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The Use of Laboratory Tests in Diagnosing Lesions of The Mouth and Jaws

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Abstract

Background: Determining odontogenic cysts and tumors necessitates an early diagnosis to avert surgeries involving extensive elimination of infected tissues. This study assesses the accuracy of the YOLO v2 deep learning network in contrast to conventional methods to detect dental caries in panoramic radiographs.

Methods: Research was done using 1602 lesions in periapical radiographs taken at Yonsei University Dental Hospital between the years 2010 and 2019. The study divided the participants into those with dentigerous cysts, odontogenic keratocysts, ameloblastoma, and the control group without any lesion. This paper aims to assess the diagnostic performance of YOLO v against that of oral and maxillofacial surgeons and general practitioners by using measures like precision, recall, accuracy, and the F1 score that will be used for objective evaluation.

Results: YOLO showed the highest metric accuracy among the three teams, with particularity percentage and amount of recall being 0.707 and 0.680, respectively. Although the results of the YOLO models did not vary much from clinical performance, none of these differences were statistically observed.

Discussion: The results of this study may point towards the possibility of the YOLO version becoming successful in the detection of jaw cysts and tumors in panoramic radiography tests. It is as competent as a human clinician in this case, which makes a potential introduction either an aid to screen patients early and curb those unnecessary morbidities in oral and maxillofacial surgery.

Conclusions: The study stresses the benefits that auto-detecting machine learning algorithms like YOLO offer in medical process automation and AI in dentistry. The good performance of YOLO in hunting for lesions and creating pictures on panoramic radiographs shows its ability to facilitate diagnosis and thus influence positive patient outcomes.

Keywords: *YOLO, cysts, radiography tests.*

Introduction

The lack of symptoms concealed the cysts and tumors until they were discovered, and their cancerous growth was already a cause for concern. Facial deformities and upsetting emotions can affect patients who go for invasive surgeries done in the late stages of such conditions (Khunger & Pant, 2021). Moreover, the fact that benign lesions can develop malignant histology into cancer over time shows, however, the dramatic situation and the vital role of early detection. Besides the panoramic radiographs, "vise," by which the dentist is able to come for the lesions at the previous stages, Nevertheless, a definitive rating of panoramic radiographs is difficult, mainly due to the overlapping of the bony parts of the face, which are superimposing.

A class of DCNNs (also known as machine learning systems) is a recent development with medical imaging in mind. ONE logic (YOLO) algorithm, which is known for its efficient box detection and classification capabilities, seems to be the thing that we need to correct some inconveniences with the interpretation of full's x-ray images (Mmutlana et al., 2022). With a self-optimizing process for both detection and classification, YOLO could cut the time of diagnosis and support medical staff in their work.

This study aims to determine the capabilities of the YOLO algorithm as a computer-assisted diagnostic instrument for the identification of odontogenic cysts and tumors on standardized radiographic images. Unlike the last studies that focused on the minimal number of lesions of the jawbone, our study uses an enormous dataset that combines the lesions of the two-bone maxilla and mandible, making it one of the largest studies in this field. This study examines YOLO's efficiency and compares it with that of oral and maxillofacial surgery (OMS) specialists and general practitioners (GPs). It is done to determine the suitability of YOLO as part of the CAD systems in clinical practice.

Methods

The sample was obtained from the Department of Oral and Maxillofacial Radiology of Yonsei University Dental Hospital, in the Department of Oral and Maxillofacial Radiology, using digital panoramic radiographs (Yang et al., 2020). The IRB's approval of the study had been granted. A balanced total of 1603 panoramic radiographs were assessed; basic patient information is stated in Table 1. We co-registered the ground-truth panoramic pictures with YOLO diagnostic marks annotated by histological diagnoses in order to come up with classifications: dentigerous cysts, odontogenic keratocysts, ameloblastomas, and none.

To deal with possible overfitting concerns, the dataset was divided into training and testing sets, where the training set uses various data augmentation techniques. Through the process of augmentation, horizontally flipping, vertically flipping, translational transformation, and upscaling were applied, which caused the number of images in the training set to rise to 16,224 and the testing set to 181 (Yang et al., 2020). Pytorch 1.2.0 is adopted to conduct this study with the support of Python 3.7.4. The entire investigation is done on the NVIDIA Quadro P5000 GPU.

