AI in Dentistry: A Comparative Analysis of Case Studies

Ahmed Zakzouk, Maka Sabashvili

The University of Georgia, School of Health Sciences and Public Health, Department of Dentistry

SUMMARY: Since the emergence of Artificial Intelligence aids in a lot of fields, the medical field specifically must be well-supervised and developed to ensure the most accurate results with minimal errors. This report is an individual observation for a dental AI to analyze and confirm some of the diagnostic capabilities of DeepCare© AI. Cases of patients in various conditions were tested for accuracy an compared with a related study as a reference. Input Data were focused on Panoramic Scans (OPGs) as practitioners daily basis type of data. AI made instant analytics for each patient. However, all of their results highlighted irrelevant errors due to algorithm limitations and misinterpretations. AI is progressively developing a great potential in the dental field. Despite being an experimental diagnostic integration that may help, Its reliability is still questionable and mostly will remain variable.

Keywords: Artificial Intelligence, Dentistry, Diagnostic Accuracy, Patient Case Study

INTRODUCTION:

The rise of Artificial Intelligence (AI) in the medical field in general and dental in specific, has drawn a lot of interest among workers and learners of the field. The integration of AI has unlocked multiple time-saving features like automated charting, treatment planning, pulp segmentation as it's racing towards more advanced utility in orthodontics and implantology.

This report was conducted after releasing a survey to the students at the University of Georgia (Tbilisi) with the name "AI In Dentistry" in 2023/2024 Spring Semester. It aims to provide a voluntary experience that may answer some interests that were discussed back in the survey.

For ensuring that findings and success rates are in the correct spectrum, an article of Ossowska et al. (2022) is taken as a reference for comparing the percentages with the outputs of this observation; Since it's related to our topic as we will compare in the Results section.

Goal:

The objective is to test the AI with different inputs, without interfering with or modifying the suggestions and the analysis that are exported by its default understanding. Based primarily on OPGs as a common everyday document between students (standard as well for a single non-professional documentation) to observe if it will identify the abnormalities in these patients. All OPGs were presented indirectly to the AI in the original static picture format; As the AI is not linked to the scanners by any means.

This report was made by a third-year clinical student who suspects that AI has not been trained well enough at this stage; Thus, it might serve as a confirmatory tool for rechecking rather than taking its diagnostic results for granted. As it may implement the idea of taking caution for using such a new technology, even for diagnostic uses.

Set-Up:

Before we delve into details, it must be mentioned that the four patients who are included in this observation have given their consent as they were examined thoroughly in the associated clinics of the University of Georgia, under proper lighting, dry oral cavity, and supervision of doctors to confirm the documentation of different types of lesions.

Each case will be discussed separately, showcasing the general and dental status of the patient, displaying the AI's own understanding and analysis of the data in a table for each patient, specifying which type of data was provided and finally comparing the real presenting case with the results.

Dental charts of patients (not included) were taken as a reference of comparison for confirmation of any unusual lesions. All correct, incorrect, questionable and uncomplete diagnoses (outputs that were shown in the user interface of the AI) will be classified in the tables.

Cases will be viewed in a sequence in which the reader will acquire as much brief information about the patient. The section of "AI's Diagnosis" will show all outputs which are visible in the platform; Note that a single tooth may have more than one output. As the success rates are calculated according to the fraction of the correct outputs to the overall number of outputs and not the quantity of teeth for each patient. As for sound (healthy) teeth, they are not reported during automated charting by default since there are no anomalies. Thus, each patient's diagnostic accuracy is calculated according to some very specific considerations to ensure fair results.

Finally, a visual interpretation showing how the AI highlights and finalize the report is attached in the following page of each case. It's important to consider the disclaimer written at the end of each generated report for averting ethical concerns.

MEET OUR PATIENTS:

Patient N1:

A 20-year-old male with a very questionable health condition. Patient is asthmatic, has hypothyroidism, showing constriction in the coronary arteries (hereditary), hypotension, and type 2 diabetes (acquired in childhood). He had a history of pulmonary edema and has been on prolonged cortisol administration trials.

