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ORIGINAL ARTICLE

Artificial Intelligence: An Aid in Diagnosis by Otoscopy

Keshav Gupta

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ABSTRACT

Recent advancements in artificial intelligence (AI) have significantly enhanced diagnostic capabilities across medical specialties. This paper explores the integration of AI in otoscopy, a fundamental procedure in otolaryngology for evaluating the ear canal and tympanic membrane. By leveraging machine learning algorithms and deep neural networks, AI systems can analyze otoscopic images with high accuracy, supporting clinicians in detecting conditions such as otitis media, tympanic membrane perforations, and cerumen impaction. This study compares AI-assisted otoscopy diagnosis in 100 patients and diagnosis on otoscopy alone in other 100 patients with the diagnosis established on examination under microscope (EUM) in all 200 patients. The findings suggest that AI-assisted otoscopy improves the diagnostic accuracy by 6%. AI assisted otoscopy holds substantial promise for improving diagnostic consistency, reducing disparities in care, and enabling early intervention in underserved populations.

KEYWORDS

• Artificial Intelligence • Machine Learning • Deep Learning • Otoscopy • Otitis Media • Tympanic Membrane • Digital Otoscope • Telemedicine • Diagnostic Accuracy • Pediatric Otolaryngology • Computer-Aided Diagnosis • CNN

INTRODUCTION

Otoscopy remains a cornerstone of clinical evaluation in otolaryngology, providing critical insights into the health of the external auditory canal and middle ear. However, diagnostic accuracy is highly dependent on clinician experience, lighting conditions, and subjective interpretation.[1] Most of the conventional otoscopes have resolution power of 1-10 micrometers. In one study, the accuracy of diagnosing AOM and AOM with effusion was 51% for pediatricians and 44% for general practitioners, as compared to 74% for otolaryngologists.[2] Misdiagnosis or delayed diagnosis of conditions such as acute otitis media (AOM) can lead to unnecessary antibiotic use or progression to chronic complications.[3]

AUTHOR'S AFFILIATION:

Associate Professor, Department of Otorhinolaryngology, United Institute of Medical Sciences, Prayagraj, Uttar Pradesh, India.

CORRESPONDING AUTHOR:

Keshav Gupta, Associate Professor, Department of Otorhinolaryngology, United Institute of Medical Sciences, Prayagraj, Uttar Pradesh, India.

E-mail: keshavpawangarg@gmail.com

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Examination under Microscope (EUM) is the gold standard of ENT Diagnosis. Here the patient is made to lie supine with his head turned to the opposite side to the ear examined. The Otologist examines the ear under a high resolution power (theoretically about 0.250 micrometers) operating microscope. EUM is more costly and time consuming as compared to conventional otoscopy.

Several AI architectures have been applied to otoscopic image analysis:

- **Convolutional Neural Networks (CNNs):** Most widely used for image classification and segmentation. Models such as ResNet, Inception, and EfficientNet have demonstrated high performance in distinguishing normal from abnormal tympanic membranes.[4]
- **Transfer Learning:** Pre-trained models fine-tuned on otoscopic datasets have reduced training time and improved accuracy, especially when data is limited.
- **Object Detection Algorithms:** Models like YOLO (You Only Look Once) and Faster R-CNN are employed to localize and classify specific pathologies such as fluid levels or perforations.
- **Ensemble Methods:** Combining multiple models to enhance robustness and reduce false positives.[5]

Artificial intelligence, particularly computer vision and deep learning, offers a transformative solution. By training models on large datasets of annotated otoscopic images, AI systems can detect subtle morphological changes and classify pathologies with precision comparable to or exceeding that of experienced clinicians. This paper examines the accuracy of AI assisted otoscopy and conventional otoscopy to the gold standard EUM.

METHODOLOGY

We conducted a prospective comparative study including 200 patients presenting to the outpatient department, Department of ENT, Shri Shankaracharya Institute of Medical Sciences, Bhilai Chhattisgarh India from January 1, 2026 to January 31, 2026.

