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Original Article

Institutional Insights into the Application of Teledentistry in Clinical Oral and Maxillofacial Pathology

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ABSTRACT

Although the number of dental professionals has seen a modest rise since 2011, nearly all counties in North Carolina—98 out of 100—are classified as Dental Health Professional Shortage Areas by the Health Resources and Services Administration, highlighting a persistent gap in access to both primary and specialized oral healthcare. Providers in these underserved regions often face challenges when attempting to refer patients to oral and maxillofacial pathologists. The COVID-19 pandemic in 2020 further accelerated the adoption of digital solutions, as social distancing measures and lockdowns forced dental schools and practitioners to explore alternative approaches for consultations, teaching, and patient care. This study shares our institution's experience using teledentistry to deliver specialized oral healthcare in rural settings. We conducted a seven-year retrospective case series analyzing patients who underwent remote evaluation of oral lesions, either synchronously or asynchronously, at ECU School of Dental Medicine and an affiliated satellite clinic. For cases that required surgical sampling, we compared the initial clinical impressions and differential diagnoses with the final pathology results to evaluate the diagnostic reliability of teledentistry assessments. A total of 71 patients were included. The majority of consultations were performed asynchronously. Most cases were referred due to suspected malignancies or infectious/reactive lesions, which accounted for 42% and 25.3% of consultations, respectively. These findings indicate that teledentistry can play a crucial role in extending specialized oral healthcare to rural communities by reducing patient travel, shortening the time to diagnosis, and minimizing the number of visits required. Teledentistry offers clinicians a practical and effective tool for evaluating and diagnosing oral mucosal lesions in remote and underserved populations.

Keywords: Rural healthcare access, Oral lesions, Teledentistry, Oral pathology, Telehealth, Oral health

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Introduction

Teledentistry has long been integrated into dental practice, demonstrating clear advantages across multiple domains, including patient and student education, access to specialized care in underserved or rural regions, faster diagnostic-to-treatment timelines, and reduced travel-related costs [1]. Its applications have been documented in cariology, oral pathology and medicine, endodontics, oral radiology, and academic instruction [2, 3].

Despite these benefits, many practitioners remain unfamiliar with the scope of teledentistry. Detecting oral lesions, particularly potentially malignant mucosal conditions, can be challenging for general dentists [4, 5]. In such situations, consultations with oral pathology specialists not only improve diagnostic accuracy but also shorten the interval to treatment, guide the need for surgical sampling, and facilitate timely referrals. These interventions can enhance early detection of oral cancers and expand access to specialized care for patients in rural communities.

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The oral health workforce continues to face challenges in North Carolina. Although the number of dentists has grown and policy initiatives have improved access, much of the state remains a Dental Health Professional Shortage Area (DHPSA), with fewer than six dentists per 10,000 residents [6]. Simultaneously, oral and oropharyngeal cancer incidence has risen, from 10.7 per 10,000 residents in 2002 to 12.8 per 10,000, with approximately 1,570 new cases projected in 2022 [7]. These factors underscore the difficulty many patients face in obtaining timely dental care, making early diagnosis and management of oral diseases increasingly critical.

The ECU School of Dental Medicine (ECU SoDM) employs a unique model combining education and patient care through eight Community Service-Learning Centers (CSLCs) across rural areas. These centers have incorporated telehealth for virtual lectures, seminars, and provider-to-provider consultations, particularly in endodontics and oral and maxillofacial pathology. Telehealth enables clinicians to provide high-quality care to patients in remote locations while supporting local providers in evaluating and managing oral conditions. This manuscript describes our experience using both synchronous and asynchronous teledentistry at the ECU SoDM Ahoskie CSLC for the assessment of oral lesions and evaluates the effectiveness of these consultations in accurate diagnosis and patient management.

Materials and Methods

We conducted a retrospective case series evaluating patients who underwent virtual assessment of oral lesions at ECU SoDM Ahoskie CSLC and the Ross Hall main campus. The study was approved by the ECU Institutional Review Board (UMCIRB 22-000936) and adhered to Helsinki Declaration standards and institutional research protocols.

Synchronous teledentistry was defined as real-time interactions between two dental providers while the patient remained in the chair. Consultations were requested by General Dentistry Faculty, Advanced Education in General Dentistry Residents, and dental students, and provided by specialists in Oral Surgery, Oral Pathology, and Oral Radiology. Real-time imaging was captured using intraoral cameras (DEXcam™ 4 HD, DEXIS™, PA, USA; SOPRO 617, Norwich, UK), connected endodontic microscopes (Global G3 Surgical Microscope, Global™, MO, USA), or extraoral cameras (InVision Teleconsultation Camera, Enovate Medical LLC, Tennessee, USA).

