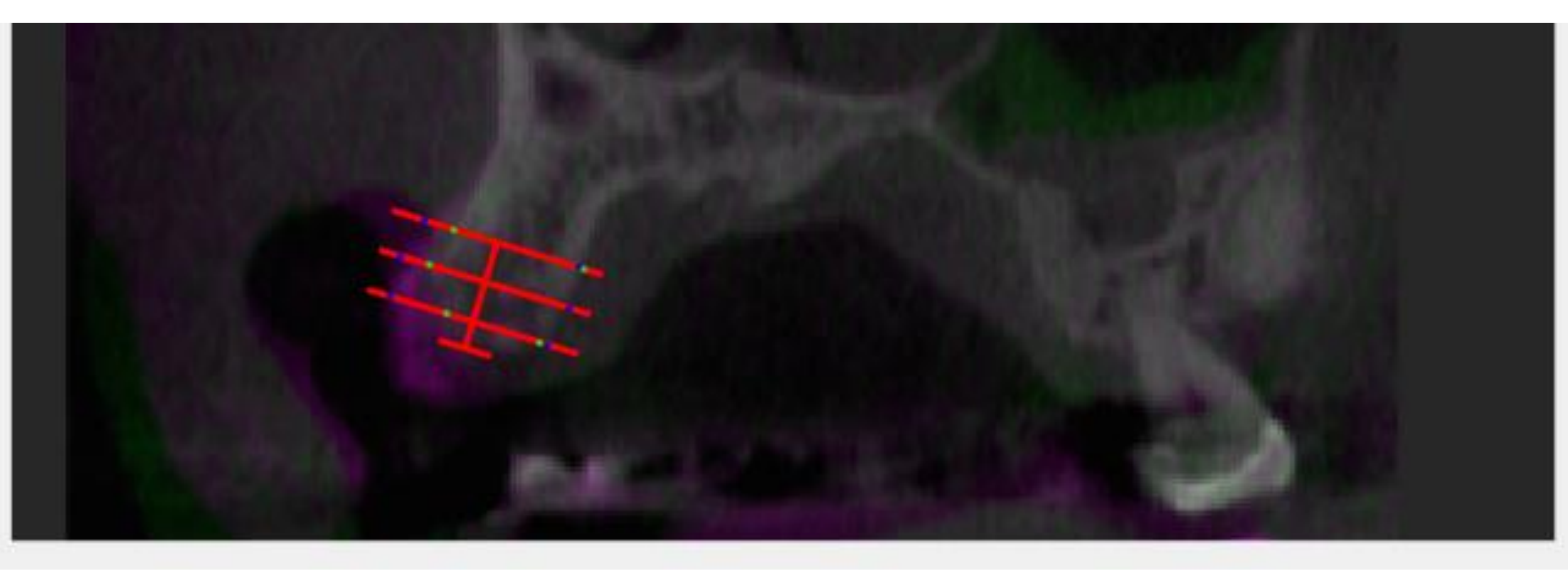
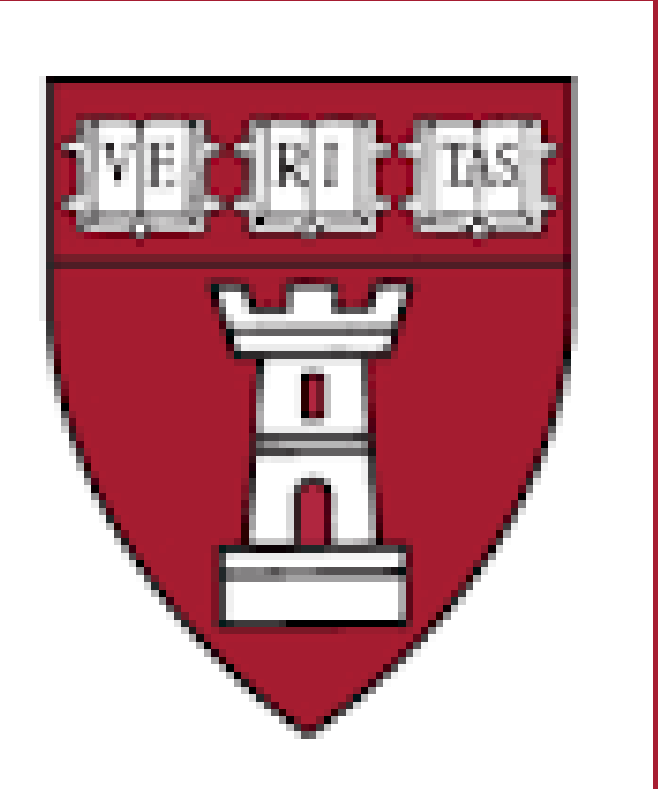


Figure 5- cross section with the two scans superimposed.