However, his oral health is very well, showing minimal complications. Patient has an orthognathic occlusion, healthy teeth (only a single superficial class I carious lesion) that has had his first ever restoration in #46, minimal supragingival hard plaque, slightly tilted yet visibly rotated anchors for anterior region, crowding in the right side due to a horizonal impaction for #48, and a vertical impaction for #18. All of these conditions have been taken care of in 2 weeks interval (except for #18). Patient has never visited a dentist since childhood; The only appointment he had before the recent one was for the extraction of a lower primary molar. The patient says that he was extracting his own primary teeth once they become loose.
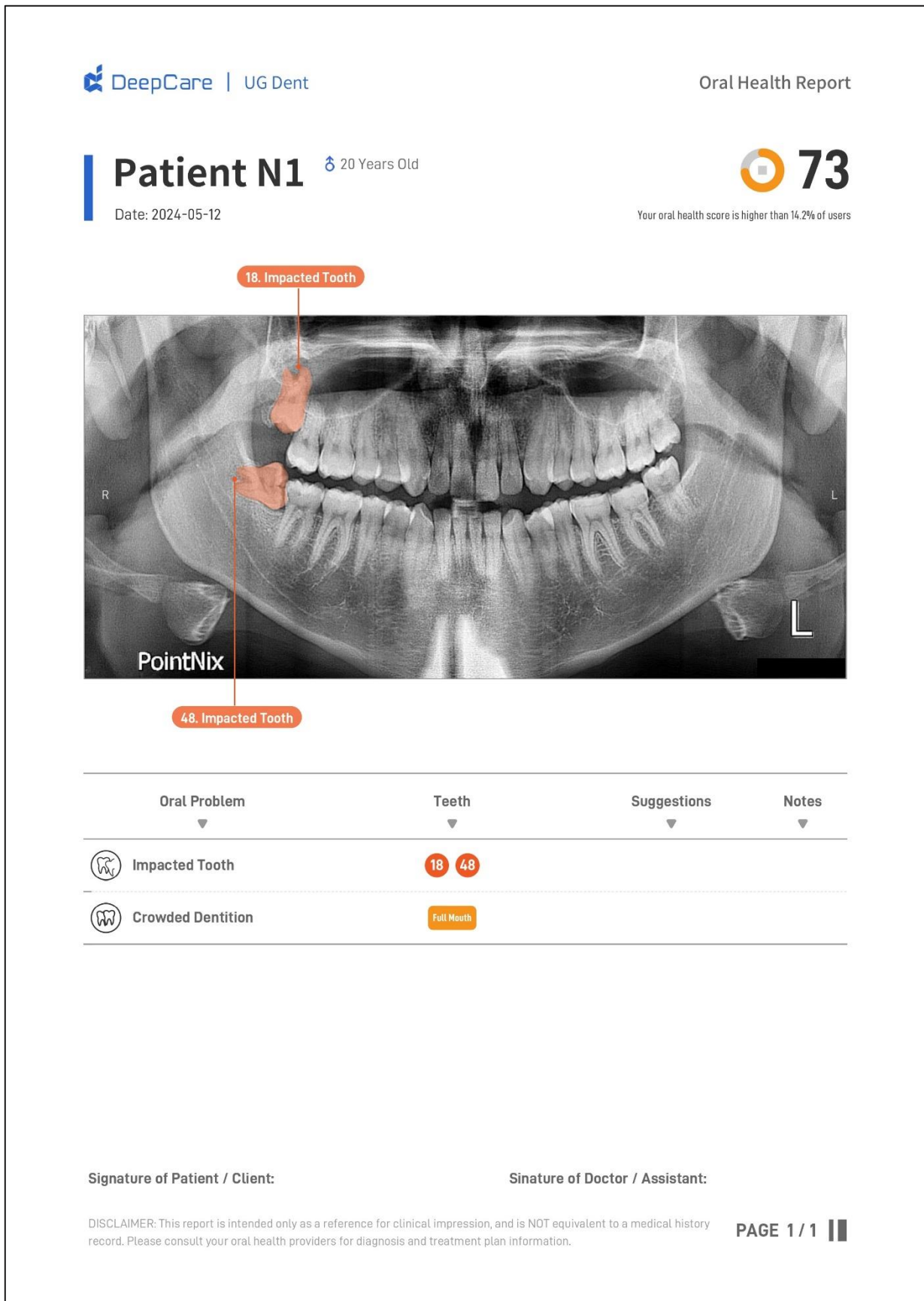
AI's Diagnosis:

Correct	Questionable /Uncomplete	Incorrect
Impacted Teeth #18, 48	Dental Crowding – Full Mouth	Filling #16, 36, 37

Table 1

AI's Final Report:

When provided with one recent OPG, AI had only determined the following: See Figure 1.