Asynchronous teledentistry involved clinicians sending patient information—including images, radiographs, case summaries, and clinical impressions—through secure messaging or electronic health records after the appointment. Consultants responded with a presumptive diagnosis, working diagnosis, and recommended management plan, typically within 24–48 hours. **Figures 1–4** provide visual representations of the synchronous and asynchronous consultation workflows at our clinics.

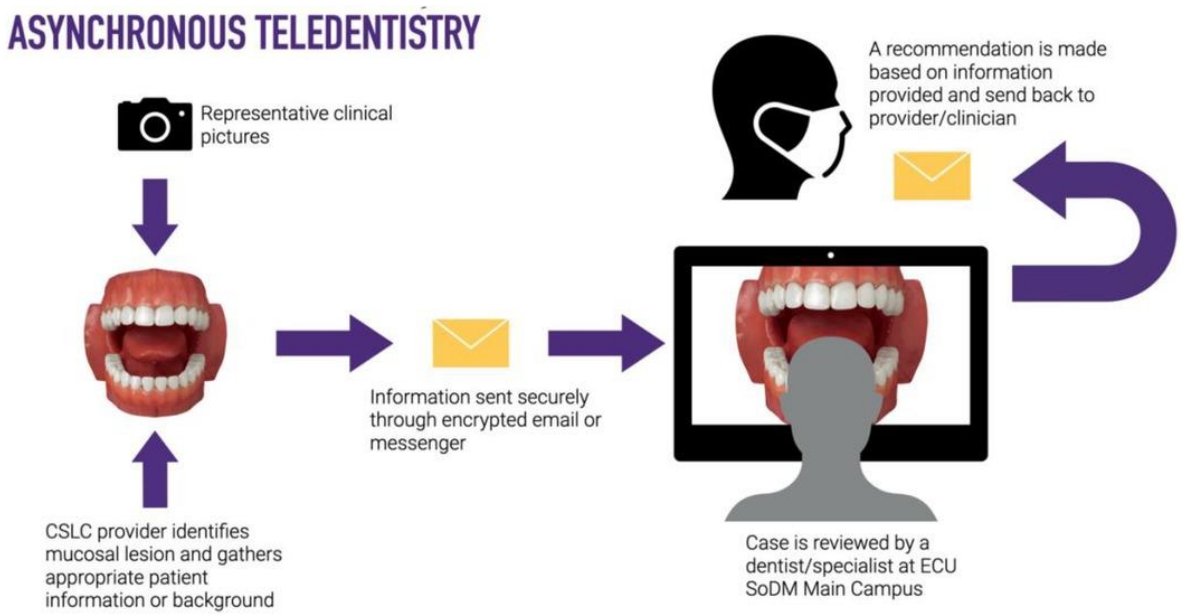

Figure 1. Diagram of an asynchronous consultation.

