IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Orthodontic Management In The Era Of Tele-Dentistry: A Review

[1] DR. GAYATHRI SWETHA G [2]DR.GNANAPRABHAVADHI M [3] DR. RAJVIKRAM N [4] DR. SARAVANAN R [5] DR. JEEVANA POOVALINGAM

[1] HOUSE SURGEON. [2] HOUSE SURGEON [3] PROFESSOR [4] PROFESSOR[5] SENIOR LECTURER

Abstract

The rapid evolution of digital health technologies has transformed orthodontic care, with teledentistry emerging as a pivotal tool for remote diagnosis, treatment planning, and patient monitoring. This comprehensive review explores the evolution, applications, and clinical efficacy of teleorthodontics, emphasizing its role in enhancing accessibility, efficiency, and patient engagement. Integration of artificial intelligence (AI), 3D imaging, and cloud-based platforms has enabled precise diagnostics, virtual consultations, and real-time treatment tracking. Despite its numerous advantages, challenges such as limited tactile assessment, data security concerns, and unequal digital access remain significant barriers. Emerging innovations, including AI-driven predictive modeling, augmented reality, wearable sensors, and blockchain-based data security, are shaping the next generation of orthodontic care. The future lies in hybrid models that combine technological sophistication with personalized, patient-centered clinical practice for sustainable and equitable orthodontic management.

Keywords: Teledentistry, Orthodontic management, Artificial intelligence, Remote monitoring, Digital dentistry

Introduction

The global shift toward digital healthcare has profoundly transformed dentistry, revolutionizing how oral health services are delivered, accessed, and managed. Modern dental practice increasingly relies on advanced digital tools such as artificial intelligence (AI), 3D printing, intraoral scanning, and cloud-based workflows to enhance diagnostic precision, streamline treatment planning, improve patient engagement, and promote personalized care. Within this transformation, teledentistry an emerging subset of telemedicine has become a key enabler of remote dental consultations, diagnostic assessments, and treatment monitoring through secure digital platforms.[1] This approach significantly enhances accessibility, particularly for individuals in rural or underserved regions and for patients requiring regular follow-ups, such as those undergoing orthodontic treatment. The COVID-19 pandemic further accelerated the adoption of teledentistry, highlighting its value in maintaining continuity of orthodontic care while minimizing in-person visits and infection risks. In orthodontics, the integration of teledentistry has ushered in a new era of patient-centered, efficient, and accessible care, enabling clinicians to conduct virtual consultations, evaluate diagnostic records, and remotely monitor treatment progress using digital imaging and video communication tools.[2]

Platforms like SmileMate, Dental Monitoring, and Odonto Aligners exemplify the use of these technologies, supporting live assessments, progress tracking, and case documentation while strengthening the orthodontist–patient relationship.[3] Patients benefit through improved convenience, reduced travel time, and timely management of appliance-related issues, whereas practitioners gain through optimized workflows, efficient resource utilization, and better communication. Despite these advantages, challenges persist in ensuring high-quality image capture, safeguarding patient data, and effectively integrating teleorthodontic workflows into conventional clinical systems. Nevertheless, continuous advancements in AI-driven diagnostics, secure telecommunication technologies, and interoperable health data systems are steadily overcoming these limitations.[4] In the Indian context, the National Telemedicine Guidelines issued in 2022 have provided a comprehensive regulatory framework to support teledentistry and other telehealth practices, outlining standards for clinician-patient authentication, informed consent, clinical evaluation, and data security. These measures reinforce patient trust and promote the ethical and effective integration of teledentistry into mainstream healthcare delivery.[5]

