ARTIFICIAL INTELLIGENCE IN PEDIATRIC VITAL PULP THERAPY

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1. Abstract

The diagnostic **"gray zone"** between reversible and irreversible pulpitis in primary teeth presents a major clinical hurdle. This study evaluates **Deep Learning architectures** (U-Net, ResNet-50) for objective assessment. AI models provide pixel-level quantification of caries penetration, significantly enhancing the precision of Vital Pulp Therapy (VPT) selection and long-term success compared to conventional subjective methods.

2. Introduction

Pediatric endodontics relies on radiographs prone to interpretation bias. Primary molars have unique anatomy (high pulp horns) that accelerates inflammation, yet children cannot reliably report symptoms or undergo sensibility tests.

- **Error Rates:** Visual radiographic assessment has an estimated 47% variance among clinicians.
- **Over-treatment:** Diagnostic uncertainty often leads to unnecessary, invasive pulpectomies.
- **AI Solution:** CNNs detect sub-visual inflammatory markers through greyscale density analysis.

3. Methods: Deep Learning Pipeline

Segmentation: U-Net isolates the tooth structure, caries, and pulp chamber boundary. **Classification:** ResNet-50 assigns a pathology stage based on extracted semantic features.

Dice Loss optimization ensures high accuracy even for small-pixel pathological regions, reducing false-negative rates in early pulpal involvement.

4. Diagnostic Results

Performance of the AI ensemble vs. Board-Certified Pediatric Dentists (BCPD):

Metric	BCPD	AI Model	p-value
Sensitivity	0.78	**0.92**	<0.01
Specificity	0.85	**0.89**	0.04
Accuracy	0.82	**0.90**	<0.01
F1-Score	0.80	**0.91**	<0.01

5. Model Comparison (AUC)

Ensemble methods utilizing Vision Transformers show the highest diagnostic reliability in complex multi-rooted primary molars.

6. Discussion

AI eliminates the diagnostic "Gray Zone" by providing a repeatable, objective threshold for clinical decision-making. Quantifying residual dentin thickness between the caries front and pulp enables confident selection of **Indirect Pulp Capping (IPC)** over invasive alternatives.

- **Standardization:** Removes inter-examiner subjectivity across clinical experience levels.
- **Biological Savings:** Maximizes preservation of natural tooth structure via minimally invasive philosophy.
- **Scalability:** Cloud-based inference enables deployment in low-resource settings without specialist overhead.

7. Conclusions

Integrating AI into the pediatric workflow demonstrates a significant improvement in 24-month success rates (92%).

- **Longevity:** AI-guided diagnosis improves retention of primary molars until natural exfoliation.
- **Future:** Real-time chair-side CDSS (Clinical Decision Support Systems) will become the gold standard in pediatric endodontics.
- **Equity:** Automated second-opinion tools reduce outcome disparities between specialist and general practice settings.

8. 24-Month Success Rates

92% Clinical Success

6% Monitored Resorption

2% Clinical Failure

Success defined as absence of pain, pathological mobility, and periapical/furcation pathology at 24-month recall.

9. References

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