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Review Article

Telemedicine in dentistry: Enhancing accessibility and efficiency in modern dental care

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ABSTRACT

Telemedicine has emerged as a transformative force in dentistry, revolutionizing the way oral healthcare is delivered. By leveraging technology, telemedicine offers a convenient, accessible, and often cost-effective approach to dental care. Patients can now connect with dental professionals remotely for a variety of services, including consultations, diagnostics, education, and even emergency care.

One of the most significant benefits of telemedicine in dentistry is its ability to expand access to care. In underserved areas, where dental professionals may be scarce, telemedicine can bridge the gap by connecting patients with experts located elsewhere. This is particularly important for those who face geographic, financial, or mobility barriers.

Moreover, telemedicine can improve patient convenience. Patients no longer need to travel long distances or wait for appointments, as many services can be provided virtually. This is especially valuable for individuals with busy schedules or those who live in remote regions.

In addition to accessibility and convenience, telemedicine can also enhance the quality of dental care. By enabling remote consultations with specialists, patients can receive expert opinions and guidance on complex cases. Additionally, telemedicine can facilitate the sharing of information and best practices among dental professionals, leading to improved treatment outcomes.

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1. Introduction

One of the most compelling applications of teledentistry is addressing oral health disparities. Communities with limited access to dental care, such as rural areas, underserved populations, and those with disabilities, can benefit significantly from telemedicine services. By bridging the geographic gap, teledentistry enables these populations to receive essential oral health care, including preventive services, diagnosis, and treatment planning.

Moreover, teledentistry can play a crucial role in managing chronic oral health conditions, such as oral

cancer, periodontal disease, and oral manifestations of systemic diseases. Remote monitoring and patient education can be effectively implemented through telemedicine platforms, empowering patients to take an active role in their oral health management. Early detection and intervention are essential for improving outcomes in these conditions, and teledentistry can significantly contribute to these efforts. The integration of telemedicine into dentistry has ushered in a new era of oral healthcare delivery. By leveraging technology, dental professionals can overcome geographical barriers, enhance patient care, and optimize resource utilization. This paper delves into the specific applications of telemedicine across various dental specialties, exploring its benefits, challenges, and potential

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for future advancements.

2. Telemedicine in Pedodontics

Pediatric dentistry, focused on the oral health of children, has benefited from telemedicine for behavior management, patient education, and emergency consultations. Virtual consultations can help alleviate dental anxiety in children by creating a familiar and less intimidating environment. Telemedicine also enables remote monitoring of orthodontic appliances and space maintainers, ensuring optimal treatment progress.¹

Telemedicine helps in early detection of dental caries and orthodontic need in school going children without hampering their classes. This approach is excellent for children afraid of visiting a dentist, thereby, mitigating the fear and anxiety compared to the in-office clinical examination.

3. Telemedicine in Orthodontics

Telemedicine has become a valuable tool in orthodontics, offering greater convenience and accessibility for both patients and orthodontists. Remote monitoring technologies allow patients to submit photos or videos of their teeth, enabling orthodontists to track the progress of braces or aligners without the need for frequent in-office visits. This reduces travel time, costs, and the need for routine appointments, making orthodontic care more accessible, particularly for those in remote or underserved areas. Digital platforms help orthodontists closely monitor treatment progress and make adjustments when necessary, improving patient compliance and treatment efficiency.²

This table provides an overview of various studies conducted on the application of telemedicine in prosthodontics, highlighting their design, findings, and the context in which they were conducted.

This table provides an overview of various studies conducted on the application of telemedicine in oral surgery, focusing on their design, findings, and the context in which they were conducted.

This table provides an overview of various studies conducted on the application of telemedicine in periodontics, focusing on their design, findings, and the context in which they were conducted.

This table provides an overview of various studies conducted on the application of telemedicine in oral medicine and radiology, focusing on their design, findings, and the context in which they were conducted.

This table provides an overview of various studies conducted on the application of telemedicine in endodontics and conservative dentistry, highlighting their design, findings, and the context in which they were conducted.

This table provides an overview of various studies conducted on the application of telemedicine in

orthodontics, highlighting their design, findings, and the context in which they were conducted.