Figure 1:AI's generated report, showing the OPG and highlights of patient N1

Patient N2:

A 21 years old student who wants an orthodontic treatment. He had to go through examination and professional cleaning prior to planning. Patient is a smoker with a questionable oral hygiene.

Patient has no history of medical issues. However, he does have fillings (#11, 21, 23, 36) including some faulty restorations (#11 & 36), generalized intrinsic & extrinsic yellowish stains, extracted upper first molars (#16 & 26) as well for #46. Multiple carious lesions (#17, 15, 14, 12, 22, 25 & 27) on upper arch, and (#34, 35, 37 & 47) on lower arch. Has a lot of tilted teeth as well.

When patient had scaling, he showed gingivitis as well for his grade-II plaque buildup and most of the extrinsic stains were removed. Additionally, the OPG shows that he needs a sinus lift.
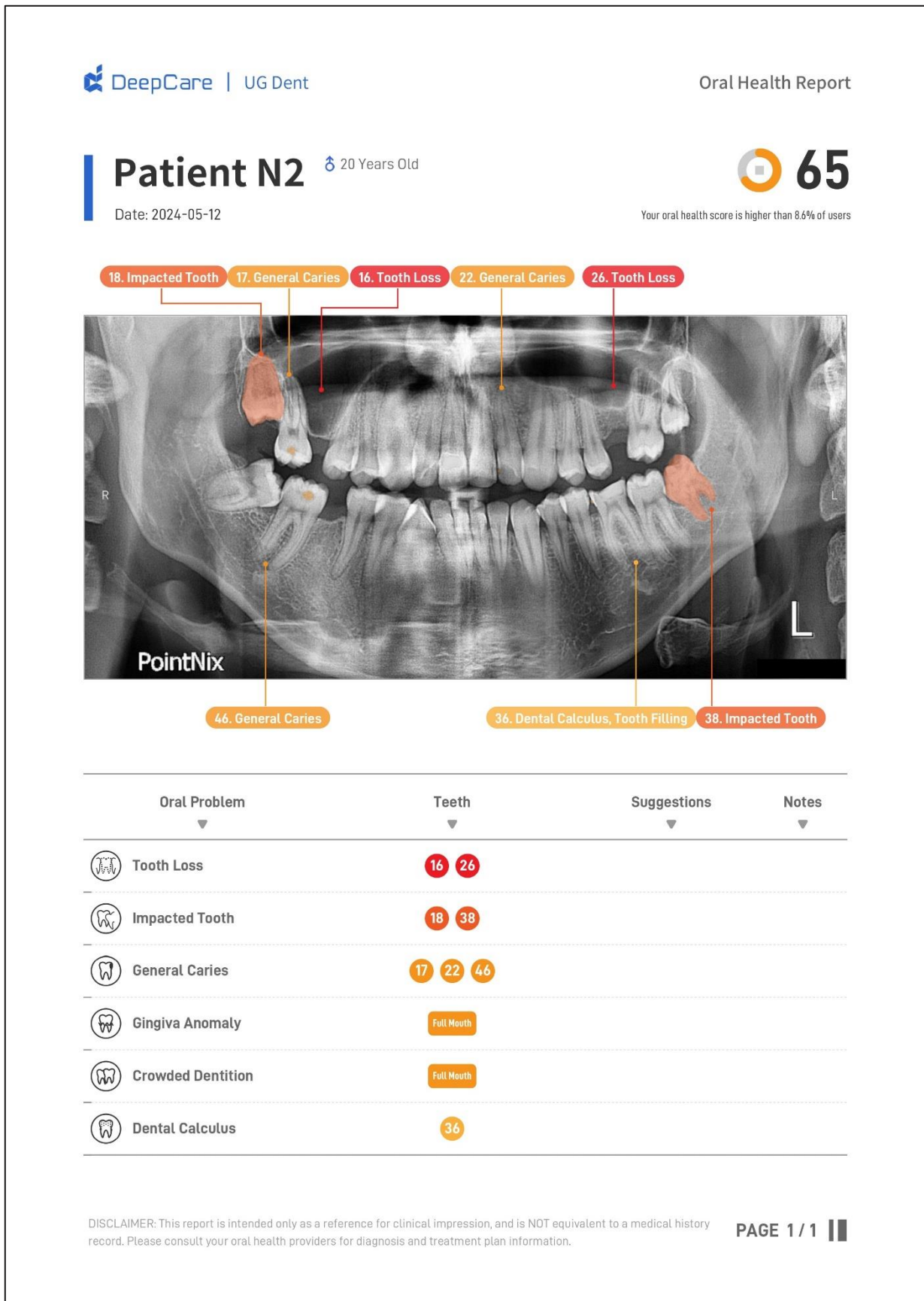
AI's Diagnosis:

Correct	Questionable /Uncomplete	Incorrect
Tooth Loss: #16, 26		*Tooth Loss:* #48
Impacted Teeth: #18, 38		
Caries: #17, 22		*Caries:* #46
Filling #11, 36	*Dental Calculus:* #36	

Table 2

AI's Final Report:

When provided with an OPG and one IOP-Frontal, AI had only determined the following: See Figure 2.

Figure 2: AI's generated report, showing the OPG and highlights of patient N2.

Patient N3:

This patient is *not to be taken for accuracy testing* due to his outdated documentation. As some of his documents were only used to test the capabilities of the AI itself as a machine.

It was intended to provide the platform with literal phone shots which are not considered typical professional materials that the AI is designed to comprehend; Imitating casual scenarios and unprofessional documentation that is commonly encountered among undergraduates.

The AI couldn't recognize multiple bony lesions, an alveolar process fracture, canine impaction, and wisdom teeth impactions. Adding to that it had identified three supernumerary teeth while the patient has only a single supernumerary developing follicle between #22 and #24 (besides the impacted canine).

AI's Diagnosis:

Correct	Questionable /Uncomplete	Incorrect
Caries #11, 27	*Dental Calculus*	
Supernumerary tooth: #Ex1		*Supernumerary teeth:* #Ex2, Ex3
Unerupted #23		*Unerupted* #24
Filling #15, 17, 26, 45, 46, 47		

Table 3

AI's Final Report:

When provided with phone-taken intraoral shots & OPG, AI had only determined the following: See Figure 3.

Figure 3: AI's generated report, showing multiple flaws based on the given documentation.

Patient N4:

A 20-year-old male with a history of orthodontic treatment that didn't completely go well as for two waves of rampant caries throughout his life. Broken lingual retainers hanging on lower canines. The patient got well-educated as he's suppressing furthermore deterioration with proper oral hygiene. Has (#15, 25, 34 and 44) orthodontically removed, tooth #24 is prepared for crown (Core). No signs of calculus, apical pathosis or bony lesions, nor findings of prosthesis at this stage. However, he still has many restorations, and some carious lesions to take care of.

AI's Diagnosis:

Correct	Questionable /Uncomplete	Incorrect
Missing from Orth #25	*Tooth Loss* #34, 44	*Missing from Orth* #14
Root Canal Therapy #12, 24, 35		*Periapical Anomaly* #35, 43
Caries #18, 23, 47, 48		*Full Crown* #13
Filling #11, 12, 14, 16, 21, 24, 26, 36, 37, 45, 46, 47		*Filling* #15

Table 4

AI's Final Report:

When provided with a recent OPG, AI had only determined the following: See Figure 4.

Figure 4: AI's generated report, showing the OPG and highlights of patient N4.