The YOLO was used for the task of lesion detection and classification in the workflow architecture. YOLO divides the input images into non-overlapping grid cells so that the system takes care of detecting suspected lesions, with each grid cell responsible for this division (Sambyal & Sarwar, 2022). Every grid cell includes two occupied cells, each topped with a confidence score. To arrive at this class-specific score, the confidence score of the probabilities of the class between the predicted and the ground truth boxes is calculated by means of intersecting over union (IOU).

The YOLO network is a deep neural network and comprises 24 convolutional layers, max pooling layers, activation functions, and another 2 fully connected layers. The prediction tensor of output (PTo) is the emitted representation of predictions for every cell, bounding box, and class. Eventually, Yolo v2 was chosen as our model, and their parameters were chosen according to both effectiveness and precision.

The Darknet was utilized as a complete framework for the training and testing processes. The YOLO-based computer-assisted diagnosis (CAD) structure is shown in figure 2 below, displaying the diagram that shows the overall scheme of the system (Sambyal & Sarwar, 2022). Here, the goal was to demonstrate the performance of the YOLO model in both teaching and testing the ability of the algorithm to detect and classify the odontogenic cysts and tumors on panoramic radiographs using a comprehensive dataset built on the most advanced deep learning techniques.

Table 1 (Yang et al., 2020)

Table 1. Demographic data of the study subjects (N = 1603).

Characteristics	Training Set (N = 1422)	Testing Set (N = 181)
Age [IQR]	42.0 [31.0; 53.0]	37.0 [25.0; 48.0]
Diagnosis		
Dentigerous cyst	1042 (73.3%)	52 (28.7%)
OKC	268 (18.8%)	48 (26.5%)
Ameloblastoma	112 (7.9%)	48 (26.5%)
No lesion*	0 (0.0%)	33 (18.2%)
Sex		
Female	455 (32.0%)	62 (34.3%)
Male	967 (68.0%)	119 (65.7%)
Location		
Mandible	1246 (87.6%)	125 (69.1%)
Maxilla	176 (12.4%)	23 (12.7%)
No lesion*	0 (0.0%)	33 (18.2%)

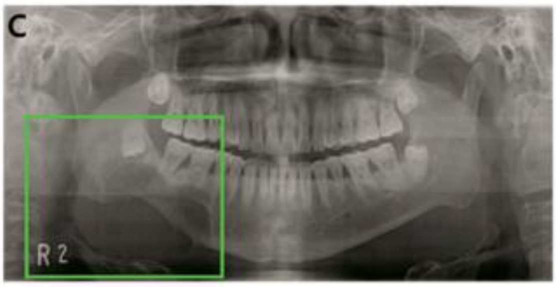

Figure 1: example of included lesions (Yang et al., 2020)

Results

The addiction of the YOLO (You Only Look Once) algorithm to the operational building blocks of clinical practice will doubtless become a milestone in terms of the diagnosis of odontogenic cysts and tumors. YOLO's live detection function, which accelerates the diagnostic process essentially, provides instant, relevant information to the clinicians, further enabling them to stay ahead of the disease process (Chen et al., 2022). YOLO solves the problem of panoramic radiograph interpretation and gives physicians the opportunity to make the right decision and start treatment on time. It is a strike in balancing the approach between early diagnosis of oral pathologies and direct treatment using radiograph interpretations.

YOLO is one of the key technological advantages because it is a perfect continuum of the existing radiographic flows in dental clinics. By including YOLO as a part of the day-to-day activities, improved efficacy in operations, delivery of personalized services to patients, and management of available resources can be achieved. However, the method of autodetection it uses takes the burden away from clinicians, thus offering them time for other important aspects of patient care. Eventually, this improves the total efficiency of dental clinics.

Furthermore, the YOLO app is flexible, and its capabilities are not limited to odontogenic lesions, giving it the potential to be the solution to many diagnostic problems in dental radiology. Intraoral imaging technology can function with various imaging parameters and lesion types, thus setting new horizons for its application, from diagnosing caries and periodontal diseases to identifying anomalies in orthodontic treatment planning (Chen et al., 2022). Via this one-of-a-kind feature, the scope of YOLO is extended as far as the scope of dentistry, within and across numerous subspecialties. This enables it to serve a broad set of investigative demands, ranging from regular to more complex cases, leading up to comprehensive patient management.