Evolution and Framework of Teledentistry

The evolution of teledentistry dates back to the late 1980s with the emergence of dental informatics, laying the foundation for digital integration in oral healthcare. It gained operational significance in 1994 through the U.S. Army's Total Dental Access Project, which pioneered remote consultations and dental education to enhance accessibility and reduce costs, particularly for military personnel and rural communities. The term *teledentistry* was formally introduced in 1997 by Cook, defining it as the application of telecommunications and digital technologies to deliver dental care, consultation, and education remotely.[6] Over the years, teledentistry has matured into a structured discipline encompassing four major components teleconsultation, involving real-time or asynchronous two-way communication between patients and dental professionals; telediagnosis, which enables remote assessment of clinical images, radiographs, and data for diagnostic and treatment purposes; telemonitoring, which allows ongoing digital tracking of patient progress, especially crucial in orthodontic management; and tele-education, which supports online professional training and patient education initiatives. Its effectiveness is driven by a range of technological enablers, including high-resolution digital imaging systems integrated with Cone Beam Computed Tomography (CBCT) for precise remote diagnostics, intraoral scanners and 3D printing for accurate data capture and appliance fabrication, cloud-based data sharing and Electronic Health Record (EHR) integration for seamless collaboration, and AI-powered diagnostic tools that enhance accuracy, personalization, and predictive analysis.[7]

Teledentistry operates through three primary workflow models: the *store-and-forward* approach, where patient data is collected and transmitted asynchronously for expert review—ideal in resource-limited settings; *real-time video conferencing*, enabling live consultations, diagnosis, and follow-up; and *hybrid models*, which combine both modalities for comprehensive care delivery. However, the expansion of teledentistry also necessitates careful attention to ethical, legal, and regulatory considerations, including stringent data privacy and cybersecurity protocols to safeguard patient information, obtaining informed consent prior to teleconsultations, and addressing cross-border legal complexities.[8] Compliance with global and national regulations such as those established by the ADA (American Dental Association), DCI (Dental Council of India), GDC (General Dental Council, UK), HIPAA (Health Insurance Portability and Accountability Act, USA), and GDPR (General Data Protection Regulation, Europe) is essential for ethical practice. In India, the *Telemedicine Practice Guidelines (2020)* provide a legal and professional framework for implementing teledentistry safely and effectively, outlining standards for authentication, consent, and data handling.[9]

Applications of Teledentistry in Orthodontic Practice

Teledentistry has brought a transformative impact to orthodontic practice, streamlining every stage from diagnosis to post-treatment follow-up through the integration of digital technologies and remote workflows. In diagnosis and treatment planning, clinicians can now obtain intraoral photographs, digital scans from intraoral scanners, and radiographic data including Cone Beam Computed Tomography (CBCT) images remotely, enabling comprehensive case assessments without necessitating in-person visits. Advanced AI-assisted software enhances these processes by performing automated cephalometric

analyses, simulating treatment outcomes, and supporting personalized virtual consultations that facilitate second opinions and inter-specialty collaborations, thereby improving clinical decision-making and patient accessibility.[10] The appliance design and fabrication phase has also been revolutionized through the seamless integration of digital impressions with CAD/CAM systems, allowing orthodontists to design and produce customized appliances such as clear aligners and fixed devices remotely using 3D printing and digital manufacturing technologies.[11]

Treatment monitoring has similarly evolved, with patients regularly submitting photos and videos via secure applications often powered by AI platforms like DentalMonitoring and SmileMate which analyze progress, detect issues such as bracket failures or poor aligner compliance, and alert clinicians in real time.[12] This approach significantly reduces the frequency of in-office visits while enhancing treatment adherence and clinical efficiency. During the post-treatment retention and follow-up stage, virtual supervision ensures continuous monitoring of retainer wear and oral hygiene practices, facilitating early identification of relapse or other complications through scheduled tele-evaluations and timely interventions.[13]

Domain	Applications
Diagnosis and Treatment Planning	• Remote collection of intraoral photographs, digital scans, and radiographs (including CBCT) for comprehensive case evaluation. • AI-assisted cephalometric analysis and virtual treatment simulation for enhanced precision and personalization. • Virtual consultations enabling second opinions and interdisciplinary collaboration.
Appliance Design and Fabrication	• Integration of digital impressions with CAD/CAM systems for appliance design. • Remote fabrication of clear aligners and customized fixed appliances using 3D printing workflows.
Treatment Monitoring	• Regular remote progress tracking through patient-uploaded photos/videos. • AI-powered applications detect appliance issues, non-compliance, or treatment deviations. • Enables timely virtual feedback and adjustments.
Post-Treatment Retention and Follow-up	• Virtual supervision of retainer use and oral hygiene maintenance. • Remote detection of relapse or hygiene issues through tele-evaluations. • Ensures long-term continuity of care.