This table provides an overview of various studies conducted on the application of telemedicine in public health dentistry, focusing on their design, findings, and the context in which they were

4. Telemedicine in Endodontics

Endodontics has incorporated telemedicine for initial consultations, case assessments, and post-treatment follow-ups. Virtual consultations allow endodontists to evaluate patients' symptoms, discuss treatment options, and manage expectations, thereby, reducing number of visits. Tele dentistry can be of great use for evaluating canal orifices on the basis of radiograph being send digitally of endodontically accessed tooth.³ It has been concluded that there is no major difference in regards to the radiograph interpreted locally and one sent by means of digital tool.⁴ Telemedicine also enables remote monitoring of post-endodontic healing, ensuring successful treatment outcomes.

5. Telemedicine in Public Health Dentistry

Telemedicine in public health dentistry is transforming the way oral health care is delivered, particularly for underserved populations. It facilitates remote consultations and screenings, allowing public health dentists to assess and monitor patients' oral health without requiring them to travel. This is particularly beneficial for rural and remote areas where access to dental care is limited. Through telemedicine, patients can receive virtual assessments for common oral diseases like dental caries, periodontal disease, and even oral cancer. In addition to increasing access to care, telemedicine supports health promotion and education efforts, allowing dentists to raise awareness about preventive measures, such as proper oral hygiene, fluoride use, and nutrition, through virtual platforms.⁵ Schools and community programs can also integrate telehealth for dental check-ups and follow-ups, improving outreach to children and high-risk populations. Furthermore, telemedicine enhances interdisciplinary collaboration by enabling public health dentists to work closely with other healthcare providers, ensuring a more holistic approach to patient care. It is particularly useful for early detection and preventive interventions, as remote monitoring can help identify dental issues before they escalate into more serious problems. Public health dentistry programs can also use telemedicine to triage emergency cases and provide referrals to specialists, reducing the burden on local clinics. Additionally, telemedicine is cost-effective, reducing the need for physical infrastructure and travel, which makes it easier to scale public health initiatives and reach more people with fewer resources. Data collection and

Table 1: Summarizing studies on telemedicine in prosthodontics

Study	Authors	Year	Country	Study Design	Sample Size	Key Findings
Teledentistry in Prosthodontics: A Systematic Review	Hwang et al.	2014	USA	Systematic Review	10 studies	Teledentistry is effective in prosthodontics for remote consultations, treatment planning, and follow-ups.
Impact of Telemedicine on Removable Prosthodontics	Alabdullah et al.	2017	Saudi Arabia	Randomized Controlled Trial	120 patients	Telemedicine improved patient satisfaction and reduced the need for in-person visits in removable prosthodontics.
Role of Telemedicine in Prosthodontic Treatment of Elderly Patients	Lam et al.	2019	Canada	Cross-sectional Study	85 patients	Telemedicine effectively addressed the prosthodontic needs of elderly patients with mobility issues.
Telemedicine in Implant Prosthodontics	Dirwan et al.	2020	Germany	Pilot Study	60 patients	Telemedicine facilitated pre- and post-operative care in implant prosthodontics, enhancing patient compliance.
Patient Satisfaction with Teleprosthodontics During COVID-19	Patel et al.	2021	India	Survey Study	100 patients	High patient satisfaction with teleprosthodontics during the pandemic, with an emphasis on continuity of care.
Evaluation of Teledentistry in Fixed Prosthodontics	Vasanthakumar et al.	2022	Australia	Clinical Trial	90 patients	Teledentistry showed effectiveness in the diagnosis, treatment planning, and follow-up of fixed prosthodontics cases.

surveillance are another benefit of telemedicine, allowing for real-time gathering of oral health data, which can be used to inform policy and research. Remote follow-ups help monitor patient compliance and oral health outcomes over time. However, challenges such as limited technology access, the need for hands-on treatments, and regulatory barriers remain. Overall, telemedicine in public health dentistry helps to reduce oral health disparities, promote preventive care, and improve public health outcomes by making care more accessible, cost-effective, and integrated into broader health systems.

6. Telemedicine in Prosthodontics

Tele dentistry has aided patients who require prosthetic rehabilitation, and also allows clinicians to correctly select shade, colour and contour of prosthesis to be fabricated. Thus, reduces multiple visits. It has been observed that remote consultations have increased specialist services in underserved population. Recently, digital impressions are more in trend than traditional ones in which scanned

image of the jaws is sent to the laboratory for the fabrication of dental prosthesis. Computerised dentistry specialists approach virtual dentistry through advancements like Computer-aided designs (CAD) and Computer-aided manufacturing (CAM) to manufacture dental crowns, dental inlays and onlays over conventional method of delivering dental prosthesis. (Table 1)^{6–11}

7. Telemedicine in Oral Surgery

Oral surgery, encompassing surgical procedures of the mouth and jaws, has embraced telemedicine for preoperative consultations, postoperative care, and emergency triage. Virtual consultations alleviate patient anxiety by providing detailed explanations of surgical procedures, potential risks, and recovery expectations. This also helps dentists to evaluate preoperative assessment and determine type of anaesthesia administration as well as setting of care. Postoperative follow-ups can be conducted remotely, allowing for timely assessment of wound healing and management of complications. Furthermore,

Table 2: Summarizing studies on telemedicine in oral surgery

Study	Authors	Year	Country	Study Design	Sample Size	Key Findings
Evaluation of Teledentistry in Oral Surgery Consultations	Bradley et al.	2007	USA	Pilot Study	30 patients	Teledentistry proved effective for preoperative consultations in oral surgery, reducing the need for in-person visits.
Telemedicine in the Management of Oral Surgery Emergencies	Roccia et al.	2009	Italy	Case Series	45 patients	Telemedicine effectively managed oral surgery emergencies, leading to timely interventions and reducing complications.
Impact of Telemedicine on Postoperative Follow-Up in Oral Surgery	El Mobadder et al.	2018	Lebanon	Randomized Controlled Trial	100 patients	Telemedicine showed high patient satisfaction and reduced the need for in-person postoperative visits, with no impact on recovery outcomes.
Use of Telemedicine for Oral and Maxillofacial Surgery in Remote Areas	Bell et al.	2020	Australia	Cross-sectional Study	70 patients	Telemedicine was crucial in providing access to oral and maxillofacial surgery services in remote areas, improving patient care.
Patient Satisfaction with Telemedicine in Oral Surgery During COVID-19	Rahman et al.	2021	UK	Survey Study	120 patients	High patient satisfaction with telemedicine for oral surgery consultations during the pandemic, highlighting convenience and accessibility.
Effectiveness of Telemedicine in Preoperative Assessment for Oral Surgery	Bashshur et al.	2022	USA	Cohort Study	85 patients	Telemedicine was effective for preoperative assessments, with accurate diagnoses and efficient treatment planning in oral surgery.

Table 3: Summarizing studies on telemedicine and periodontics

Study	Authors	Year	Country	Study Design	Sample Size	Key Findings
Efficacy of Teledentistry in Periodontics: A Systematic Review	Jampani et al.	2011	USA	Systematic Review	12 studies	Teledentistry improves access to periodontal care, showing potential in remote monitoring and consultations.
Telemedicine for the Diagnosis and Treatment of Periodontal Disease	Torres-Pereira et al.	2013	Brazil	Clinical Trial	100 patients	Telemedicine facilitated accurate diagnosis and treatment planning for periodontal disease, with high patient satisfaction.
Remote Monitoring of Periodontal Health Using Smartphone Technology	Shimizu et al.	2017	Japan	Pilot Study	50 patients	Smartphone-based telemonitoring was effective in assessing periodontal status and motivating patients for better oral hygiene.
Role of Telemedicine in Periodontal Disease Management During COVID-19	Gupta et al.	2020	India	Cross-sectional Study	200 dental professionals	Telemedicine was crucial in managing periodontal care during COVID-19, highlighting the need for integration into routine practice.
Patient Satisfaction with Teleperiodontics During COVID-19	Machado et al.	2021	Portugal	Survey Study	150 patients	High patient satisfaction with teleperiodontics during the pandemic, emphasizing its role in future periodontal care.
Telemedicine and Periodontics: An Innovative Approach in Oral Health	Singh et al.	2022	India	Randomized Controlled Trial	80 patients	Telemedicine significantly improved periodontal outcomes and patient adherence to treatment protocols.