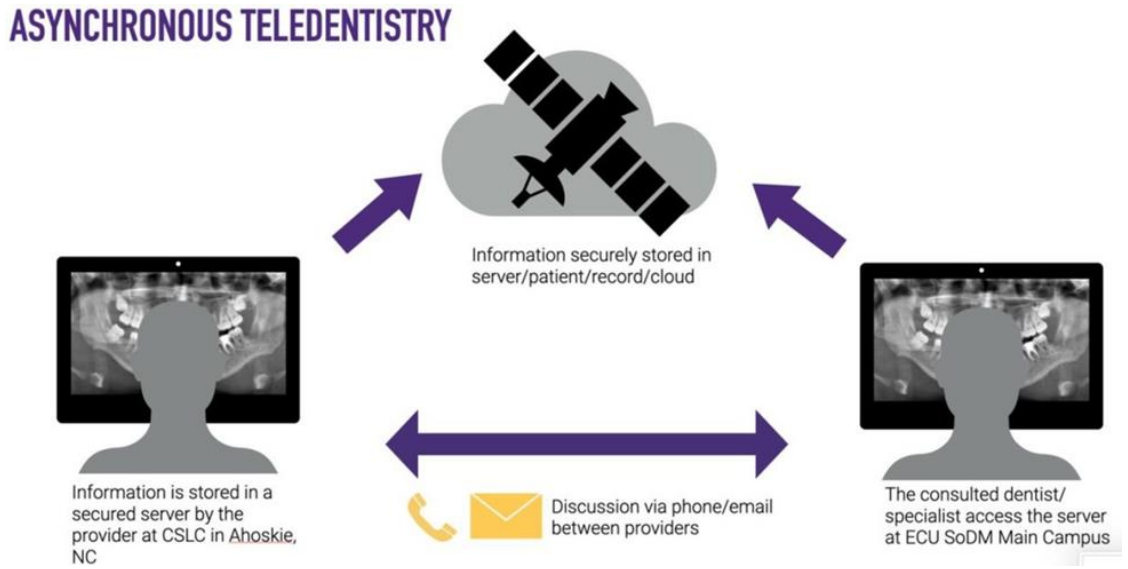

Figure 2. Diagram of the "store-and-forward" workflow for asynchronous and synchronous consultations.

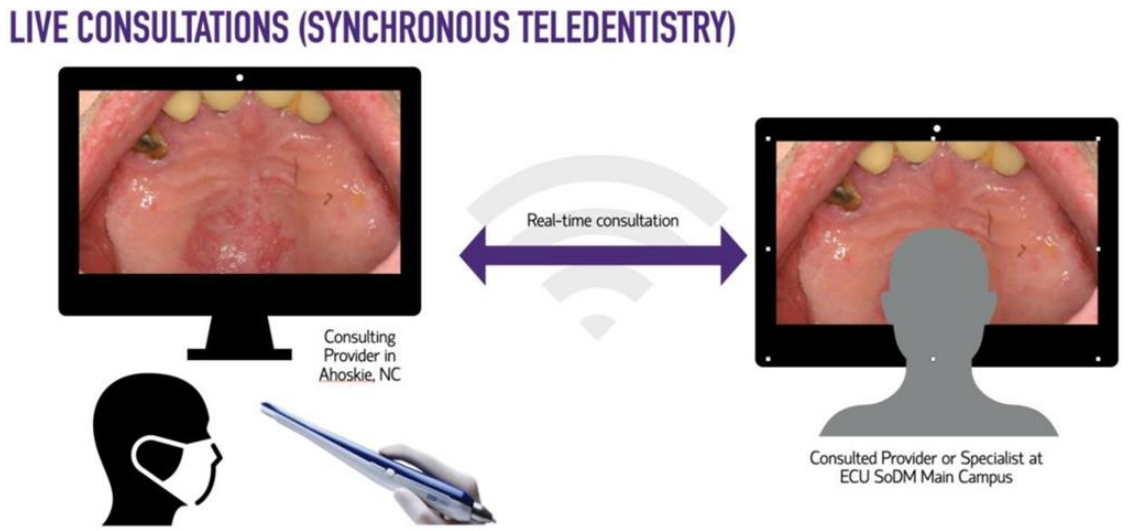

Figure 3. Workflow diagram of synchronous or "real-time" consultations.

Figure 4. Example of synchronous "provider-to-provider "consultation between a satellite clinic in Spruce Pine, NC and Main Campus in Greenville, NC (313 miles apart).

All patients presenting with oral mucosal or radiographic lesions of concern were evaluated remotely via synchronous or asynchronous teledentistry between January 1, 2014, and December 31, 2021, and were included in this study. The assessment of oral lesion management followed Donabedian's framework for process improvement, focusing on the care delivery modality, the type of care provided, and the impact of teledentistry on patient care. The clinic biopsy log was cross-checked against

procedural and billing codes as well as surgical pathology records. For cases involving surgical sampling, initial clinical impressions or differential diagnoses were compared with final histopathologic results to determine the accuracy of teledentistry-based evaluations. Statistical analysis was performed using IBM SPSS Statistics (Version 28.0, IBM Corp, Armonk, NY, 2021) to calculate F-scores and assess equality of variance between groups [8]. All biopsy specimens were examined by a board-certified oral and maxillofacial pathologist.

Additional variables collected included the type of teledentistry used (synchronous vs. asynchronous), patient home location (urban vs. rural), type of consulting provider (dental student, AEGD resident, or faculty), clinical presentation and initial differential diagnoses, histopathologic findings, time elapsed between consultation and treatment, and treatment outcomes, when available. The interval between consultation and treatment was measured in days from the remote evaluation to the day of biopsy, where applicable.

Results and Discussion

The study cohort comprised 71 patients, aged 10 to 82 years (mean 57), with males representing 63% of the population, resulting in a male-to-female ratio of approximately 2:1. The majority of consultations were asynchronous (store-and-forward), relying on clinical images or radiographs. All patients resided in areas designated as rural by zip code. About 80% of consultations were initiated by dental residents, faculty, or dental students.