Clinical Efficacy and Patient-Centered Outcomes in Teleorthodontics

Emerging clinical evidence demonstrates that teleorthodontics offers comparable effectiveness to conventional in-office orthodontic care while delivering distinct advantages in patient-centered outcomes. Studies and meta-analyses have shown that remote monitoring systems, particularly those utilizing platforms such as DentalMonitoring®, significantly reduce the number of face-to-face appointments by an average of approximately 2.75 visits and shorten the refinement phase during clear aligner treatments.[14] Despite reduced in-person interactions, treatment accuracy and clinical outcomes remain consistent for various orthodontic procedures, including interceptive and aligner therapies, confirming that teledentistry can successfully supplement or partially replace conventional approaches without compromising quality of care. From a patient perspective, satisfaction levels are notably high, with individuals citing enhanced convenience, reduced travel burden, and improved communication with clinicians as key benefits.[15]

Regular virtual follow-ups and interactive digital engagement foster stronger adherence, motivation, and accountability throughout the treatment process. During the COVID-19 pandemic, teledentistry proved particularly valuable by ensuring continuity of care, managing orthodontic emergencies remotely, and minimizing infection risks while providing psychological reassurance to patients.[16] Economically, teleorthodontics enhances cost-effectiveness by decreasing chairside time and operational expenses, ultimately reducing treatment costs for both practitioners and patients. Moreover, its ability to transcend geographic and socioeconomic barriers has expanded access to orthodontic expertise in underserved and rural areas, promoting greater equity in oral healthcare delivery.[17]

Challenges and Considerations in Teleorthodontic Practice

Despite its transformative potential, teleorthodontics faces several clinical, technological, and ethical challenges that must be addressed to ensure its safe and effective integration into mainstream orthodontic care. A key limitation lies in the lack of tactile assessment and manual intervention, as many orthodontic procedures require physical manipulation, palpation, and appliance adjustments that cannot be performed remotely.[18] Consequently, teledentistry's role is currently confined primarily to diagnosis, monitoring, and minor troubleshooting, while complex treatments still necessitate in-person visits. Another significant constraint is variable image quality and inconsistent patient compliance, as the accuracy of remote assessments depends heavily on the quality of intraoral photographs and videos captured by patients. Inadequate lighting, incorrect angulation, or incomplete visualization can compromise diagnostic accuracy, while irregular submission schedules and procedural errors may further limit effectiveness.[19] Technological barriers also persist, particularly in low-resource or rural areas where poor internet connectivity, limited access to compatible devices, and low digital literacy impede implementation, potentially widening the digital divide in dental care accessibility.[20] Moreover, privacy, data security, and consent issues remain pressing concerns; safeguarding sensitive health data during storage and transmission requires robust encryption, while patients must provide informed consent that explicitly outlines the limitations, risks, and responsibilities associated with teleconsultations.[21] The dependence on commercial AI platforms, such as DentalMonitoring™, poses additional challenges due to limited algorithmic transparency, high costs, and lack of interoperability, which may restrict widespread adoption and clinical standardization. Furthermore, a degree of professional skepticism persists among practitioners regarding the long-term efficacy and diagnostic reliability of teleorthodontics, underscoring the need for more extensive clinical research and validation.[22]

Emerging Technologies and Future Directions in Teleorthodontics[23-25]

Aspect	Application
Artificial Intelligence (AI)	Enhances diagnosis, treatment prediction, and progress assessment through automated analysis and predictive modeling.
Machine Learning Models	Used for facial symmetry evaluation, tooth movement tracking, and anomaly detection.
Wearable Sensors & IoT Devices	Enable real-time monitoring of patient compliance and appliance usage.
Standardized Teleorthodontic Care Models	Development of uniform clinical protocols to ensure quality, safety, and consistency in remote orthodontic care.
Augmented Reality (AR) & Virtual Reality (VR)	Facilitate immersive patient communication, virtual demonstrations, and enhanced patient education.
Blockchain Technology	Ensures secure, tamper-proof storage and sharing of dental records and patient data.
AI-Driven Automated Aligner Adjustments	Enables personalized, data-based optimization of aligner fit and treatment progression.

Conclusion

Teledentistry represents a transformative shift in orthodontic management, redefining how diagnosis, monitoring, and patient interactions are conducted through digital platforms. It enhances accessibility, efficiency, and patient engagement while maintaining the quality of care. However, its long-term success depends on robust clinical validation, ethical regulation, and professional acceptance. The future of orthodontics lies in hybrid digital ecosystems that seamlessly integrate technology with patient-centered clinical care.

References

1. Kayalar E, Küçükkurt B. Applications and effectiveness of teledentistry in orthodontic practice during the COVID-19 restrictions. J World Fed Orthod. 2023 Jun;12(3):118-124. doi: 10.1016/j.ejwf.2023.04.002. Epub 2023 May 11. PMID: 37179245; PMCID: PMC10174472.
2. Batham, P. R., Kalia, U. D. P., & Dilliwal, S. (2014). Teledentistry and its role in orthodontic patient management. *International Journal of Stomatology & Occlusion Medicine*, *7*(1), 6–12. https://doi.org/10.1007/S12548-013-0097-4
3. Bais DR, Maheshwari S, Suting GS, G A. Tele-orthodontics: A Future in Covid19 Era. Int J Dent Med Sci Res. 2022 Jan-Feb;4(1):131–135. doi:10.35629/5252-0401131135.
4. Wadhawan, R., Kumar, S., Mathur, S., Soni, S. K., Santosh, G. K., Parambil, A. T., Parihar, S. S., & Chacko, A. (2024). Teleorthodontics: Navigating skepticism and uncertainity. *IP Indian Journal Of Orthodontics And Dentofacial Research*, *10*(2), 73–77. https://doi.org/10.18231/j.ijodr.2024.014
5. Dinakaran D, Manjunatha N, Kumar CN, Math SB. Telemedicine practice guidelines of India, 2020: Implications and challenges. Indian J Psychiatry. 2021 Jan-Feb;63(1):97-101. doi: 10.4103/psychiatry.IndianJPsychiatry_476_20. Epub 2021 Feb 15. PMID: 34083829; PMCID: PMC8106416.

6. Precision Orthodontics in the Digital Era: AI, Teledentistry, and 3D Innovations for Individualized Treatment. (2023). *Journal of Angiotherapy*, *7*(1), 1–7. https://doi.org/10.25163/angiotherapy.7110289
7. Impact, Utility and Need for Tele Orthodontics in Recent Times-A Systematic Review. (2023). *Journal of Oral & Dental Health*, *7*(2). https://doi.org/10.33140/jodh.07.02.02
8. Lo Giudice, A., Ronsivalle, V., Venezia, P., Ragusa, R., Palazzo, G., Leonardi, R., & Lazzara, A. (2022). Teleorthodontics: Where Are We Going? From Skepticism to the Clinical Applications of a New Medical Communication and Management System. *International Journal of Dentistry*, *2022*, 1–8. https://doi.org/10.1155/2022/7301576
9. Park, J. H., Park, J. H., Kim, J. H., Rogowski, L., Al Shami, S., & Howell, S. E. I. (2021). Implementation of teledentistry for orthodontic practices. *Journal of the World Federation of Orthodontists*, *10*(1), 9–13. https://doi.org/10.1016/J.EJWF.2021.01.002
10. Criollo Chalco, M. M., Espinoza Siranaula, E. L., León Abad, M. C., Nivelo Tenesaca, D. E., & Bravo Calderón, M. E. (2024). Teleodontologia y su implementación en la gestión de clínicas dentales: una revisión de la literatura. *Recima21*. https://doi.org/10.47820/recima21.v5i8.5527
11. Torres, D., Santos, M., & Normando, D. (2023). Is teledentistry effective to monitor the evolution of orthodontic treatment? A systematic review and meta-analysis. *Dental Press Journal of Orthodontics*, *28*. https://doi.org/10.1590/2177-6709.28.4.e2322195.oar
12. Maspero, C., Maspero, C., Abate, A., Abate, A., Cavagnetto, D., Cavagnetto, D., El Morsi, M., El Morsi, M., Fama, A., Fama, A., Farronato, M., & Farronato, M. (2020). Available Technologies, Applications and Benefits of Teleorthodontics. A Literature Review and Possible Applications during the COVID-19 Pandemic. *Journal of Clinical Medicine*, *9*(6), 1891. https://doi.org/10.3390/JCM9061891
13. Caruso, S., Caruso, S., Pellegrino, M., Skafi, R., Nota, A., & Tecco, S. (2021). A Knowledge-Based Algorithm for Automatic Monitoring of Orthodontic Treatment: The Dental Monitoring System. Two Cases. *Sensors*, *21*(5), 1856. https://doi.org/10.3390/S21051856
14. Peanchitlertkajorn, S., Ngamdachakij, C., Wongwatjana, B. *et al.* The implementation of teledentistry training in orthodontic practice: an explanatory sequential mixed-methods study. *BMC Med Educ* **24**, 1555 (2024). https://doi.org/10.1186/s12909-024-06509-5
15. Palta A, Gulrez M, Sharma B, Vats V, Sachdeva A. Role of teledentistry in dental care [Internet]. ***J Dent Spec***. 2022 [cited 2025 Nov 01];10(1):3-7. Available from: https://doi.org/10.18231/j.jds.2022.002
16. Almishkha, S. I., Sulaimani, O. M., Almutairi, M. R., Baazeem, R. S., Alwadi, M. A., Alkhadra, S. S., Almarshad, &. O. N., Almutairi, A. G., Alsubaie, K. M. B., Alosiml, F. K., Awadallah Aladwani, M. (2023). "Precision Orthodontics in the Digital Era: AI, Teledentistry, and 3D Innovations for Individualized Treatment", Integrative Biomedical Research, 7(1),1-8,10289
17. Shenoy S, Bhat SS, Bhat VS. Tele dentistry - A modern day boon to dental practice [Internet]. ***Arch Dent Res***. 2023 [cited 2025 Nov 01];13(1):59-63. Available from: https://doi.org/10.18231/j.adr.2023.013
18. Cook J, Mullings C, Vowles R, Ireland R, Stephens C. Online orthodontic advice: a protocol for a pilot teledentistry system. Journal of telemedicine and telecare 2001;7.6:324-333.
19. Stephens C, Cook J, Mullings, C. Orthodontic referrals via TeleDent Southwest. Dental Clinics of North America, 2002;46.3:507-520
20. Gupta G, Vaid N. The world of orthodontic apps. APOS Trends Orthod. 2017;7(2):73– 79. http://dx.doi.org/ 10.4103/2321- 1407.202608
21. Ismaeel Hansa, Steven J. Semaan, Nikhilesh R. Vaid, Donald J. Ferguson, Remote monitoring and "Tele-orthodontics": Concept, scope and applications, Seminars in Orthodontics, Vol 24, Issue 4, 2018, Pages 470-481.
22. Mandall NA, O'Brien K.D, Brady J, Worthington HV, Harvey L. Teledentistry for screening new patient orthodontic referrals. Part 1: A randomised controlled trial. British dental journal 2005;199.10:659- 662

23. Berndt J, Leone P, King G. Using teledentistry to provide interceptive orthodontic services to disadvantaged children. American Journal of Orthodontics and Dentofacial Orthopedics 2008;134.5:700-706.
24. Saccomanno S, Quinzi V, Sarhan S, Laganà D, Marzo G. Perspectives of teleorthodontics in the COVID-19 emergency and as a future tool in daily practice. European Journal of Paediatric Dentistry. 2020 Jun;21(2):157-162. DOI: 10.23804/ejpd.2020.21.02.12
25. Kotantoula G, Haisraeli-Shalish M, Jerrold L. Teleorthodontics. Am J Orthod Dentofacial Orthop. 2017 Jan;151(1):219- 221. doi: 10.1016/j.ajodo.2016.10.012. PMID: 28024777