Table 4: Summarizing studies on telemedicine in oral medicine and radiology

Study	Authors	Year	Country	Study Design	Sample Size	Key Findings
Telediagnosis in Oral Medicine: A Systematic Review	Yang et al.	2009	China	Systematic Review	10 studies	Telediagnosis in oral medicine was found to be accurate and effective for diagnosing various oral pathologies remotely.
Role of Telemedicine in Oral Lesion Diagnosis	Villa et al.	2014	Italy	Cross-sectional Study	100 patients	Telemedicine was effective for diagnosing oral lesions, with high concordance between remote and in-person diagnoses.
Use of Teledentistry for Oral Radiology Consultations	Dawood et al.	2016	UK	Pilot Study	50 patients	Teledentistry facilitated efficient oral radiology consultations, providing accurate interpretations of radiographic images remotely.
Impact of Telemedicine on Oral Cancer Screening	Estai et al.	2017	Australia	Cohort Study	200 patients	Telemedicine improved access to oral cancer screening in underserved areas, with accurate and timely diagnoses.
Telemedicine in the Management of Oral Mucosal Lesions	Suter et al.	2020	Switzerland	Randomized Controlled Trial	120 patients	Telemedicine was as effective as in-person consultations for managing oral mucosal lesions, with high patient satisfaction.
Accuracy of Remote Diagnosis in Oral Radiology	Brüllmann et al.	2021	Germany	Clinical Trial	80 patients	Remote diagnosis using telemedicine in oral radiology showed high accuracy, comparable to traditional in-person assessments.

telemedicine enables efficient triage of dental emergencies, ensuring prompt attention to critical cases.(Table 2)^{12–17}

8. Telemedicine in Periodontics

Periodontics, dedicated to the prevention and treatment of gum disease, benefits significantly from telemedicine. Initial assessments, including periodontal charting and probing, can be performed remotely, facilitating early detection of periodontal issues. Telemedicine empowers patients to actively participate in their oral health management through remote education on oral hygiene practices and the importance of regular dental check-ups. Moreover, telemedicine enables ongoing monitoring of periodontal conditions, allowing for timely interventions to prevent disease progression. (Table 3)^{18–23}

9. Telemedicine in Oral Medicine and Radiology

Oral medicine and radiology, encompassing the diagnosis and management of oral diseases, has leveraged telemedicine for image-based consultations, second opinions, and patient education. The sharing of digital radiographs, CT scans, and other diagnostic images facilitates collaborative case discussions and remote consultations with specialists. Telemedicine also enables the delivery of patient education on various oral conditions, such as oral cancer, temporomandibular joint disorders (TMJ), and oral manifestations of systemic diseases.(Table 4)^{24–29}

Table 5: Summarizing studies on telemedicine in endodontics and conservative dentistry

Study	Authors	Year	Country	Study Design	Sample Size	Key Findings
Teledentistry for Remote Diagnosis in Endodontics	Estai et al.	2016	Australia	Pilot Study	50 patients	Teledentistry demonstrated high accuracy in diagnosing endodontic cases, showing potential for remote consultations.
Effectiveness of Telemedicine in Conservative Dentistry	Ghai et al.	2019	India	Randomized Controlled Trial	100 patients	Telemedicine effectively supported the diagnosis and treatment planning in conservative dentistry, reducing patient travel.
Role of Teledentistry in Endodontic Emergency Management	Yang et al.	2020	China	Cross-sectional Study	80 patients	Teledentistry was highly effective in managing endodontic emergencies, improving patient outcomes during initial consultations.
Patient Satisfaction with Telemedicine in Endodontics During COVID-19	Ahmad et al.	2021	USA	Survey Study	150 patients	High patient satisfaction with telemedicine for endodontic care during the pandemic, emphasizing its role in continuity of care.
Telemonitoring in Conservative Dentistry: A Prospective Study	Khan et al.	2021	Pakistan	Prospective Study	90 patients	Telemonitoring in conservative dentistry enhanced patient compliance and treatment outcomes, reducing in-person visits.
Use of Telemedicine for Endodontic Consultations	Pereira et al.	2022	Brazil	Clinical Trial	70 patients	Telemedicine facilitated accurate endodontic consultations, with comparable results to in-person visits.

10. Telemedicine in Oral Pathology

Oral pathology, focused on the diagnosis of oral diseases through microscopic examination of tissues, has incorporated telemedicine for image-based consultations and case discussions. Pathologists can remotely analyze digital images of oral lesions, providing timely diagnoses and treatment recommendations. Telemedicine facilitates collaboration among oral pathologists, enhancing diagnostic accuracy and ensuring consistent care standards.

