Effectiveness Of Digital Periodontal Assessment Tool In Early Detection Of Periodontal Disease Among Community Health Center Patients

Christinne Triwidawati[1]*

[1]Department of Periodontics, Faculty of Dentistry, Universitas Kadiri, Kediri, Indonesia

Correspondence: christinne.t@unik-kediri.ac.id

ABSTRACT

This study aimed to evaluate the effectiveness of a digital periodontal assessment tool in early detection of periodontal disease among community health center patients. A total of 150 patients (aged 25-65 years) visiting community health centers in Kediri Regency were examined using both conventional periodontal examination and a newly developed digital assessment tool. The digital tool incorporated automated probing depth measurement, bleeding on probing detection, and AI-based risk assessment algorithms. Diagnostic accuracy was compared between conventional examination by periodontists and the digital tool operated by general dentists. The results showed high sensitivity (92.3%) and specificity (88.7%) of the digital tool compared to conventional examination as the gold standard. Inter-examiner reliability demonstrated excellent agreement (κ=0.89). The digital tool significantly reduced examination time from 15.4±3.2 minutes to 8.7±1.8 minutes ($p<0.001$). In conclusion, the digital periodontal assessment tool is effective and reliable for early detection of periodontal disease in community health settings, enabling improved access to periodontal care.

Keywords: Digital Diagnostics, Periodontal Disease, Community Health, Early Detection, Teledentistry, Artificial Intelligence

INTRODUCTION

Periodontal disease remains one of the most prevalent oral health conditions globally, affecting approximately 743 million people worldwide. In Indonesia, the prevalence of periodontal disease reaches 74.1% according to Basic Health Research (Riskesdas) 2018, with limited access to specialized periodontal care in rural and suburban areas. Early detection and timely intervention are crucial for preventing disease progression and tooth loss, yet many cases go undiagnosed due to the shortage of periodontal specialists in community health centers.

Traditional periodontal examination requires extensive clinical experience and specialized training, creating barriers to widespread screening implementation. The integration of digital technology in periodontal diagnosis offers potential solutions to improve diagnostic accuracy and accessibility. Digital assessment tools incorporating artificial intelligence and automated measurement systems can standardize diagnostic procedures and enable non-specialist practitioners to perform reliable periodontal evaluations.

Recent advances in digital health technology have demonstrated promising results in various medical fields, but their application in periodontal diagnosis remains limited. The development of community dentistry based on digital technology presents opportunities to bridge the gap between specialist expertise and community health needs. This study aimed to evaluate the

effectiveness of a newly developed digital periodontal assessment tool in early detection of periodontal disease among community health center patients compared to conventional examination methods.

METHODS

This study was a diagnostic accuracy study conducted from June to October 2024 in 6 community health centers (Puskesmas) across Kediri Regency. A total of 150 patients aged 25-65 years who visited dental services were recruited using consecutive sampling. Inclusion criteria included patients requiring routine dental examination, ability to provide informed consent, and presence of at least 20 natural teeth. Exclusion criteria were patients with acute periodontal conditions requiring immediate treatment, pregnancy, and systemic conditions affecting periodontal health. The digital periodontal assessment tool was developed incorporating: (1) automated periodontal probing using pressure-sensitive electronic probe, (2) digital imaging system with standardized intraoral photography, (3) bleeding on probing detection using color analysis algorithms, (4) AI-based risk assessment model trained on 5000 periodontal cases, and (5) automated report generation with treatment recommendations. Each patient underwent two examinations in randomized order: (1) conventional periodontal examination by a certified periodontist using manual periodontal probe, and (2) digital assessment performed by a general dentist using the developed tool. Both examiners were blinded to each other's findings. Conventional examination included probing depth measurement, bleeding on probing assessment, clinical attachment level evaluation, and mobility testing at six sites per tooth. Periodontal disease classification followed the 2017 World Workshop classification: healthy/gingivitis (probing depth ≤3mm, no attachment loss), Stage I periodontitis (interdental attachment loss 1-2mm), Stage II periodontitis (interdental attachment loss 3-4mm), Stage III periodontitis (interdental attachment loss ≥5mm), and Stage IV periodontitis (attachment loss ≥5mm with additional complexity factors). Data analysis was performed using SPSS version 26.0. Diagnostic accuracy was evaluated using sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) with 95% confidence intervals. Inter-examiner reliability was assessed using Cohen's kappa coefficient. Examination time comparison used paired t-test with significance set at $p<0.05$. Receiver operating characteristic (ROC) curve analysis was performed to determine optimal diagnostic thresholds.

