



## Telemedicine in Orthodontics: A Literature Review

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### