



Comparison of Ultrasonography, CBCT, Transgingival Probing, and Probe Transparency with Histological Gingival Thickness: A Diagnostic Accuracy Study Revisiting Thick Versus Thin Gingiva

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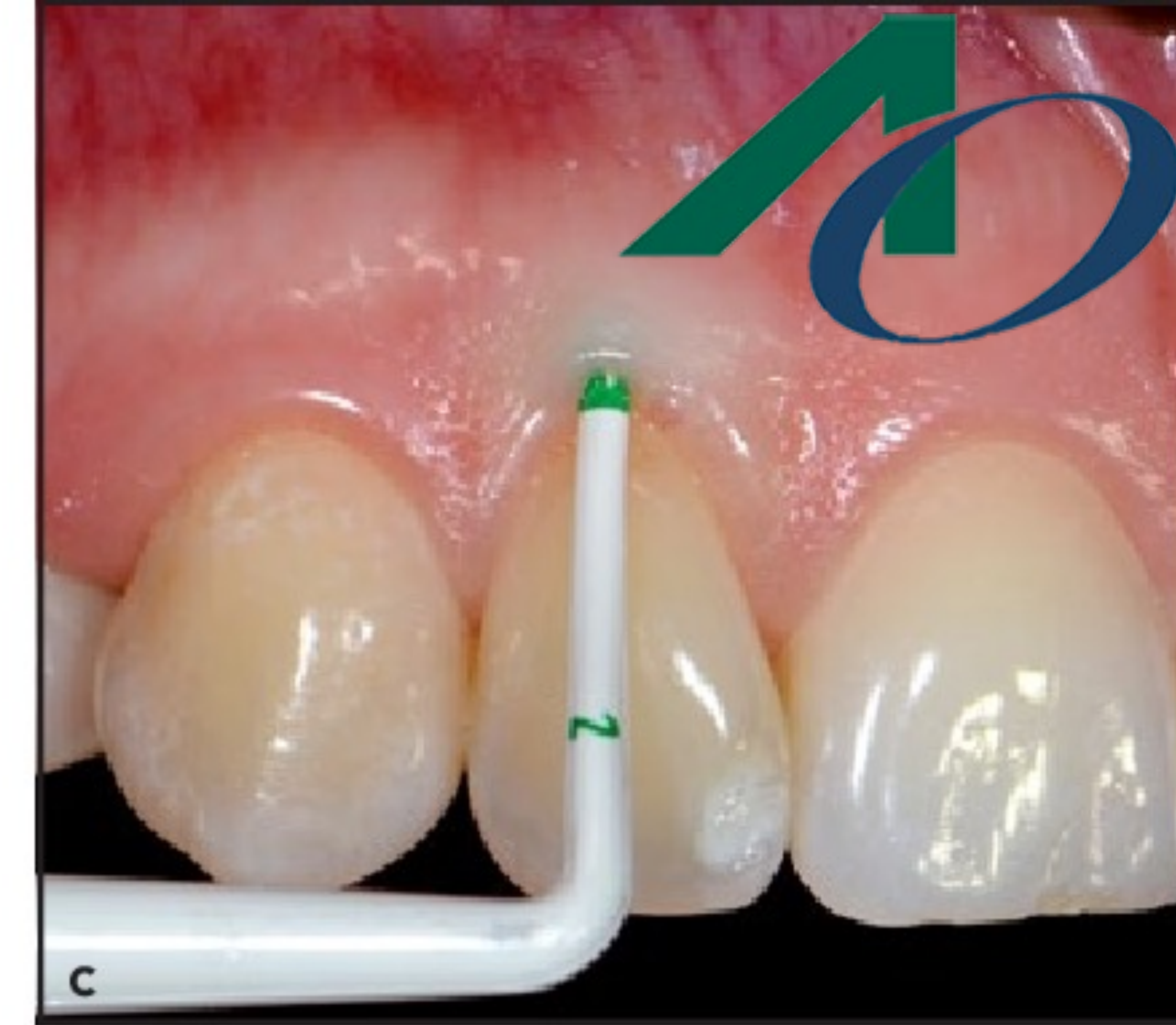


Introduction

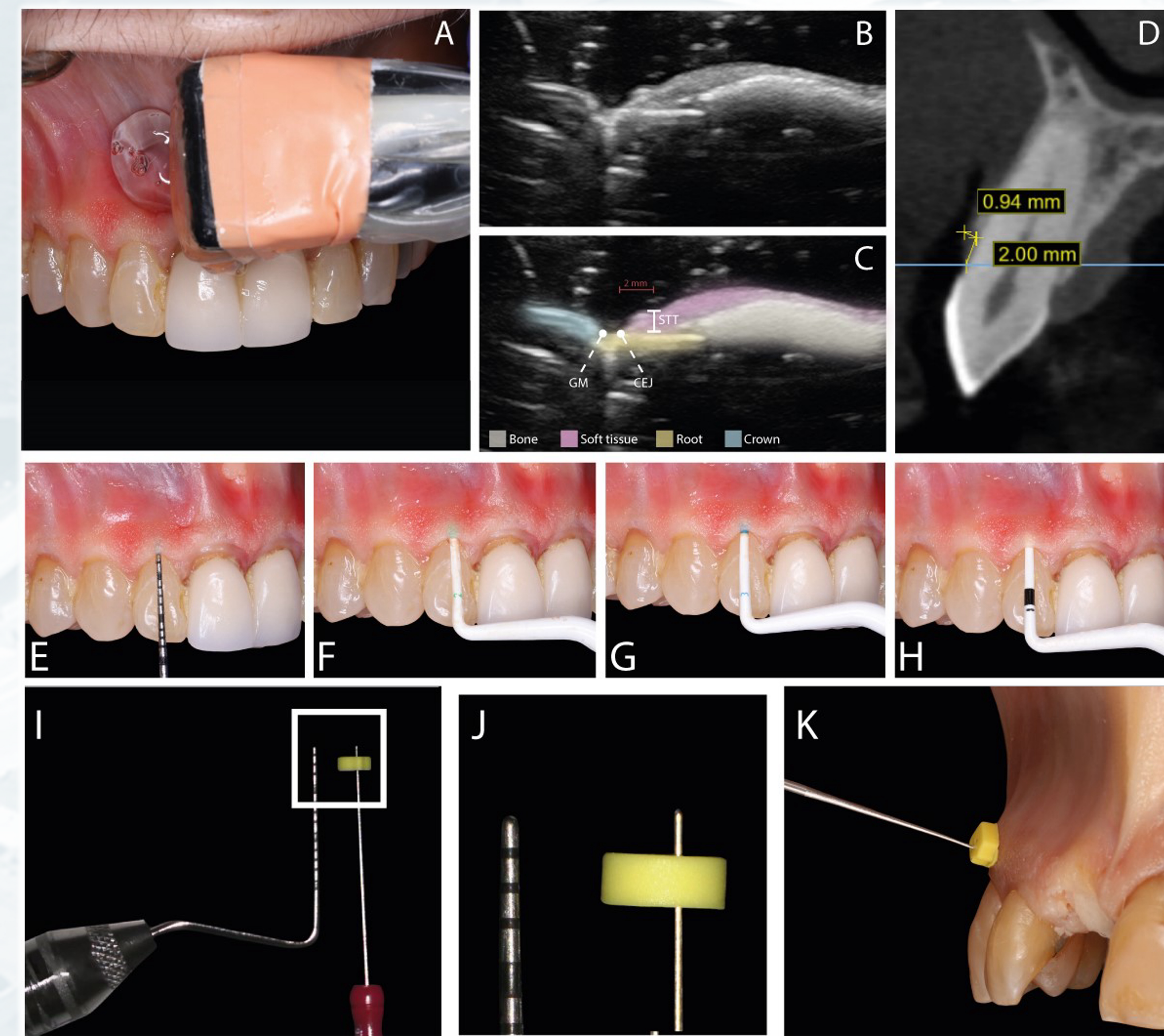
- ❖ Gingival thickness (GT) is a critical aspect of the periodontal phenotype and influences the success of periodontal, implant, orthodontic, and prosthetic treatments.
- ❖ The 2017 World Workshop classified GT as thin (<1 mm) or thick (≥ 1 mm), emphasizing the higher risk of gingival recession in thin gingiva and the importance of accurate assessment during treatments.

Objective

- ❖ Primary outcome: Accuracy of methods in GT measurement based on histology.
- ❖ Secondary outcomes:
 - ❖ Agreement between methods.
 - ❖ Accuracy of stainless-steel color-coded probes in categorizing gingiva as thick and thin according to 1 mm threshold.
 - ❖ Establish a new cutoff for thin and thick gingiva based on histology.

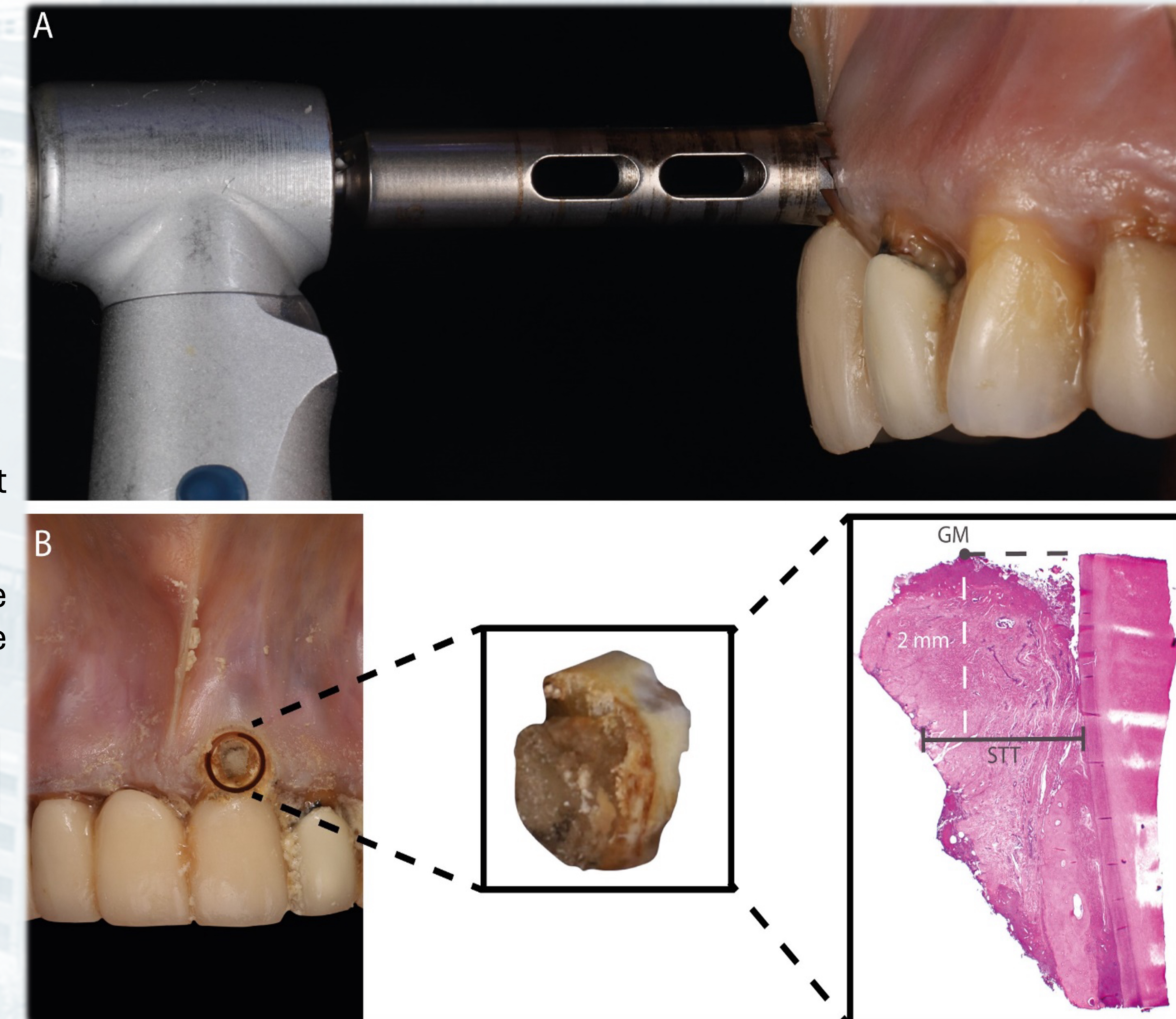


Methods and Materials



- ❖ Design: Diagnostic accuracy cadaveric study.
- ❖ Subjects: 16 fresh cadaver heads with intact gingivae.
- ❖ All measurements were performed on the midfacial gingiva and 2 mm apical to free gingival margin.

CBCT(D) → US (A-C) → PT (E-H) → TGP (I-K) → Histology

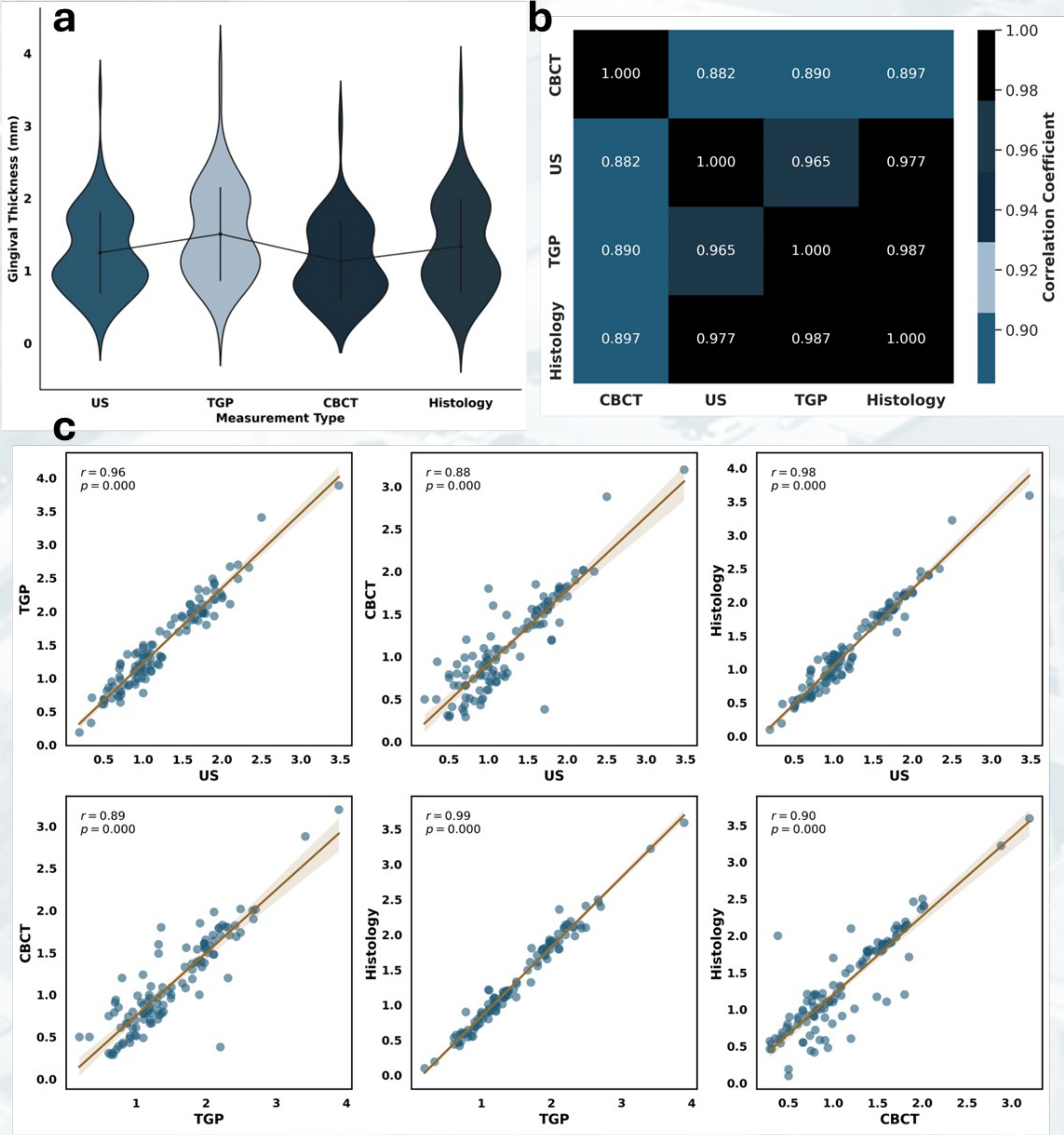


Histological sample and quantification of gingival thickness. (A) Obtaining histological samples with a trephine bur. (B) Obtaining site and macroscopic and microscopic view of the sample. GT was measured in a buccolingual direction, from the outer surface of the gingiva to the hard tissue (either the root surface or buccal bone), perpendicular to the tissue layers. Abbreviations: **GM**: gingival margin, **STT**: soft tissue thickness.

(A) Ultrasonographic assessment using a miniaturized probe. (B) Mid-facial ultrasound scan of one of the included sites. (C) Annotated midfacial scan with soft tissue demarcated in pink color. (D) Cone beam computed tomographic gingival thickness assessment. (E) Stainless steel probe transparency. (F-H) Color-coded probe visibility. (I-K) Transgingival probing method and assessment of measured thickness under microscope (16X).