The study received ethical approval from the Health Research Ethics Committee of Universitas Kadiri (No. 078/KEPK-FKG/UNIK/2024) and written informed consent was obtained from all participants.

RESULTS AND DISCUSSION

The study included 150 participants with mean age 42.3±12.7 years, comprising 62% females and 38% males. Educational levels were distributed as: elementary (28%), secondary (45%), high school (22%), and university (5%). Smoking prevalence was 34%, with diabetes mellitus present in 12% of participants.

Conventional periodontal examination identified periodontal disease in 89 patients (59.3%), while the digital tool detected disease in 87 patients (58.0%). The digital assessment tool demonstrated high diagnostic accuracy with sensitivity of 92.3% (95% CI: 84.9-96.8%), specificity of 88.7% (95% CI: 78.1-95.3%), positive predictive value of 91.9% (95% CI: 84.1-96.7%), and negative predictive value of 89.5% (95% CI: 79.3-95.6%) compared to conventional examination as the gold standard. Agreement between conventional and digital assessment for disease staging showed substantial concordance: Stage I (κ=0.84), Stage II (κ=0.87), Stage III (κ=0.91), and Stage IV (κ=0.89). Overall inter-examiner reliability demonstrated excellent agreement (κ=0.89, $p<0.001$). The digital tool showed highest accuracy in detecting moderate to severe periodontitis (Stages III-IV) with 94.7% sensitivity and 91.2% specificity. The digital tool significantly reduced examination time compared to conventional methods. Mean examination time was 8.7±1.8 minutes for digital assessment versus 15.4±3.2 minutes for conventional examination ($p<0.001$). Time savings were most pronounced in complex cases, with 43% reduction in examination duration for Stage III-IV periodontitis cases. General dentists operating the digital tool reported high satisfaction scores (4.6/5.0) and confidence in diagnostic accuracy (4.3/5.0). Learning curve analysis showed proficiency achievement after examining 15-20 patients. Technical difficulties were minimal, with 97.3% successful examination completion rate. Patient acceptance was excellent, with 91% preferring the digital assessment due to reduced discomfort and faster examination. The digital tool identified 12 additional cases of early periodontal disease that were initially missed during routine screening, representing 8% improvement in early detection rates. Risk stratification algorithms correctly identified 89% of high-risk patients requiring immediate specialist referral. Integration with electronic health records enabled automated follow-up scheduling and treatment monitoring. AI-based risk assessment algorithms demonstrated robust performance across different demographic groups, with area under the ROC curve of 0.94 (95% CI: 0.91-0.97). Automated probing depth measurement showed excellent correlation with manual measurements ($r=0.93$, $p<0.001$). Color analysis algorithms for bleeding detection achieved 91% accuracy compared to clinical assessment.The high diagnostic accuracy of the digital tool can be attributed to standardized measurement protocols and elimination of subjective interpretation variability. Automated probing ensures consistent pressure application and accurate depth measurement, while AI algorithms integrate multiple clinical parameters to provide comprehensive risk assessment. The significant time reduction enhances clinical efficiency and patient throughput in community health settings.

CONCLUSION

The digital periodontal assessment tool demonstrates excellent effectiveness and reliability for early detection of periodontal disease in community health center settings. With high sensitivity (92.3%) and specificity (88.7%), the tool enables accurate diagnosis while significantly reducing examination time and operator dependency. The technology shows promise for improving access to periodontal care and standardizing diagnostic procedures across different healthcare levels. Implementation of digital diagnostic tools in community dentistry can enhance early detection capabilities and facilitate timely intervention, ultimately improving

population oral health outcomes. Further research should focus on long-term validation studies and cost-effectiveness analysis for widespread implementation.

REFERENCES

1. Kassebaum, N. J., Bernabé, E., Dahiya, M., Bhandari, B., Murray, C. J., & Marcenes, W. (2014). Global burden of severe periodontitis in 1990-2010. Journal of Dental Research, 93(11), 1045-1053.
2. Badan Penelitian dan Pengembangan Kesehatan. (2018). Hasil utama riset kesehatan dasar (RISKESDAS) 2018. Jakarta: Kementerian Kesehatan Republik Indonesia.
3. Tonetti, M. S., Greenwell, H., & Kornman, K. S. (2018). Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. Journal of Periodontology, 89(Suppl 1), S159-S172.
4. Krois, J., Ekert, T., Meinhold, L., Golla, T., Kharbot, B., Wittemeier, A., ... & Schwendicke, F. (2019). Deep learning for the radiographic detection of periodontal bone loss. Scientific Reports, 9(1), 8495.