In the same vein, the YOLO approach fits into the transformations in healthcare going on currently, such as the rapid growth of AI and machine learning for decision-making that is based on medical evidence. In the era of the dental industry's digitalization, YOLO sticks to the principles; its technology's purpose is to eliminate the problems in the field of oral and maxillofacial radiology that are inherent or traditional. The fact that it is in clinical routine nowadays is a result of the tendency of dentistry to introduce innovative technologies that facilitate providing patients with better diagnostic results and predicted outcomes, which is commonly considered a stimulation of innovative approaches in dental diagnostics.

Despite the yeoman service provided by YOLO in dental practice, its actual integration into routine clinical practice would hinge on the combined efforts of dental practitioners, technologists, and regulatory authorities. Acknowledging technical, ethical, and legal issues is of primary importance, which will later guarantee the applicable use of YOLO in diagnostic settings (Cazzato et al., 2020). The development of strong validation criteria, quality assurance protocols, and the abidance of regulations on data confidentiality are core characteristics of this procedure, which, in turn, reflect trust and confidence in YOLO as a credible diagnostic tool.

YOLO positions itself as an innovator in dental and maxillofacial radiology. It promises the experience of being allowed to interpret images with increased accuracy faster and easier, as well as anytime and anywhere the analysis might be needed. Frost histography dental diagnostics marks the beginning of a new era in dentistry, which is anticipated to spark a practical revolution in the field of dentistry and enter the digital age. The more that digital dentistry becomes popular with the aid of YOLO, the clearer the potential of this technology in providing quality patient care and diagnostic tools to dentists.

To illustrate this more, figure 2 below depicts the confusion zone, which shows the diagnoses for each class of lesions. This grid also offers key details about YOLO and humans' performance in the proper determination of mandibular injuries and other benign lesions (Cazzato et al., 2020). Graphically, the confusion matrix is used to show the cases correctly diagnosed (true positive and true negative), and on the other side, the missed cases (false positive and false negative). A comprehensive representative of diagnostic accuracy is offered, and areas that can be improved are shown.

In total, the YOLO shows an overall accuracy of 0.633, which is somewhat higher than OMS2 and GP1, with accuracies of 0.635 and 0.597, respectively. Among OMS specialists, OMS3 outperformed almost all other classifiers with a F1 score of 0.694, while barely the second place among them was occupied by YOLO with a F1 score of 0.693 (Yang et al., 2020). This clearly indicates that YOLO can match the results of a well-experienced OMS specialist making just as precise diagnostic claims about the odontogenic lesions. The comparison of the diagnostic efficiency between YOLO and human medical professionals derives from the device's suitability and reliability for use in a radiology study that is related to the oral and maxillofacial systems.

Table 2: (Yang et al., 2020)

Precision	Dentigerous Cyst	OKC	Ameloblastoma	No Lesion*	Mean (sd)
YOLO	0.804	0.635	0.889	0.500	0.707 (0.174)
OMS specialist					0.671 (0.124)
OMS1	0.662	0.513	0.643	0.857	0.669 (0.142)
OMS2	0.717	0.491	0.576	0.789	0.643 (0.135)
OMS3	0.717	0.529	0.826	0.738	0.703 (0.125)
GP					0.658 (0.138)
GP1	0.705	0.492	0.633	0.604	0.608 (0.089)
GP2	0.804	0.635	0.889	0.500	0.707 (0.174)
Recall	**Dentigerous Cyst**	**OKC**	**Ameloblastoma**	**No Lesion***	**Mean (sd)**
YOLO	0.774	0.702	0.333	0.909	0.680 (0.246)
OMS specialist					0.673 (0.203)
OMS1	0.811	0.426	0.563	0.909	0.677 (0.222)
OMS2	0.717	0.596	0.396	0.909	0.654 (0.215)
OMS3	0.623	0.787	0.396	0.939	0.686 (0.233)
GP					0.649 (0.21)
GP1	0.585	0.617	0.396	0.879	0.619 (0.199)
GP2	0.774	0.702	0.333	0.909	0.68 (0.246)