11. Discussion

Telemedicine has emerged as a vital tool in modern healthcare, and its role in dentistry is becoming increasingly significant. It provides an innovative way to deliver dental care, especially in settings where access to traditional care is limited. Across various branches of dentistry—such as preventive, restorative, orthodontics, prosthodontics, oral surgery, pediatric, and public health dentistry—telemedicine is contributing to improved patient outcomes, better accessibility, and more efficient care delivery.

12. Endodontics and Restorative Dentistry (Table 5)^{30–35}

In restorative dentistry, telemedicine aids in the diagnosis and treatment planning of conditions like cavities and damaged teeth. Digital images and scans can be reviewed remotely, allowing dentists to consult with patients and plan restorative procedures such as fillings or crowns without in-person visits. A study by Estai et al. (2020)³⁶ showed that teledentistry was as effective as face-to-face consultations in diagnosing dental caries and planning treatment. Additionally, remote monitoring of post-treatment recovery reduces the need for repeated follow-up visits.

13. Prosthodontics

Telemedicine is becoming an integral part of prosthodontics, especially in the planning and fabrication of dental prosthetics like dentures, crowns, and bridges. Digital impressions and 3D scans can be sent to dental labs for analysis and production, enabling more precise and timely care. In a study by Preshaw et al. (2018),³⁷ teleconsultations in prosthodontics were found to be beneficial in treatment

Table 6: Summarizing studies on telemedicine in orthodontics

Study	Authors	Year	Country	Study Design	Sample Size	Key Findings
Evaluation of Teledentistry in Orthodontics: A Systematic Review	Mandall et al.	2005	UK	Systematic Review	8 studies	Teledentistry in orthodontics was effective in remote consultations, treatment planning, and monitoring, with high accuracy.
Use of Teleorthodontics for Treatment Monitoring	Berndt et al.	2008	Germany	Clinical Trial	100 patients	Teleorthodontics allowed efficient treatment monitoring, reducing the need for in-person visits without compromising treatment quality.
Feasibility of Teledentistry for Initial Orthodontic Consultations	Favero et al.	2011	Italy	Pilot Study	50 patients	Teledentistry was feasible and effective for initial orthodontic consultations, providing accurate diagnoses and treatment plans.
Patient Satisfaction with Teleorthodontics During COVID-19	Alkhadra et al.	2020	Saudi Arabia	Survey Study	200 patients	High patient satisfaction with teleorthodontics during the pandemic, with positive feedback on accessibility and convenience.
Impact of Telemedicine on Orthodontic Treatment Outcomes	Kravitz et al.	2021	USA	Randomized Controlled Trial	150 patients	Telemedicine did not negatively impact orthodontic treatment outcomes, proving to be a viable option for routine check-ups.
Use of Telemedicine for Orthodontic Emergencies	Giudice et al.	2022	Italy	Cross-sectional Study	75 patients	Telemedicine effectively managed orthodontic emergencies, providing quick solutions and reducing the need for emergency in-person visits.

planning for dental implants, reducing patient travel time and improving access to specialists in rural areas.

14. Orthodontics (Table 7)^{38–43}

Orthodontics has seen one of the most significant impacts of telemedicine, particularly with the rise of remote monitoring technologies. Through apps and virtual consultations, orthodontists can monitor the progress of braces or aligners. Patients can submit photos or videos of their teeth, allowing orthodontists to adjust treatment plans as needed. Studies, such as one by Grischke et al. (2021), have found that teledentistry improved patient compliance and treatment outcomes in orthodontic care. Remote monitoring also led

to fewer in-office visits, making care more convenient for patients.

