The Dental Detectives: Artificial Intelligence's (AI) Evolving Role In Caries Detection: Vinaya Sree Samala

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RESEARCH QUESTION

- Does AI improve dentist accuracy in caries detection on radiographs?

INTRODUCTION

- Dental Caries, caused by bacteria, sugars, and acids, damage teeth, affecting **60%-90%** of people globally. Causes pain, disrupts sleep, diet, and social well-being, and burdening public health.
- Accurate, early caries detection is vital, but traditional methods have limitations. Emerging techniques aim to overcome these, though challenges remain.
- Like a powerful human brain, AI analyzes dental X-rays to detect hidden caries that dentists might miss, improving early detection and preventive care.

METHODS

- **Databases Searched:** CINAHL, MEDLINE, and PubMed.
- **Search Terms:** "Artificial Intelligence" or "AI" AND "Dental caries" or "caries" AND "detect*" or "diagnosis*".
- **Selection:** 25 out of 30 peer-reviewed full-text articles from 2019 to 2024 were chosen.
- **Inclusion Criteria:** This review focused on AI for caries detection, permanent teeth X-rays, prioritizing studies with clear datasets.
- **Exclusion Criteria:** Irrelevant & non-caries oral disease studies excluded.
- **Themes Identified:**

- Assessing AI Model Precision for Detection
- Exploration of Various AI Models
- Image Processing Methods Analysis
- Cost-Benefit Analysis of AI Integration

RESULTS

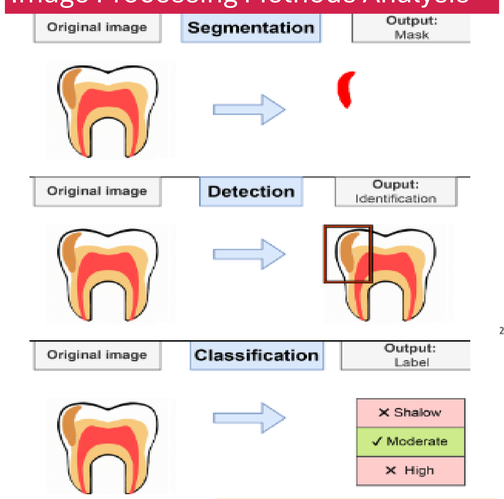
- Studies confirm a strong link between use of AI for enhanced accurate caries detection on X-rays.
- AI models outperform dentists, detecting caries with **71%-99.2%** accuracy on various X-ray types, with an overall accuracy of **80%-97.1%**
- AI models detect caries with high sensitivity ranging from **0.44 to 0.86**, specificity from **0.85 to 0.98**.
- Increasing the training data from 10% to 25% improved the performance of AI models on X-rays.
- Deep learning dominates AI for caries detection with 69% of studies.

Assessing AI Model Precision for Detection

Arm	Subgroup	ROC AUC	Accuracy	F1- score	Sensitivity	Specificity	PPV	NPV
Dentists without AI	Overall	**0.85** (0.83, 0.86)	0.93 (0.92, 0.95)	**0.76** (0.73, 0.78)	**0.72** (0.64, 0.79)	0.97 (0.96, 0.98)	0.80 (0.72, 0.86)	0.95 (0.94, 0.97)
	Enamel caries	**0.81** (0.78, 0.83)	0.94 (0.92, 0.95)	**0.64** (0.60, 0.68)	**0.64** (0.53, 0.74)	0.97 (0.96, 0.98)	0.67 (0.56, 0.77)	0.97 (0.95, 0.98)
	Early dentin caries	0.89 (0.86, 0.91)	0.96 (0.95, 0.97)	0.65 (0.60, 0.71)	0.81 (0.66, 0.91)	0.97 (0.96, 0.98)	0.55 (0.42, 0.68)	0.99 (0.98, 1.00)
	Advanced dentin caries	0.92 (0.89, 0.96)	0.97 (0.95, 0.98)	0.58 (0.46, 0.71)	0.87 (0.66, 0.97)	0.97 (0.96, 0.98)	0.42 (0.28, 0.57)	1.00 (0.99, 1.00)
Dentists with AI	Overall	**0.89** (0.87, 0.90)	0.94 (0.93, 0.96)	**0.81** (0.78, 0.84)	**0.81** (0.74, 0.87)	0.97 (0.95, 0.98)	0.82 (0.75, 0.88)	0.97 (0.95, 0.98)
	Enamel caries	**0.86** (0.84, 0.88)	0.95 (0.93, 0.96)	**0.73** (0.68, 0.77)	**0.75** (0.65, 0.83)	0.97 (0.95, 0.98)	0.71 (0.61, 0.80)	0.97 (0.96, 0.98)
	Early dentin caries	0.92 (0.90, 0.94)	0.96 (0.95, 0.97)	0.70 (0.63, 0.77)	0.86 (0.73, 0.95)	0.97 (0.95, 0.98)	0.57 (0.44, 0.69)	0.99 (0.99, 1.00)
	Advanced dentin caries	0.95 (0.92, 0.97)	0.97 (0.95, 0.98)	0.59 (0.51, 0.67)	0.91 (0.72, 0.99)	0.97 (0.95, 0.98)	0.42 (0.28, 0.57)	1.00 (0.99, 1.00)

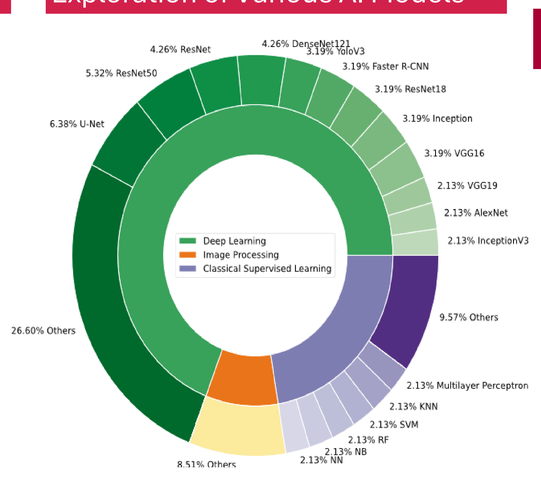
(Mertens et al., 2021)

Image Processing Methods Analysis



(Zanini et al., 2024)

Exploration of Various AI Models



(Zanini et al., 2024)

DISCUSSION

- Research shows AI excels at finding and diagnosing caries in X-rays, achieving high accuracy with potential to enhance treatment, and patient outcomes.
- Deep learning, especially Convolutional Neural Networks, significantly boosts caries diagnosis accuracy in X-ray images.
- Image processing techniques like contrast enhancement and thresholding improve. radiograph quality for caries detection.
- AI-powered caries detection is more cost-effective than dentists alone.
- AI in dentistry offers early detection of caries, potentially predicting future problems, paving the way for personalized preventive care.

CONCLUSION

- While promising, AI integration in dentistry is still evolving. Further research can solidify its clinical value and address knowledge gaps.
- By harnessing AI's potential, dentistry can move towards more precise and enhanced patient care.

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