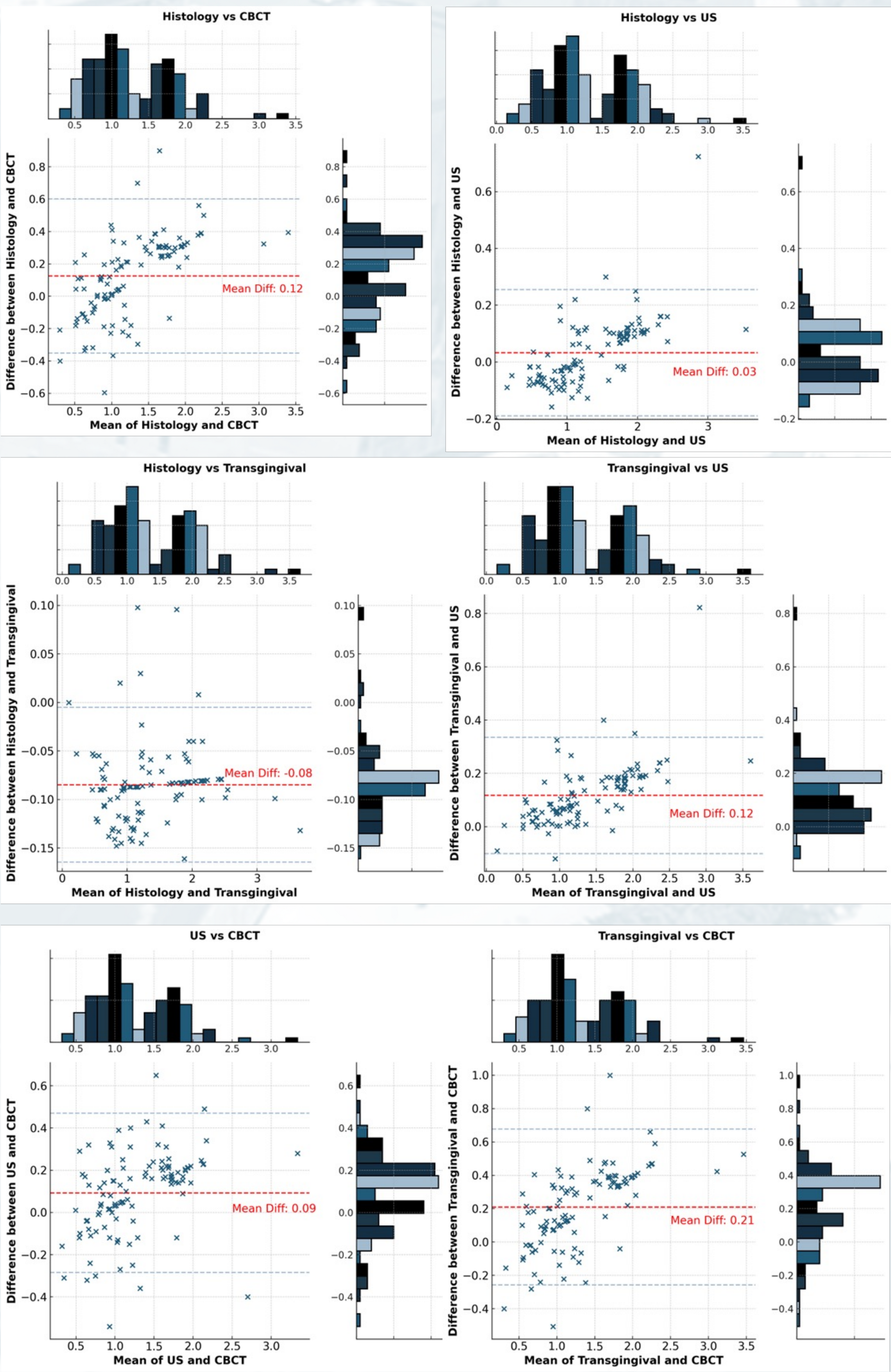
Results



(A) Violin plot illustrating the distribution of GT measurements. The width of each violin represents the probability density of the data at various thickness levels. The solid line within each violin indicates the median GT, while the black bars represent the interquartile range. **(B)** Heatmap of the correlation coefficients between GT. **(C)** Scatter plots showing the correlations between GT measurements with corresponding Pearson correlation coefficients (r) and p-values.

- ❖ 115 teeth were examined, yielding a mean GT of 1.34 ± 0.65 mm histologically.
- ❖ US and CBCT underestimated GT (mean differences of 0.032 mm and 0.125 mm, respectively)
- ❖ TGP overestimated GT (mean difference of -0.085 mm).

Variables	ICC	P-value
US vs TGP	0.87	0.01
US vs CBCT	0.86	<0.001
US vs Histology	0.95	<0.001
TGP vs CBCT	0.73	0.02
TGP vs Histology	0.95	0.008
CBCT vs Histology	0.83	<0.001