For analysis, clinical impressions or reasons for oral pathology consultation were categorized as suspicious for malignancy or potentially malignant lesions, immune-mediated disorders, developmental lesions, or viral/infectious/reactive conditions. The most common categories were potentially malignant lesions (42%) and infectious/reactive conditions (25.3%). Developmental lesions, including odontogenic and non-odontogenic cysts and tumors not associated with odontogenic infections, accounted for 21.1% of cases. **Table 1** summarizes the clinical appearance of lesions and the number of encounters in each category.

Table 1. Number and percentages of differential diagnoses or reasons for teledentistry consultation with remote oral and maxillofacial pathology

Clinical Concern / Differential Diagnosis	Cases n [%]
Suspected malignancy or potentially malignant lesions, e.g.: **• "Rule out malignancy"** **• "Leukoplakia"** **• "Erythroleukoplakia"**	24 [42%]
Immune-mediated disorders, e.g.: **• "Lichenoid reaction vs. lichen planus"** **• "Rule out lichenoid reaction"** **• "Desquamative gingivitis"**	2 [3.5%]
Developmental lesions (odontogenic or non-odontogenic), e.g.: **• "OKC vs. ameloblastoma"** **• "Radiolucent lesion unrelated to dentition"** **• "Painless palatal swelling"**	12 [21.1%]
Viral lesions, e.g.: **• "Cauliflower-like growth"** **• "Papillomatous lesion"** **• "Papillary mass on posterior palate"**	4 [7%]
Infectious or reactive conditions, e.g.: **• "Upper lip swelling after trauma"** **• "Lower mucosal lip nodule"** **• "Periapical radiolucency"**	15 [26.3%]

Among the cases reviewed, 57 required surgical biopsy—either incisional or excisional—with subsequent microscopic analysis. The choice to proceed with biopsy was made jointly by the patient and both the local and remote providers, following a careful review of the clinical presentation, comprehensive medical history, and any additional diagnostic tests deemed necessary. The average time from initial consultation to biopsy was 9.6 days. Biopsy outcomes were categorized into seven groups: malignant tumors, benign tumors, premalignant mucosal disorders, infectious lesions, reactive lesions, developmental anomalies, and immune-mediated conditions. Reactive lesions comprised the largest subset, representing 36.84% of all diagnoses, and included entities such as pyogenic granulomas, traumatic ulcerative granulomas with stromal eosinophilia, and traumatic fibromas. Malignant tumors were identified in eight patients. **Table 2** provides a detailed breakdown of biopsy results by category. Comparison between the preliminary clinical impressions and final histopathology demonstrated strong concordance, with an F-score of 0.80.

Table 2. Final histopathological diagnoses for lesions that required surgical biopsy/sampling following a teledentistry consultation. There are examples of the specific diagnoses assigned to cases.

Final histopathological diagnosis category	Examples of specific diagnoses	Cases n [%]
Malignant or premalignant neoplasms	• Oral epithelial dysplasia • Adenoid cystic carcinoma	8 [14%]

Infectious conditions	• Radicular cyst • Periapical granuloma • Actinomycosis • Candidiasis	12 [21%]
Reactive lesions	• Mucocele • Traumatic ulcerative granuloma with stromal eosinophilia • Pyogenic granuloma • Gingival fibroma	21 [36.8%]
Developmental cysts/tumors (odontogenic or non-odontogenic)	• Dentigerous cyst • Lateral periodontal cyst • Nasopalatine duct cyst	6 [10.5%]
Benign neoplasms	• Hemangioma • Odontoma	6 [10.5%]
Immune-mediated conditions	• Lichen planus • Lichenoid mucositis	4 [7%]

Teledentistry has significantly enhanced the impact of ECU SoDM by fostering professional collaboration among providers, maintaining effective communication between the School of Dental Medicine and faculty at its CSLCs, expanding the availability and quality of oral healthcare for rural populations, and reducing the time needed for diagnostic evaluation through the Division of Oral and Maxillofacial Pathology. Our findings indicate that teledentistry can improve access to specialized dental care without requiring complex technology or extensive infrastructure.

Previous studies have similarly documented the use of virtual imaging and radiographs for remote consultations in oral lesion diagnosis [5, 9, 10]. While in-person evaluations remain the gold standard for definitive diagnosis, teledentistry has proven to be a valuable tool, particularly when high-resolution clinical images and comprehensive case summaries are available to prioritize referrals, especially in cases with high suspicion for malignancy [11-14].

