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## ABSTRACT

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## REMOTE DIAGNOSIS OF TRAUMATIC PROSTHETIC STOMATITIS USING A TELEMEDICINE DEVICE

The digital photography protocol has been successfully applied in various areas of dental practice. The use of digital photography in teledentistry expands the possibilities for the remote diagnosis of a range of dental conditions. Several authors described the use of digital photography for diagnosing diseases of the oral mucosa and remote assessment of traumatic dental injuries.

**The aim** of this study was to assess the level of agreement between experts when suspecting traumatic prosthetic stomatitis caused by partial removable dentures (PRDs) by comparing in-person and remote diagnoses.

**Materials and methods:** This study included 57 patients who were fitted with PRDs. Patients received treatment at the clinic of the dentistry department of the Educational-Scientific Medical Institute of Sumy State University (Sumy) and the dental office of the University Clinic of Sumy State University (Sumy). Clinical examination data were recorded in the outpatient dental record (form 043/o), and digital photographs were taken using a telemedicine device camera, stored on the device's memory card, and synchronized with cloud storage. Six experts remotely formulated their diagnoses based on an analysis of digital photographs. The accuracy of remote diagnosis was assessed by comparing it to the "gold standard" of in-person diagnosis at the clinic. Data were analyzed using Gwet's AC1 test to evaluate the agreement between the two methods.

**Results:** The agreement levels between researchers for in-person and remote diagnoses formulated exclusively using images were 0.83 or higher (95% confidence interval: 0.73–0.91).

**Conclusion:** The accuracy of remote diagnoses was comparable to those made directly in the clinic. Telemedicine systems can be an effective tool for the remote visual assessment of a patient's

condition during the post-prosthesis period. Keywords: Teledentistry, prosthetic stomatitis, partial removable dentures, diagnostic visualization.

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## ВІДДАЛЕНА ДІАГНОСТИКА ТРАВМАТИЧНИХ ПРОТЕЗНИХ СТОМАТИТІВ З ВИКОРИСТАННЯМ ТЕЛЕМЕДИЧНОГО ПРИСТРОЮ

Цифровий фотопротокол успішно застосовується у різних напрямках стоматологічної практики. Використання цифрової фотографії в телестоматології дозволяє розширити можливості для віддаленої діагностики ряду стоматологічних захворювань. Низкою авторів описано застосування цифрової фотографії для діагностики захворювань слизової оболонки порожнини рота, а також для віддаленої оцінки травматичних пошкоджень зубів.

**Метою** дослідження обрана оцінка рівня згоди між експертами при підозрі на наявність травматичного протезного стоматиту, викликаного частковим знімним пластинковим протезом (ЧЗПП) при порівнянні діагнозів, поставлених очно та дистанційно.

**Матеріали та методи:** у вибірку увійшли 57 пацієнтів, яким було виготовлено ЧЗПП. Пацієнти проходили лікування на базі клініки кафедри стоматології Навчально-наукового медичного інституту Сумського державного університету (м. Суми) та стоматологічного кабінету Університетської клініки Сумського державного університету (м. Суми). Дані клінічного обстеження заносилися до амбулаторної карти стоматологічного хворого (форма 043/о), а цифрові фотографії знімалися камерою телемедичного пристрою зі збереженням їх на картці пам'яті пристрою та синхронізацією з хмарним сховищем. Шестеро експертів віддалено сформулювали свої діагнози на основі аналізу цифрових фотографій. Точність дистанційної діагностики оцінювали шляхом її порівняння із «золотим стандартом» очної діагностики в клініці. Дані були проаналізовані за допомогою тесту Gwet AC1 для оцінки узгодженості між двома методами.

**Результати:** рівні згоди між дослідниками між очним та віддаленим діагнозами, сформульованими виключно за допомогою зображень, становили 0,83 або вище (95% довірчий інтервал: 0,73–0,91).

**Висновок:** точність віддалених діагнозів можна порівняти з діагнозами, поставленими безпосередньо в клініці. Телемедичні системи можуть бути ефективним інструментом для віддаленого візуального оцінювання стану пацієнта в періоді після накладання протезу.

**Ключові слова:** телестоматологія, протезний стоматит, часткові знімні протези, діагностична візуалізація.

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**ABBREVIATION**

PRD – partial removable dentures

**INTRODUCTION**

Traumatic prosthetic stomatitis is the most common complication associated with prosthetic plate dentures [1, 2]. This is because of the insufficient conformity of the prosthesis base shape to the prosthetic bed [3]. Because of the action of such a prosthesis on the tissues of the oral cavity, a range of symptoms characteristic of both acute and chronic trauma of the oral mucosa may develop. In the period from 1 to 7 days after prosthesis application, patients may experience erosions, pressure sores, and ulcers on the mucous membrane of the prosthetic bed [4, 5].