Informed and written consent were taken. Declaration of Heinskii was signed. The patients were divided in two groups A and B of 100 patients each. Group A was subjected to conventional otoscopy followed by EUM while group B was subjected to AI assisted otoscopy followed by EUM.

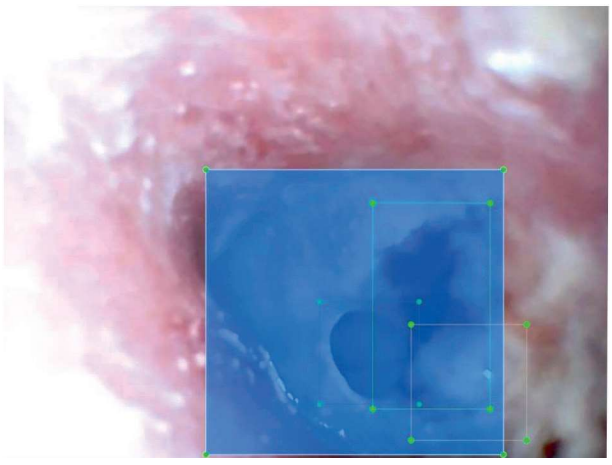
For AI assisted otoscopy, 400 previous images taken by Otoscope Remmie Pro version 2.0.2.5 www.remmiehealth.com copyright 2023 Remmie Inc., DBA Remmie Health were obtained on smartphone Smartphone iPhone 12 version iOS 18.6.2.

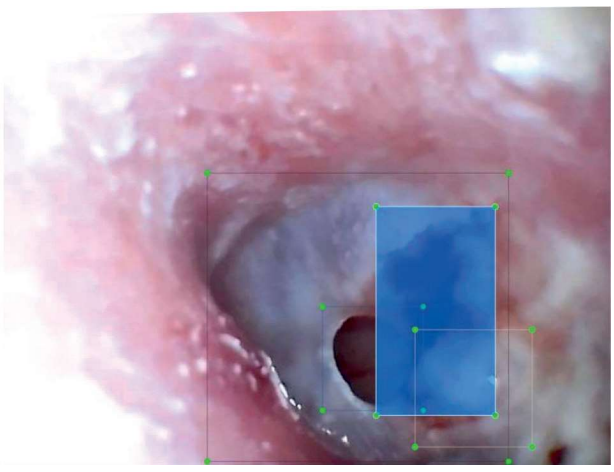
The otoscopic uncompressed images were further stored on desktop Dell Inspiron Processor Intel(R) Core(TM) i3-6100U CPU @ 2.30GHz 2.30 GHz Installed RAM 4.00 GB (3.89 GB usable) Storage 238 GB SSD JAJS600M256C Graphics Card AMD Radeon (TM) R5 M335 (2 GB), Intel(R) HD Graphics 520 (128 MB) System Type 64-bit operating system, x64-based processor Operating system Edition Windows 10 Pro Version 22H2.

AI app used was Labelimg Windows v1.8.1 YOLO model.

Labelimg was trained on 400 otoscopic images on YOLO model.

The trained system was used for AI assisted otoscopy in 100 patients of group B.