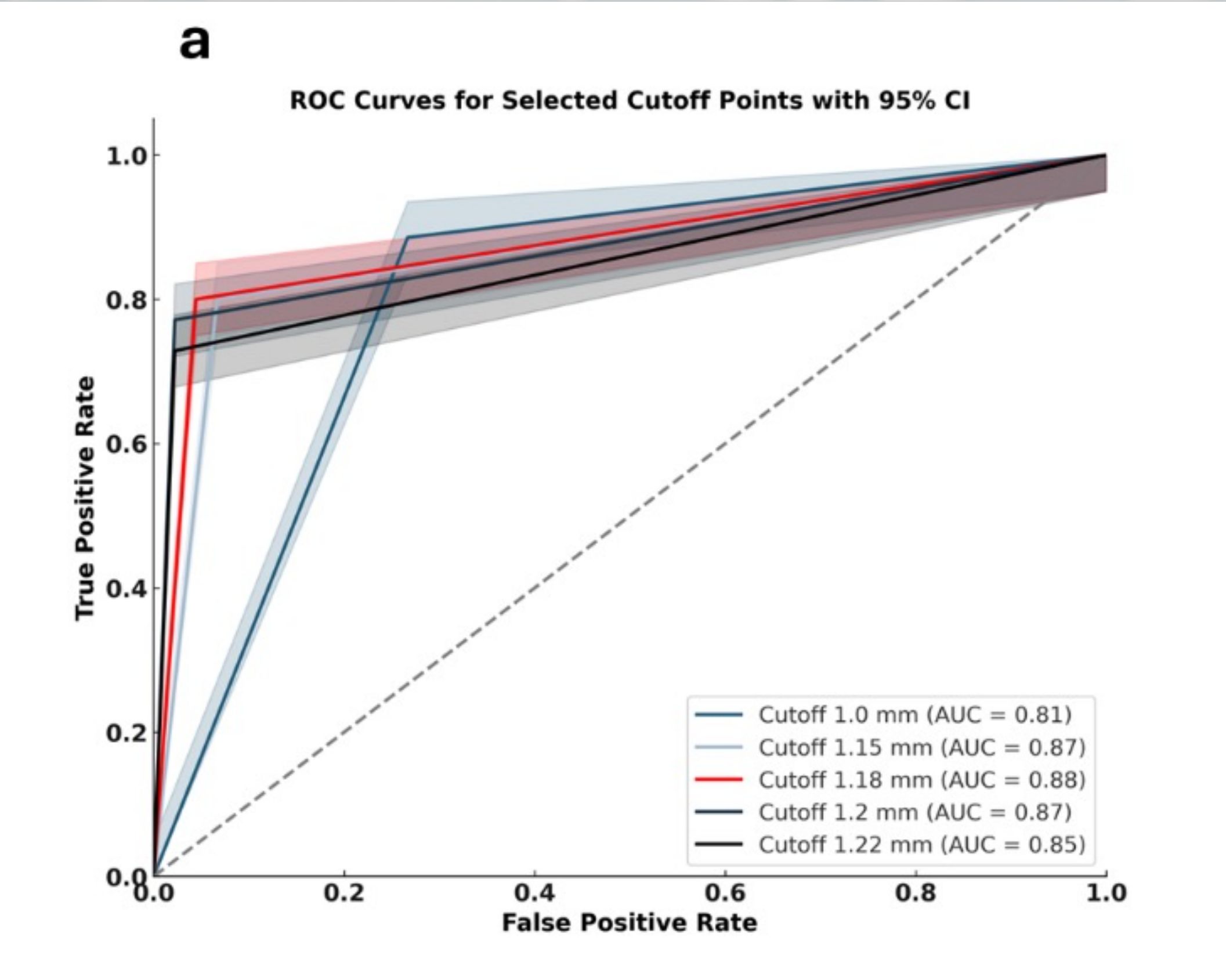
