

Assessment and Validation of Preoperative Three-Dimensional Volumetric Analysis to Predict Bone Graft Success in Alveolar Cleft Reconstruction

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Background

- Cleft lip ± palate (CLP) is one of the most common congenital anomalies worldwide
- Iliac crest bone graft (ICBG) is the standard of care for **alveolar bone grafting**
 - Recombinant human bone morphogenetic protein with demineralized bone matrix (**rhBMP-2/DBM**) has been proposed as an alternative
- The success of ABG can be attributed to many factors, such as preoperative cleft size, cleft phenotype, and timing of repair
- Our study aims to identify the best predictor for **successful bony bridge formation** in ABG

Methods

- Retrospective review of patients with **unilateral CLP** who underwent ABG from 2016-2022
 - *Inclusion Criteria:* Pre- and postoperative cone beam CT
- **Cleft volume** was calculated using a *trapezoidal pyramid model*
- **Statistical analyses:** Receiver operating characteristic (ROC) analysis was used to determine the *strongest predictor* of successful bony bridge formation **among age at ABG, preoperative cleft width, and preoperative cleft volume**
- Area Under the Curve (AUC)>0.700 was the marker of adequate sensitivity and specificity.

Figure 1. Preoperative alveolar cleft volume calculation based on the trapezoidal pyramid model

