

# From Image to Chairside Decision-Making: Unsupervised Morphological Clustering of Carious Lesions in Intraoral Photographs and Its Alignment with Clinical Severity

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## BACKGROUND

- Dental caries affects 2+ billion people globally
- Current AI focuses on binary detection, not morphological variety
- Gap exists between image-based phenotypes and ICDAS clinical scales
- Intraoral cameras enable efficient caries screening
- Need to bridge pixel-level analysis with clinical decision support

## OBJECTIVE

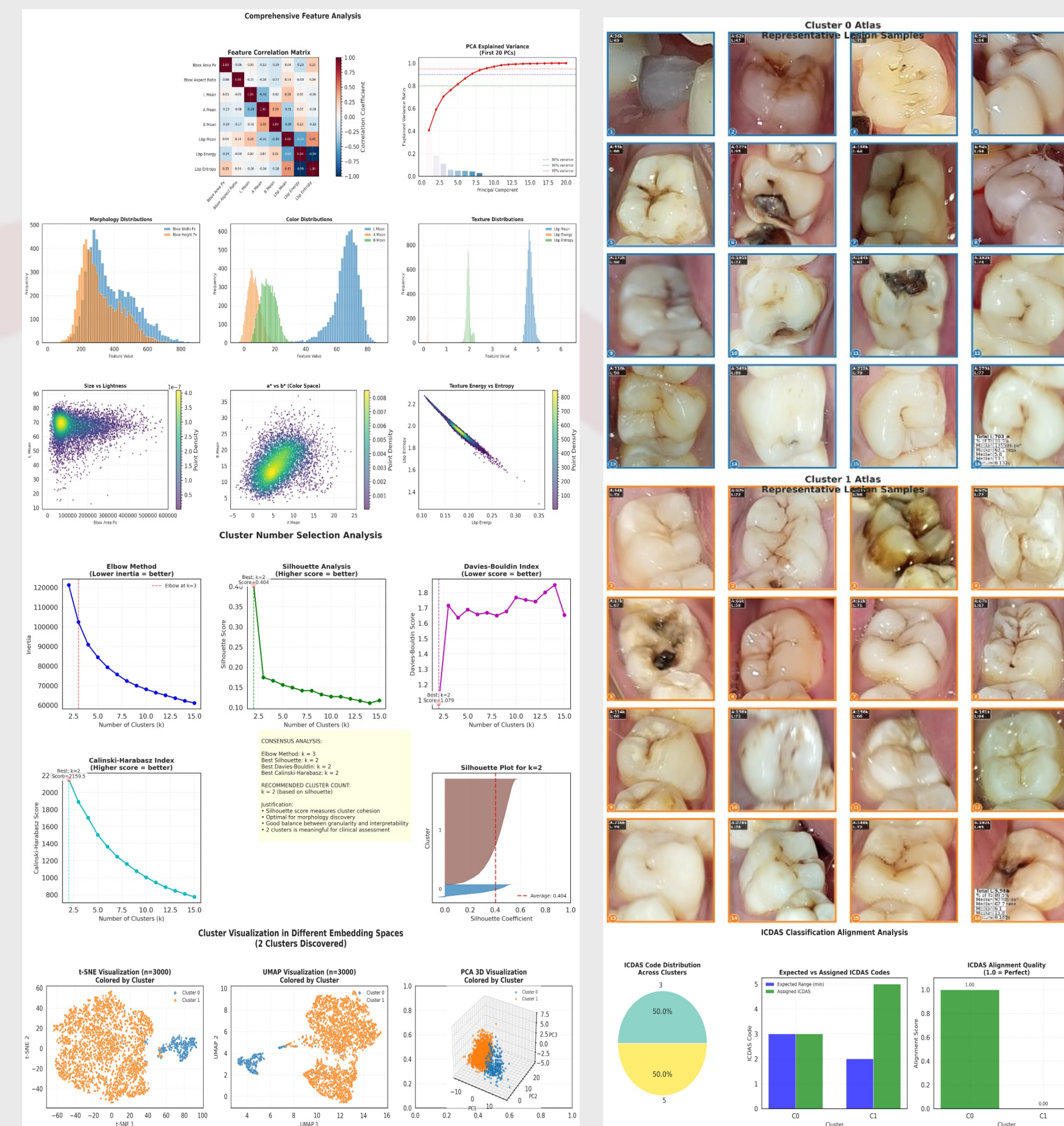
- Apply unsupervised clustering on lesion patches from open intraoral caries dataset
- Evaluate alignment with ICDAS codes and treatment recommendations
- Create interpretable feature space (morphology, LAB color, LBP texture)
- Develop foundation for data-driven lesion grading