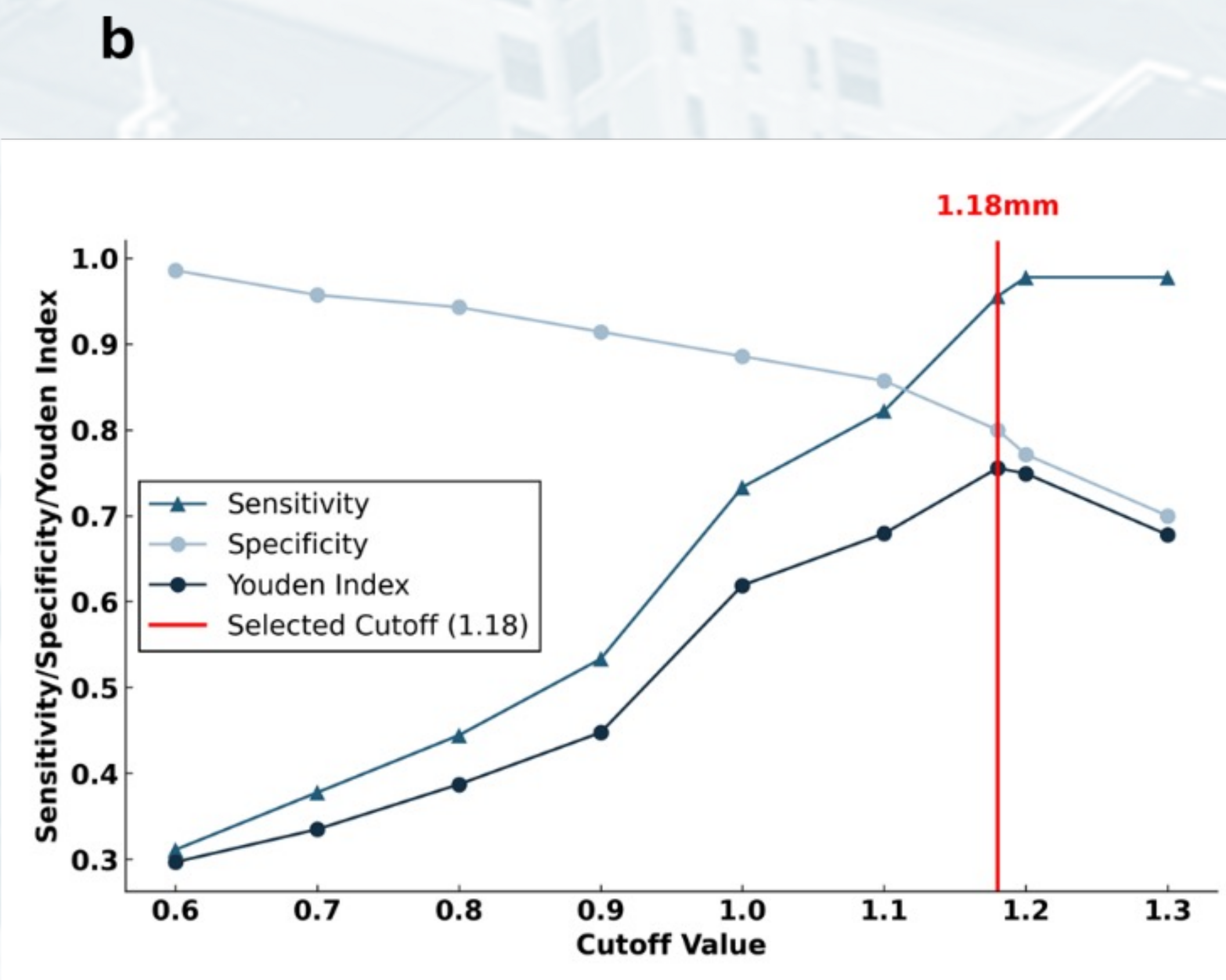