This is especially relevant for older adults, who comprised a large proportion of lesions in our study. Teledentistry is particularly advantageous for aging populations and individuals facing health disparities or limited access to dental care. For instance, the 2018 North Carolina Health Equity Report noted that in 2016, 32% of White adults, 44% of African American adults, and 51% of Hispanic/Latinx adults in North Carolina did not visit a dental provider. Limited availability of dental professionals in rural areas, long travel distances to urban centers, and financial barriers are key factors contributing to these disparities [15, 16]. By reducing barriers such as travel, mobility limitations, and social or physical isolation, teledentistry can help bridge these gaps in care [17].

The majority of biopsy findings in our study were benign lesions, primarily associated with reactive or infectious etiologies, including pyogenic granulomas, traumatic fibromas, and hyperkeratosis. Despite this, most virtual consultations were initiated due to clinical concern for malignancy. These results align with previous literature reporting teledentistry as an effective screening tool for oral mucosal lesions and early oral cancer detection, consistent with the strong diagnostic accuracy observed in our study [10, 13, 18]. Eight cases (14%) were identified as malignant or potentially malignant lesions, corroborating findings such as those reported by Petruzzi and De Benedittis [19], including a middle-aged African American patient with a mass on the floor of the mouth **(Figure 5)**. Notably, the biopsy and initial management of this patient were performed by a senior dental student under on-site faculty supervision, with guidance from a remote oral pathologist via teledentistry [20]. This illustrates not only the clinical utility of teledentistry but also its educational and research value, providing students with increased exposure to specialized care. Similar models of remote education and clinical support were first explored by the U.S. Armed Forces and have been further developed in the context of the COVID-19 pandemic [21-23].

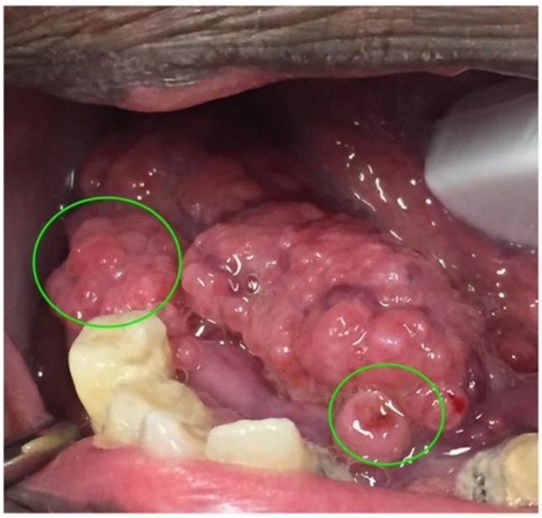

Figure 5. Biopsy locations recommended remotely by the oral and maxillofacial pathologist during a synchronous teledentistry consultation. Image adapted from Bankhead *et al*. [20].

Our experience demonstrates that using intraoral and high-resolution extraoral imaging devices can greatly expand access to specialized dental care for patients in rural communities. Teledentistry is not intended to replace traditional in-person consultations but rather

serves as a supportive tool in clinical oral pathology, assisting general practitioners when diagnostic uncertainty exists and facilitating appropriate patient management. This support is especially crucial in rural regions where patients often must travel long distances to consult an oral and maxillofacial pathologist or oral medicine specialist. All participants in this study resided in rural areas of Eastern North Carolina, primarily within or near Hertford County. In these areas, fewer than five dental professionals provide care for a population exceeding 4,000 residents, and to our knowledge, there are no practicing oral and maxillofacial pathologists or oral medicine specialists, making our CSLC the only source of access to this level of specialized dental care locally.

Several limitations of this study should be noted. Its retrospective design may have led to underreporting of remote consultations that did not result in surgical sampling. Additionally, the data were collected by multiple providers over several years, which could introduce variability. The absence of a control group is another limitation, though conducting a controlled study within our patient population and institutional setting is challenging.

Conclusion

Enhancing the early detection of oral lesions through teledentistry represents a critical step toward timely diagnosis and intervention. By enabling specialists to evaluate and manage lesions remotely, teledentistry removes geographical barriers and facilitates early identification, particularly for malignant and potentially malignant conditions. Future research should explore the economic implications of providing these services and compare outcomes with traditional in-person evaluations. Surveys assessing dental provider satisfaction with teledentistry could further inform its implementation and optimization in clinical practice.

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Conflict of Interest: None

Financial Support: None

Ethics Statement: The studies involving human participants were reviewed and approved by East Carolina University University and Medical Center Institutional Review Board. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

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