15
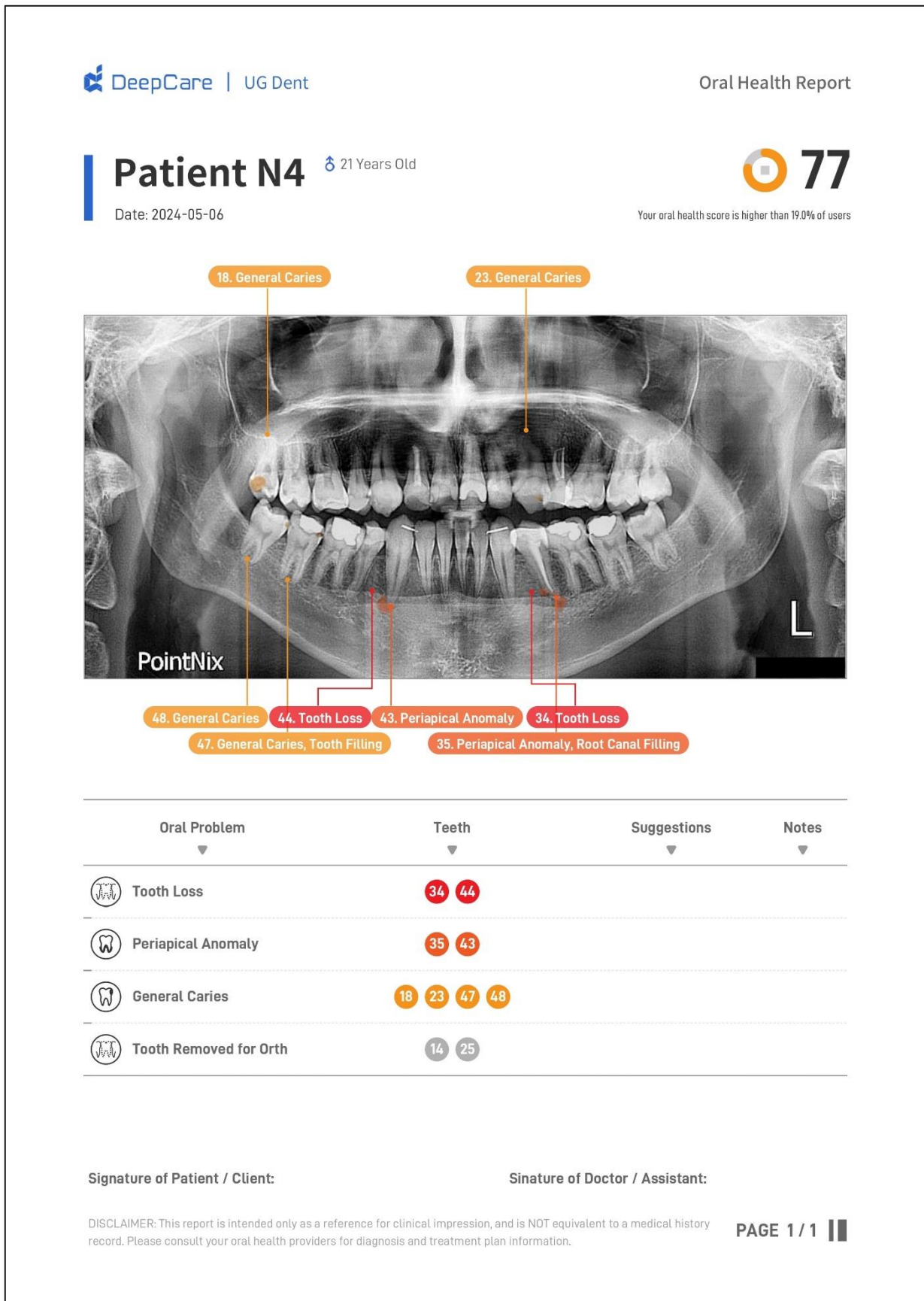
RESULTS:

In this section, the *tilted (italic)* outputs will be counted as a false positive fraction from all of the outputs (in the platform for each patient). Results are mostly focused on the restorative aspect. As they may include some interesting concerns discussed with different points of view.

Patient N1: Three miscounted teeth as "*Filling*" as well for "*full mouth* crowding" when its slightly present only on the right side. 4 out of 6 diagnoses were incorrect; Making a fraction of 12.5% when considering the sound teeth that are not mentioned for abnormalities by default.

Patient N2: Tooth #46 has no *caries* since it's missing; #47 and 48 were *nomenclated* for #46 and 47, respectively. As for #48 it exists in an impacted position and is not *missing*. As "*dental calculus*" is not to be observed in OPG, especially after scaling. 3 out of 12 diagnoses were incorrect, making a false positive fraction of 9.09% out of all outputs (including sound teeth).