When fitting partial removable dentures (PRDs), patients also undergo a period of adaptation to the prosthesis, accompanied by significant discomfort such as excessive salivation, sensation of a foreign body in the mouth, and partial loss of taste and temperature sensitivity [6, 7, 8]. During this period, the main task of the dentist is to monitor the adaptation process of the tissues of the prosthetic bed to the prosthesis and to differentiate between signs of direct traumatic action of the PRD based on the temporary side effects of its application [6, 8].

Accessibility of follow-up examinations and specialist consultations is a critical factor in the success of prosthetic treatment. The inability to make frequent visits to dentists is a problem for many patients, especially those living in rural areas [9]. In such circumstances, the use of teledentistry allows for timely diagnosis and prevention of possible complications during prosthetic treatment [10, 11].

Digital photography using a smartphone camera is a technically simple and widely feasible method to provide remote monitoring and consultation. Photographs of dental interventions are actively used in research, student education, and patient communication [12].

Teledentistry is experiencing rapid development, driven by advancements in information and telecommunication technologies. The application of various teledentistry practices is limited by ethical and legislative norms [11, 12].

The necessity to analyze the reliability of remote diagnosis during the patient's adaptation period to PRDs led to the selection of the aim of this study.

**MATERIALS AND METHODS**

The study included patients undergoing orthopedic treatment at the clinic of the dentistry department and the university clinic, who were fitted with PRDs that met clinical requirements. The patients underwent training using prostheses and received recommendations

for the adaptation period. Care and usage instructions for the prosthesis were provided according to a pre-agreed standardized protocol. Follow-up examinations were scheduled for each patient after 2 days. Patients who underwent follow-up examination at the department clinic were selected for the study. Patients with toxic and allergic reactions to PRD components were excluded from the study. During the clinical follow-up examination, the dentist assessed the presence or absence of traumatic prosthetic stomatitis by using a commonly accepted methodology.

For the clinical assessment of the prosthetic bed condition, the researcher inquired about patient complaints of pain during prosthesis use and difficulty in chewing food. The objective symptoms of mechanical trauma include erosions, pressure sores, and ulcers on the mucous membrane of the oral cavity.

Based on the results of the clinical examination, the condition of the patient's oral mucous membrane was characterized as satisfactory, or a diagnosis of traumatic prosthetic stomatitis was established.

Examination findings were recorded in outpatient dental records (form 043/o). After clinical assessment of the prosthetic bed tissues, the researcher performed imaging of the oral cavity area where the prosthesis was previously located using the TytoPro telemedicine control device (TytoCare Ltd., Israel).

The imaging was conducted so that the prosthetic bed area occupied no less than 80% of the image area.

The images were stored on the memory card of the device and synchronized with the cloud storage in their original quality without compression. Each image was numbered from 1 to 57, corresponding to the patient's number in the study. Before the imaging procedure, all patients were informed of the study and provided consent to participate.

Six experts, independently of each other, received links to the photographs of the 57 patients and instructions for their assessment. Each expert was required to determine the presence or absence of traumatic prosthetic stomatitis by using a photograph of the patient's prosthetic bed. No additional information regarding the patients was provided to the experts.

The experts' conclusions regarding each of the proposed images were entered into a text document, where the photograph number corresponded to the conclusion regarding the patient's condition. The conclusions were sent to the researcher via email.

To assess the agreement of conclusions between the experts who conducted clinical diagnosis and those who used remote diagnosis via digital photography, Gwet's

AC1 criterion was utilized [13, 14]. Agreement assessment using Gwet's AC1 criterion provides more reliable results than Cohen's kappa [15].

**RESULTS AND DISCUSSION**

Overall, the study included 57 patients, the majority of whom were male (63%). The ages of the patients ranged from 52 to 61 years.

Among the 57 patients, clinical examination detected 12 individuals (21%) with symptoms of traumatic prosthetic stomatitis. All symptoms were indicative of acute mechanical trauma, such as erosion. The characteristics of the study population are summarized in Table 1.