Discussion

The comparison of YoloToothy performance to that of human clinicians in diagnosing odontogenic cysts and tumors highlights the great strides deep learning models can achieve in medical imaging, while also outlining their inherent limitations. The figure depicts a graphic of parameters that are yielded for YOLO, oral and maxillofacial surgery (OMS) specialists, and general practitioners (GPs) (Chen et al., 2022). The proposed measurements provide the groups of participants with the ability to efficiently locate and label the odontogenic lesions on the panoramic radiographs. Being blessed with the highest accuracy and recall scores, this implies the diagnostic capability of the HAL-YOLO is on par with that of human healthcare providers, but this only means it is statistically no better.

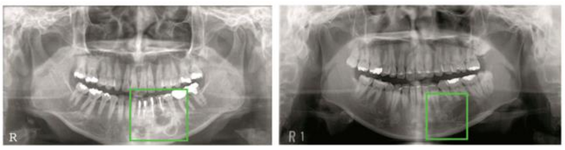

Figure 2: (Yang et al., 2020)

Figure 2, the mixed-up matrix, is also used to provide further details about the class of lesions and their diagnoses. Through drawing a visual representation of TP, FP, TN and FN results, confusion matrix depicts the precision and a list of to be improved aspects in both model and human experts' diagnostic abilities.

The use of deep learning conveyed neural network (CNN) designs, like that of YOLO, has reshaped medical imaging diagnosis process (Yang et al., 2020). Traditionally, the expertise of doctors and radiologists was the essential element for validation of imaging. On the flip side, developments in deep learning fare well in some tasks exceeding human abilities, including image recognition and classification. In our research, we established that YOLO could, indeed, was helpful in detecting and diagnosing odontogenic cysts and tumors on panoramic radiographs, but there were also its drawbacks.

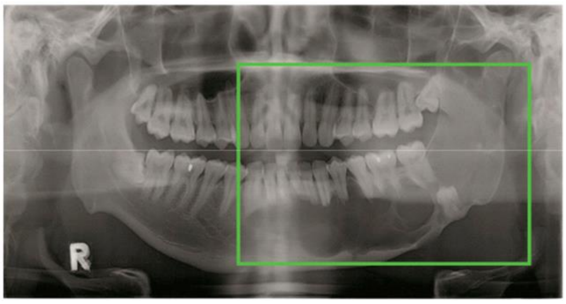

Figure 3: (Yang et al., 2020)

YOLO is one of the main strengths of being instantaneous in identifying and classifying objects that occur all in the same layer. Contrary to classifier-based approaches that are very complicated and time-consuming and, at the end, involve a lot of post-processing techniques, YOLO frames the detection problem as a very simple regression issue, optimizing it and speeding it up (Yang et al., 2020). Although YOLO's widespread use faces challenges, its high processing speed for the analysis of images is notable, allowing the classification in as little as 20 milliseconds, significantly reducing the analysis time compared to human beings.

Achieving the highest degree of YOLO model fine-tuning is vital to maximizing the frequency at which the model learns. Technologies like avoiding overfitting, adjusting learning rates, and implementing dropout layers and channels with data augmentation play a role a role in improving the modeling accuracy and the model's specifications. Furthermore, Yolo portrays a good amount of contextual comprehension of the picture, which can be attributed to the human cognitive system. This allows for fewer false positive values compared to traditional techniques.

Conclusion

The deployment of YOLO models in clinical settings signifies a new level of development in oral and maxillofacial radiology. This study evaluation shows the technicality and effectiveness of applying the YOLO to detect and diagnose panoramic radiographs of odontogenic cysts and tumors. YOLO empowers physicians to achieve this by utilizing its real-time detection capabilities and obtaining high precision and recall, which comes with the benefits of quickening the diagnosis process and rendering better outcomes to patients. The comparison between YOLO algorithms and human professionals achieved equal diagnostic performance. In addition, YOLO algorithms had the ability to analyze images very quickly while providing results that were accurate. It is the fast and highly specific processing of the images and their contexts that ensures the high overall accuracy of this technique in identifying the lesions without a large number of false positives. Although Yolo is not entirely a human expert replacement, its presence is still considered an effective added value for medical practitioners, simply because it can help in timely decision-making as well as expert opinion support.

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