Patient N3: The AI framed the teeth out of the shot. However, it showed multiple errors in nomenclature, such as adding or missing teeth. AI couldn't detect any impaction, three regions of bony resorption in the mandible (symphysis, right and left angles) and an alveolar process fracture in the maxillary upper left quadrant; Meaning it needs furthermore training.

Patient N4: Some orthodontic extractions were mistaken for other premolars despite their evident morphology, as well as generalizing some for "*Tooth loss*" instead. One restoration was counted as "*Full Crown*". As for counting Mental Foramina reverberations as "*Periapical anomalies*". 6 out of 36 outputs were incorrect, forming a false positive fraction of 16.67%.

Success Rates:

Success rates of diagnosis for patients *N1*, *N2* and *N4* were 87.5%, 90.91% and 83.33%, respectively. Comparing the accuracy results with those reported by Abdalla-Aslan et al. (2020), where their algorithms detected *93.6% of dental restorations*. Along with Geetha et al.'s (2020) accuracy for *caries detection with 97.1%* success rate. See Table 5.

Patient	N1	N2	N3	N4
False Positive Percentage	12.5%	9.09%	–	16.67%
Accuracy	87.5%	90.91%	–	83.33%

Table 5: Note that Patient 3 was excluded from accuracy testing due to intended submission of an unprofessional OPG input; Only to understand the analytical capabilities as it will be unfair for comparison with reference rates.

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE STUDY:

After introducing a variety of data of different patients, DeepCare© AI seems that it does an acceptable work as a diagnostic tool. However, it always generated some errors including false or uncomplete diagnosis. This observation was meant to be tested with varying data like patient's condition and quality of documentations that were provided. As all of their OPGs have been submitted externally to the AI as a platform; However, integrated AIs that may directly exist in the scanner's software would have better prognosis to interpret the data more accurately. All of these patients have given consent to use their own documents for furthermore study.

Some results showed some obvious issues with the nomenclature, morphology, and restorations. Adding that it seems only to be focused on operative/therapeutic point of view and less towards the surgical one; Due to complete misinterpretation of bony lesions such as resorptions, fractures as well for ignoring some impactions.

It's important to mention that this observation was only focused on the prophylactic use of AI in the dental field; And was never aimed to test the other capabilities that were available during the demo access of it (that may give potentially better or accurate diagnosis) such as "Ceph AI", CBCT Segmentation and Implant Planning. That could of course utilize advanced data entries and may come with a decent output of it.

At this stage, AI is still a new integration in the dental field. Which can be helpful in one way or another such as automated charting, storing documentations and tracking the patient's visits on their timeline. Could be used for initial screening and may be worth rechecking for lesions that are suspicious and need furthermore focused clinical examinations for confirmation. However, it is still far from reaching the peak of human intelligence in critical thinking or considering all the aspects of dentistry while planning the treatment according to each patient's indications.

PURPOSE: A MESSAGE FROM THE AUTHOR:

This Report is never intended to advertise nor judge the corporation that owns DeepCare© AI. In fact, we are grateful that they have provided a demo access for deep-understanding for such technology. As in general, neural networks of many AI platforms in the dental field are not fully trained at the moment for 100% accuracy.

My humble message out of this report is to warn as many people in the dental field as possible. Especially for junior students and practitioners who are eager to be the first among all for using such technology and introducing it to others.

Based on the previous conclusions, if any treatment plan was executed according only to the AI's potentially questionable diagnosis, operators are the first to be blamed if any

complications or iatrogenic factors have occurred. As the spectrum of this ethical problem may also involve the AI as a machine itself, influencers who blindly promote such services just to be "Up-to-Date" as well for practitioners that may not compare and notice the outputs.

In general, it is crucial to question what the references and sources for any artificial intelligence are, and how frequently its neural networks are capable of updating and expanding their knowledge. Meaning that it is important to know about the foundation of the tech, and not only taking the fancy user interface of it for a divine representation of professionalism.

Abbreviations: AI- Artificial Intelligence, OPG- Orthopantomogram, IOP- IntraOral Photo

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