*Table 1 – Characteristics of the study population (in % out of total number of participants)*

Diagnosis/condition	Sex		Total
	Male	Female	
Traumatic prosthetic stomatitis	4 (7%)	5 (9%)	9 (16%)
Satisfactory condition	32 (56%)	16 (28%)	48 (84%)
Total	36 (63%)	21 (37%)	57 (100%)

Gwet's AC1 criterion was used to assess agreement between experts. The standard interval scale for interpreting agreement was established as follows:  $0.8 \leq AC1 \leq 1.0$  (very good);  $0.6 \leq AC1 < 0.8$  (good);  $0.4 \leq AC1 < 0.6$  (fair);  $0.2 \leq AC1 < 0.4$  (poor); and  $<0.2$  (very poor) [13, 14].

An agreement assessment of expert opinions was conducted separately for the group of patients with confirmed traumatic prosthetic stomatitis and for patients with satisfactory conditions.

In the group of patients with clinically confirmed traumatic prosthetic stomatitis, the agreement value was 0.71 (95% confidence interval (95% CI): 0.58-0.85) (Figure 1).

For patients with satisfactory tissue conditions of the prosthetic bed, the agreement value was 0.76 (95% CI: 0.67-0.88) (Figure 1).

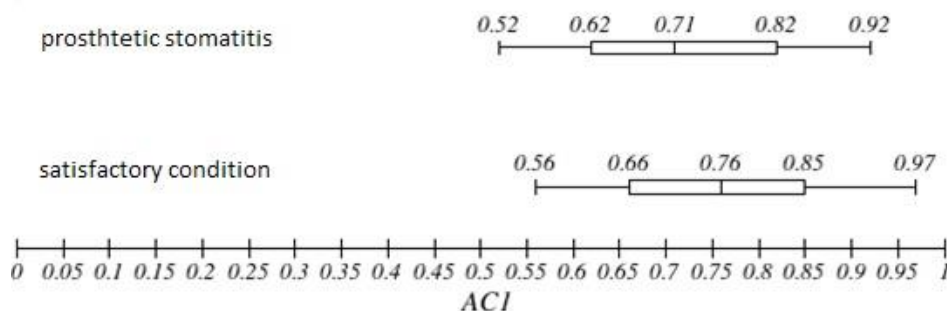
The data showed that the values were concentrated around the mean, suggesting that there were no ambiguities in the diagnoses.

The agreement between the opinions of experts for each of the comparisons in the nominal scale was deemed "good."

The slightly lower agreement result for patients with prosthetic stomatitis may be attributed to cases of less pronounced mucous membrane damage, making it difficult to detect in photographs.

This finding emphasizes the significance of thorough clinical examination for identifying patients with traumatic prosthetic stomatitis, even without the use of remote diagnostic techniques. However, it also underscores the prevalence of this condition in patients fitted with partially removable dentures.

Further analysis revealed a high level of agreement between the conclusions drawn by experts using remote diagnosis through digital photography and those conducting clinical diagnosis. Gwet's AC1 criterion was used to assess this agreement, which provided reliable results compared to other methods.



*Figure 1 – Agreement values of expert opinions in the group of patients with clinically confirmed traumatic prosthetic stomatitis and in patients with satisfactory conditions of the mucous membrane of the prosthetic bed*

These findings indicate that remote diagnosis using digital photography can be a useful tool in assessing traumatic prosthetic stomatitis, particularly in cases where patients residing in rural areas cannot easily visit the dentist. Moreover, the convenience and accessibility

of digital photography make it a practical option for remote diagnosis in dental practice.

The results obtained from the two patient groups demonstrate that remote assessment of the prosthetic field state via photography is comparable to clinical

evaluation. Examining digital images for remote diagnostics provides additional opportunities for multidisciplinary consultation and collaborative patient management by specialists in the same field.

In situations where clinical diagnosis is not feasible, this approach allows for timely patient consultation and prevents the development of serious complications.

The straightforward nature of the proposed methodology makes it suitable for widespread application by both medical personnel and nonprofessionals.

Incorporating additional medical information, such as patient history and complaints, into the remote diagnostic algorithm can enhance diagnostic accuracy.

This study did not consider other forms of the

negative impact of partial removable dentures (PRDs) on the tissues of the prosthetic field, including toxic reactions to excess monomers in the plastic base of the denture, allergic reactions to denture components, hyperplastic reactions of the oral mucosa, and infectious lesions of the prosthetic bed due to wearing PRDs. Furthermore, the initial conditions for denture fixation and stabilization were not considered. Therefore, it is essential to study these factors in future studies.

### CONCLUSION

The assessment of the level of agreement between expert opinions regarding clinical and remote diagnostics of traumatic prosthetic stomatitis is deemed to be "good," thereby facilitating its integration into the teledentistry practice complex.