## MATERIALS & METHODS

- **Dataset:** 6,313 images, 6,687 lesion patches from 2,150 caries-positive photos
- **24 Features:** Morphological (4) + LAB Color (6) + LBP Texture (14)
- **Pipeline:** Z-standardization → PCA (20 components) → K-means clustering
- **Evaluation:** Elbow, silhouette, Calinski-Harabasz, Davies-Bouldin indices
- **Clinical Mapping:** Two calibrated dentists reviewed cluster atlases

## RESULT

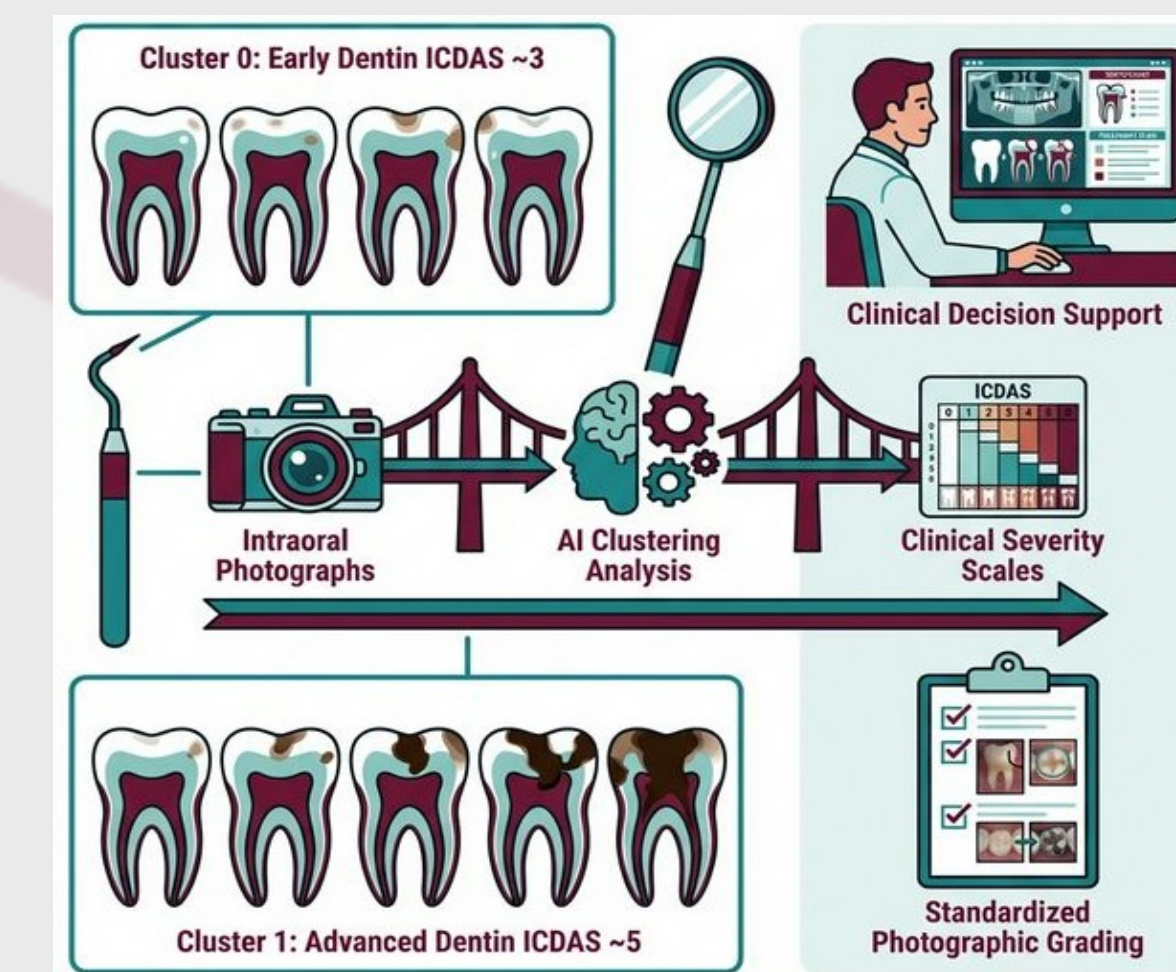
- **Feature importance:** Size (height/width) explains >99% of separability
- **Alignment:** 50% ICDAS, 50% treatment alignment



Cluster	Lesions	Area	Characteristics	ICDAS	Treatment
0	703 (10.5%)	~135,600 px <sup>2</sup>	Lower L*, higher entropy (chalky/brownish)	~3	Preventive + Monitor
1	5,984 (89.5%)	~92,700 px <sup>2</sup>	Higher L*, higher energy (cavitated/dentin)	~5	Restorative

## CONCLUSION

- Two dominant clusters identified using unsupervised learning on open data
- Clusters align with early vs. advanced dentin lesions
- Data-driven morphology clusters bridge images and clinical severity scales
- Potential for decision-support tools and standardized photographic grading



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