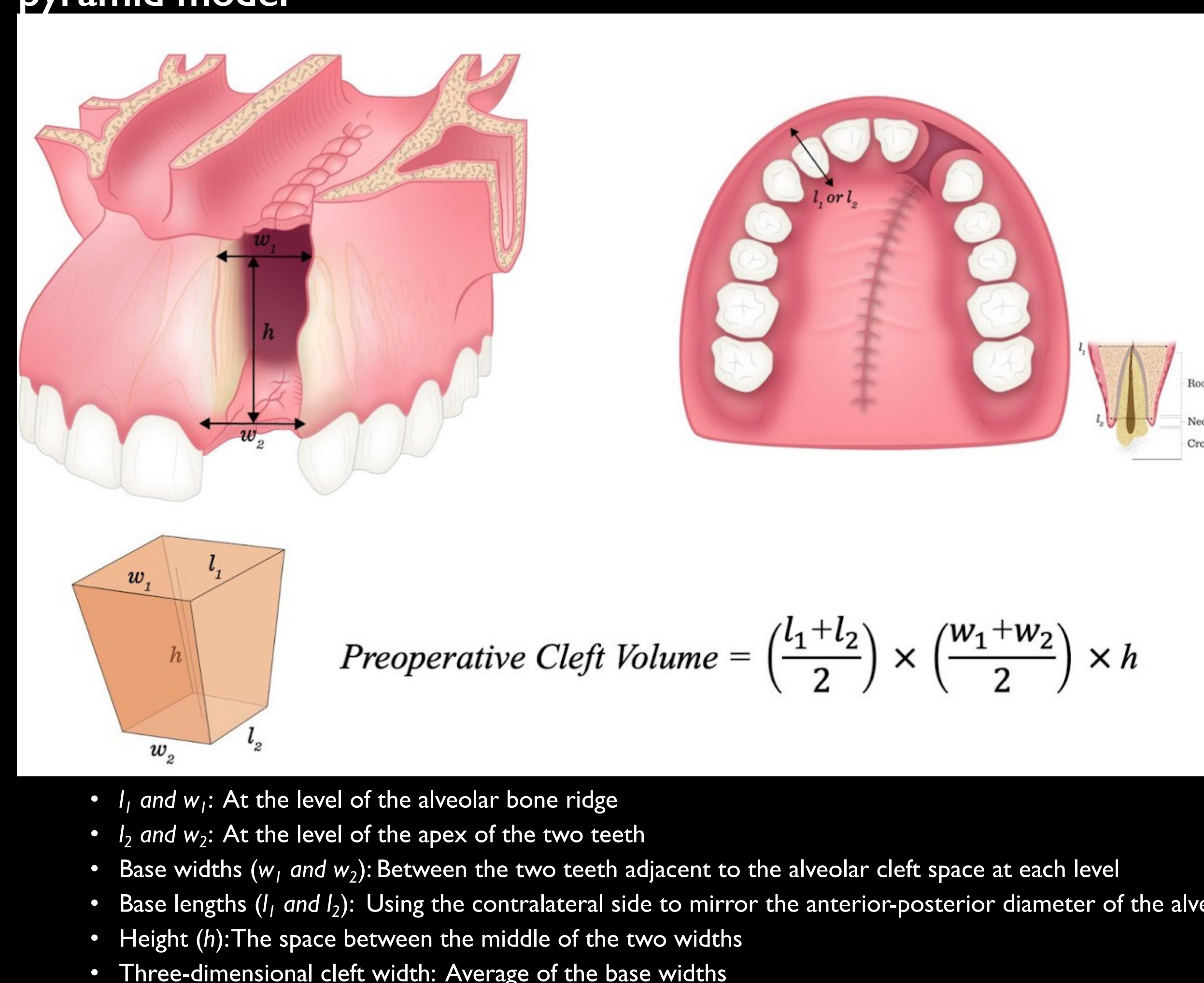


Figure 2. ROC curves for predicting success or failure of bone bridge formation

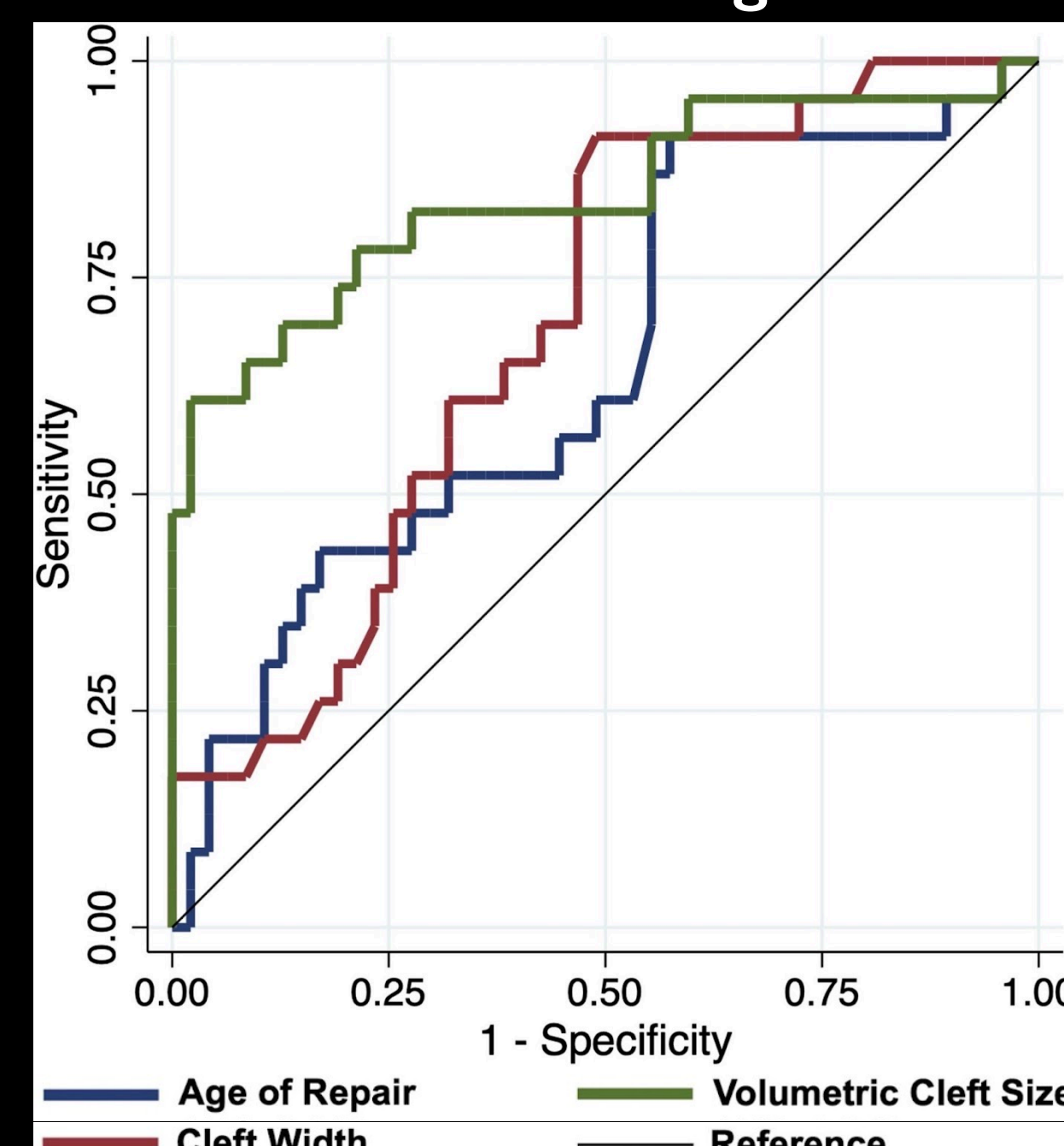


Table 1. Comparison of ROC curves between predictors of successful bone bridge formation

	AUC	95% CI	p-value
Cleft Volume	0.843	[0.730 – 0.955]	Reference
Cleft Width	0.695	[0.570 – 0.821]	p=0.013*
Age of Repair	0.649	[0.509 – 0.789]	p=0.033*

Results

- 248 patients were screened → 70 patients included:
 - **32 ICBG** and **38 rhBMP-2/DBM**
- Overall **clinical graft success rate: 94.3%**
 - Only 4 (5.7%) cases of revision surgeries
- Bony bridge formation based on CBCT: 67.1%
 - ICBG: 75.0% vs. rhBMP-2/DBM: 60.5%; p=0.199
- AUC of the ROC curve for **cleft volume was 0.843** (95% CI: 0.730–0.955), indicating **good performance of the model**
- Cleft volume had a **significantly larger AUC** compared to **cleft width** (0.843 vs. 0.695; p=0.013) and **age of repair** (0.843 vs. 0.649; p=0.033)
- Individually, cleft volume strongly predicted successful bony bridge formation for both graft cohorts:
 - **ICBG:** AUC 0.953 [95% CI: 0.885–1.000]
 - **rhBMP-2/DBM:** AUC 0.780 [95% CI: 0.608–0.951]
- Overall follow-up time: 26.9±15.9 months

Conclusion

- Our findings identified preoperative volumetric cleft size as the **strongest predictor for successful bony bridge formation** in ABG
 - Larger cleft volume → less likelihood of bony bridge formation
- Clinicians can **prioritize volumetric analysis via CBCT** to better predict graft failure among clefts of varying sizes