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Results

Of the 2,000+ patient records screened, 68 met the inclusion and exclusion criteria and were included in the study. There was no statistically significant difference at baseline between the resorbable and the non-resorbable membrane groups for any of the examined variables (age, 2mm, 5mm, and 8mm below the alveolar crest) (Table 1).

Variable	Resorbable		Non-Resorbable		
	N	Mean ± SE	N	Mean ± SE	p-value
Age	34	58.35 ± 16.59	34	59.53 ± 10.09	0.725*
CT width- 2 mm	34	5.13 ± 2.32	34	4.52 ± 1.89	0.311**
CT width- 5 mm	34	7.24 ± 3.10	34	6.92 ± 2.78	0.941**
CT width- 8 mm	34	8.53 ± 3.18	34	8.41 ± 3.01	0.867*

TABLE 1: BASELINE CLINICAL MEASUREMENTS: COMPARISON BETWEEN GROUPS

*t-test for unpaired observations **Man-Whitney test for nonparametric data Bold values represent significant (P<0.05) values

Variable	Baseline		Re-entry		
	N	Mean ± SE (mm)	N	Mean ± SE (mm)	p-value
CT width- 2 mm	34	5.13 ± 2.32	34	5.34 ± 3.20	0.728**
CT width- 5 mm	34	7.24 ± 3.10	34	8.78 ± 2.96	<0.0001**
CT width- 8 mm	34	8.53 ± 3.18	34	10.25 ± 2.81	<0.0001*

TABLE 2: CHANGES IN CLINICAL MEASUREMENTS: BASELINE TO REENTRY (RESORBABLE)

*t-test for paired observations **Wilcoxon signed-rank test for nonparametric data Bold values represent significant (P<0.05) values

Variable	Baseline		Re-entry		
	N	Mean ± SE (mm)	N	Mean ±SE (mm)	p-value
CT width- 2 mm	34	4.52 ± 1.89	34	5.82 ± 2.76	0.004*
CT width- 5 mm	34	6.92 ± 2.78	34	8.47 ± 2.32	<0.0001*
CT width- 8 mm	34	8.41 ± 3.01	34	9.61 ± 2.08	<0.0001*

TABLE 3: CHANGES IN CLINICAL MEASUREMENTS: BASELINE TO REENTRY (NON-RESORBABLE)

*t-test for paired observations **Wilcoxon signed-rank test for nonparametric data Bold values represent significant (P<0.05) values

Variable	Resorbable		Non-resorbable		
	N	Mean ± SE (mm)	N	Mean ± SE (mm)	p-value*
ΔCT width- 2 mm	34	0.21 ± 1.97	34	1.31 ± 2.43	0.045*
ΔCT width- 5 mm	34	1.54 ± 1.74	34	1.55 ± 1.93	1.000**
ΔCT width- 8 mm	34	1.72 ± 1.83	34	1.21 ± 1.58	0.254**

TABLE 4: : COMPARISON BETWEEN GROUPS: CLINICAL OUTCOMES

*t-test for unpaired observations **Man-Whitney test for nonparametric data Bold values represent significant (P<0.05) values

For **resorbable membranes**, there was no statistically significant gain in ridge width at 2mm below the alveolar crest from baseline to re-entry (p=0.728). However, the gain in ridge width at 5mm and 8mm below the alveolar crest (1.54 ± 1.74mm and 1.72 ± 1.83mm respectively) was statistically significant (Table 2).

For **non-resorbable membranes**, the gain in ridge width was statistically significant at all measurements below the alveolar crest. The mean bone gain was 1.31 ± 2.43mm at 2mm, 1.55 ± 1.93 mm at 5mm and 1.21 ± 1.58 mm at 8mm below the alveolar crest (Table 3).

There was a statistically significant difference in bone gain between the resorbable and non-resorbable membrane groups at 2mm below the alveolar crest (p=0.045). However, at 5mm and at 8mm (p=1.000 and p=0.254 respectively) there was no statistically significant difference between the two groups (Table 4).

Conclusion

The results demonstrated a significant increase in ridge width with the use of both resorbable and non-resorbable membranes. The use of non-resorbable membranes was shown to be more effective at 2mm from the alveolar crest.

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