### PROSPECTS FOR FUTURE RESEARCH

Future investigations should encompass a diverse array of pathological manifestations potentially induced by the application of Removable Partial Dentures (RPDs), including toxicological and/or allergenic responses. Moreover, the augmentation of teledental methodologies for patient surveillance warrants further investigation.

### AUTHOR CONTRIBUTIONS

All authors substantively contributed to the drafting of the initial and revised versions of this paper. They take full responsibility for the integrity of all aspects of the work.

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### CONFLICT OF INTEREST

The authors declare no conflict of interest.

### REFERENCES/СПИСОК ЛІТЕРАТУРИ

- Gendreau L, Loewy ZG. Epidemiology and etiology of denture stomatitis. *J Prosthodont.* 2011 Jun;20(4):251-60. <https://doi.org/10.1111/j.1532-849X.2011.00698.x>. Epub 2011 Apr 4. PMID: 21463383.
- McReynolds DE, Moorthy A, Moneley JO, Jabra-Rizk MA, Sultan AS. Denture stomatitis: an interdisciplinary clinical review. *J Prosthodont.* 2023 Aug;32(7):560-570. <https://doi.org/10.1111/jopr.13687>. Epub 2023 Apr 18. PMID: 36988151.
- Golik VP, Ruzin GP. The quality of fixed prosthetics as a factor in the development of inflammatory processes in the maxillofacial region. *Ukrainskiy stomatologicheskii al'manakh.* 2012. № 4. S.110-116.
- Hannah VE, O'Donnell L, Robertson D, Ramage G. Denture Stomatitis: Causes, Cures and Prevention. *Prim Dent J.* 2017 Dec 1;6(4):46-51. <https://doi.org/10.1308/205016817822230175>. PMID: 29258641.
- Benaissa FZ, Fouad KM, Sofiane C, Latifa K. Stomatitis under prosthetic. Epidemiological study. *IOSR Journal of Dental and Medical Sciences.* 2016;15(6):131-139
- Brantes MF, Azevedo RS, Rozza-de-Menezes RE, Póvoa HC, Tucci R, Gouvêa AF, Takahama-Jr A. Analysis of risk factors for maxillary denture-related oral mucosal lesions: A cross-sectional study. *Med Oral Patol Oral Cir Bucal.* 2019 May 1;24(3):e305-e313. <https://doi.org/10.4317/medoral.22826>. PMID: 31011141; PMCID: PMC6530958.
- Wang LL, Liu XH, Yang LM, Li XX. [Clinical analysis of denture-related oral mucosal lesions in 185 patients with removable denture]. *Shanghai Kou Qiang Yi Xue.* 2020 Feb;29(1):85-88. Chinese. PMID: 32524128.
- Özkan G, Okyay P. The relationship of oral mucosal lesions and removable prostheses: quantitative and qualitative study. *Balkan Journal of Dental Medicine* 2020;24(3):161-169. <https://doi.org/10.2478/bjdm-2020-0026>
- Fahim A, Saleem Z, Malik K, Atta K, Mahmood R, Alam M et al. Exploring challenges and mitigation strategies towards practicing teledentistry. *BMC Oral*

- Health 2022;22(1). <https://doi.org/10.1186/s12903-022-02685-2>
10. Khan SA, Omar H. Teledentistry in practice: literature review. *Telemedicine and e-Health*. 2013;19:7
  11. Raucci-Neto W, Pereira M, Cerqueira N, Louzada V, Castro-Raucci L, Leoni G. Knowledge, perception, and experience of dentists about teledentistry. *International Dental Journal* 2022;72(4):456-462. <https://doi.org/10.1016/j.identj.2021.07.007>
  12. Mariño R, Ghanim A. Teledentistry: a systematic review of the literature. *J Telemed Telecare*. 2013;1-5.
  13. Gwet KL. Computing inter-rater reliability and its variance in the presence of high agreement. *Br J Math Stat Psychol*. 2008;61:29-48.
  14. Gwet KL. Inter-rater reliability with R. Inter-Rate Reliability Publications. Available at: <https://agreestat.com/books/cac5/chapter1/chap1.pdf>
  15. Wongpakaran N, Wongpakaran T, Wedding D, Gwet KL. A comparison of Cohen's Kappa and Gwet's AC1 when calculating inter-rater reliability coefficients: a study conducted with personality disorder samples. *BMC Med Res Methodol*. 2013 Apr 29;13:61. <https://doi.org/10.1186/1471-2288-13-61>. PMID: 23627889; PMCID: PMC3643869.

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