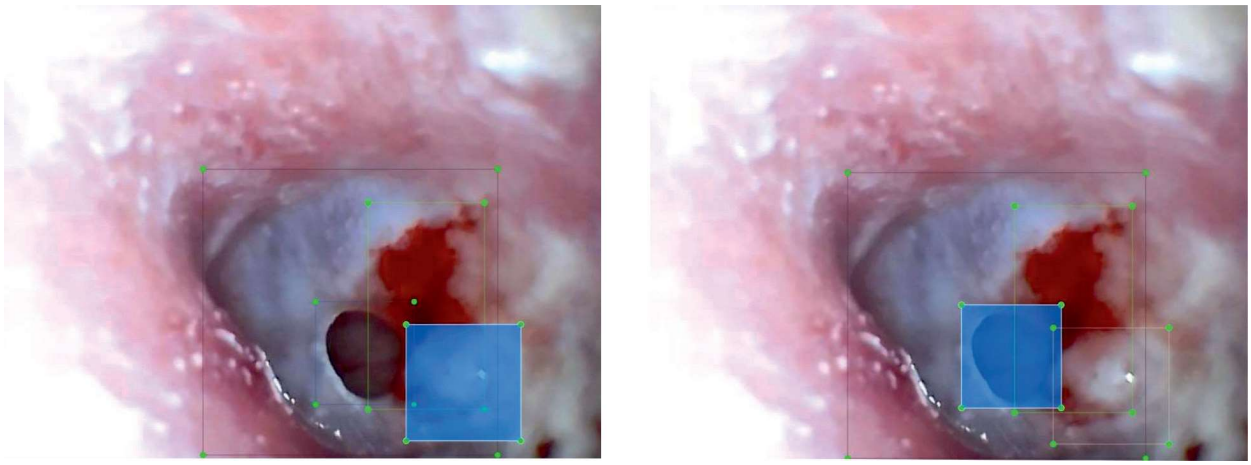


Figure 1-4: Training of labelimg to identify tympanic membrane, blood, dicharge and perforation in an otoscopic image

The diagnosis obtained on EUM in all 200 patients was considered final. The diagnosis on otoscopy in group A and B was compared to the EUM diagnosis. Student t chart was used for group comparison on IBM SSPS 28 and accuracy of diagnosis in both groups was used to draw inferences.

OBSERVATIONS

Table 1: Matching of Otoscopic diagnosis with EUM

Groups	Group A (n=100)	Group B (n=100)
Match	93 (am)	99 (bm)
Unmatch	7 (au)	1 (bu)

CALCULATIONS

Table 2: Calculations for matching of diagnosis in group A and group B

Sample	Group A	Group B	n-a	n-b
Match	93 (am)	99 (bm)	7	1
Unmatch	7 (au)	1 (bu)	93	99
Value/n	.93	.01	0.7	0.1
Final	94	100	6	0

RESULT

Use of AI assisted otoscopy improves the accuracy of diagnosis by 6% as compared to conventional otoscopy. Also, this accuracy level is equivalent to the gold standard (EUM).

DISCUSSION

AI assisted otoscopy has shown promising results in various analysis and meta-analysis. The present study shows an improvement in diagnostic accuracy by 6% on using AI assisted otoscopy using the ZOLO model on Labelimg. The results are in conjunction with most of the other studies using Chatgpt, Google Gemini, ZOLO model and other image recognition AI platforms.[1,2,4] The present study is a very short duration study with a small sample size. It may be considered as a pilot project only for the further research work. However, its easy to use, very effective as may be easily diversified because of the use of the ZOLO platform which is very flexible and perfect for the industrial application. Future research should focus on:

- Developing federated learning frameworks to train models across institutions without sharing sensitive patient data.
- Creating standardized datasets with diverse demographic representation and multi-observer annotations.
- Designing lightweight, mobile-compatible AI models for use in low-resource settings.
- Exploring multimodal AI systems that combine otoscopy with audiometry, patient history, and genetic data for holistic diagnosis.[6]

Additionally, longitudinal studies are needed to assess the impact of AI-assisted otoscopy on clinical outcomes, antibiotic stewardship, and healthcare costs.

CONCLUSION

Artificial intelligence is emerging as a powerful adjunct in otoscopy, offering enhanced diagnostic accuracy, consistency, and accessibility. In the present study, it increaese the diagnostic accuracy by 6% and also brings it comparable to the gold standard EUM. By reducing diagnostic variability and supporting

clinicians in real-time decision-making, AI has the potential to transform otolaryngological care—particularly in primary care and remote settings. However, responsible development, rigorous validation, and thoughtful integration into clinical practice are essential to realize its full potential. As technology evolves, AI will not replace clinicians but will empower them to deliver more precise, timely, and equitable care.

Ethical issues: None

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Conflicts of interest: As author, I declare that no conflicts of interest are involved in the present study.

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