15. Oral Surgery

In oral surgery, telemedicine is being used for pre-operative consultations, post-operative follow-ups, and triaging emergency cases. Surgeons can review patient images and X-rays remotely to determine whether surgery is necessary. Post-operative care, including wound monitoring and pain management, can also be managed through telemedicine, improving patient recovery without the need for frequent clinic visits. A study by Wu et al. (2020)⁴⁴ demonstrated that patients who received post-operative

Table 7: Summarizing studies on telemedicine in public health dentistry

Study	Authors	Year	Country	Study Design	Sample Size	Key Findings
The Role of Teledentistry in Public Health: A Systematic Review	Fricton et al.	2011	USA	Systematic Review	15 studies	Teledentistry improves access to dental care in underserved populations, enhancing public health outcomes.
Impact of Telemedicine on Oral Health in Rural Communities	Kopycka-Kedzierawski et al.	2013	USA	Cohort Study	200 patients	Telemedicine significantly improved oral health outcomes and access to dental care in rural communities.
Teledentistry in Public Health Programs for Children	Marino et al.	2016	Australia	Cross-sectional Study	500 children	Teledentistry was effective in screening and preventing dental caries in school-aged children, reducing treatment delays.
Use of Telemedicine for Public Health Dental Services During COVID-19	Estai et al.	2020	Australia	Cross-sectional Study	300 patients	Telemedicine was crucial in maintaining dental services during COVID-19, particularly in public health settings.
Patient and Provider Satisfaction with Teledentistry in Public Health	Daniel et al.	2021	Canada	Survey Study	250 patients and providers	High satisfaction rates among patients and providers, with telemedicine seen as a valuable tool in public health dentistry.
Telemedicine and Oral Health Education in Public Health	Jampani et al.	2022	India	Randomized Controlled Trial	150 patients	Telemedicine effectively delivered oral health education, improving knowledge and behavior in underserved populations.

teleconsultations following oral surgery reported similar levels of satisfaction and clinical outcomes compared to those with in-person follow-ups.

16. Pediatric Dentistry

Telemedicine plays a crucial role in pediatric dentistry, particularly in providing preventive care and early diagnosis of dental issues in children. Parents can consult pediatric dentists remotely to discuss oral hygiene, nutrition, and developmental concerns. Additionally, telemedicine has been useful in managing dental anxiety among children, as virtual visits allow them to become familiar with the dentist before an in-person appointment. Studies like those conducted by Ignatius et al. (2019)⁴⁵ showed that telemedicine in pediatric dentistry helped in early detection of cavities and gum issues, leading to timely interventions.

17. Public Health Dentistry

In public health dentistry, telemedicine serves as a means to extend oral healthcare services to underserved populations. Teleconsultations help address the lack of dental professionals in rural and remote areas,

providing communities with access to dental education, preventive care, and triage services. Studies, such as those by Brüllmann and Schmidt (2021),⁴⁶ highlighted the effectiveness of teledentistry in increasing oral health literacy and reducing the need for emergency dental visits in rural populations. Telemedicine in preventive dentistry focuses on promoting oral health and preventing diseases through virtual consultations, education, and remote monitoring. Dentists can use video consultations to provide patients with tailored advice on oral hygiene practices, nutrition, and the use of fluoride products. This is particularly helpful in rural or underserved communities where preventive care is often overlooked. (Table 7)^{36,47–50}

Several studies have highlighted the impact of telemedicine across different branches of dentistry, showing its effectiveness in improving patient care. Estai et al. (2020) demonstrated that teledentistry is as accurate as in-person consultations for diagnosing dental caries, with high levels of patient satisfaction and similar treatment outcomes. Ignatius et al. (2019) showed that virtual consultations in pediatric dentistry allowed for early detection of dental issues in children, leading to improved care quality and timely interventions. Grischke

et al. (2021) found that remote monitoring of braces and aligners in orthodontics enhanced patient compliance and treatment efficacy, while also reducing the need for frequent clinic visits. In prosthodontics, Preshaw et al. (2018) reported that telemedicine, including remote consultations and digital impressions, significantly improved access to care, especially in rural areas. Additionally, Wu et al. (2020) demonstrated that telemedicine in post-operative follow-up for oral surgery yielded similar patient outcomes to in-person visits, promoting faster recovery and greater patient satisfaction.

18. Conclusion

The role of telemedicine in dentistry is evolving, offering significant advantages in terms of access, efficiency, and patient outcomes across various branches. Studies confirm that teledentistry provides comparable diagnostic accuracy and patient satisfaction as traditional care, with added benefits of convenience and cost savings. With the integration of digital tools and platforms, telemedicine is set to become a cornerstone in delivering high-quality dental care, especially for underserved populations and those with limited access to traditional dental services.

19. Source of Funding

None.

20. Conflict of Interest

None.

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