Bland-Altman plots with histograms showing the agreement between GT measurements across different methods. The red dashed line indicates the mean difference (Mean Diff), and the dotted lines represent the 95% limits of agreement. Histograms display the distribution of GT measurements for each method.



Results

Formulas for estimating histological thickness using alternative measurement methods	
Histological GT =	-0.06 + (1.12 × US GT)
Histological GT =	0.23 + (1.00 × CBCT GT)
Histological GT =	-0.13 + (0.97 × TGP GT)



The results of receiver operating characteristic (ROC) analysis on qualitative gingival thickness assessment methods (stainless steel probe and color-coded probes). To convert the four categories of color-coded probes to a binary outcome, thin and moderate categories were merged to thin and thick and very thick categories into thick gingiva.

Probe type	PPV	NPV	Sensitivity	Specificity	Accuracy	AUC
Stainless steel	88.6%	73.3%	83.8%	80.5%	82.6%	0.82
Color-coded	100%	74.5%	100%	81.1%	87.8%	0.90
Kappa statistics for agreement between stainless steel and color-coded probes				0.78 (p < 0.001) *Substantial agreement		

Conclusion

- ❖ Although histology remains as the GT reference standard, US, CBCT, and TGP demonstrated clinically acceptable accuracy. US exhibited the closest agreement with histology and is the most practical non-invasive method, while CBCT and TGP are reliable alternatives.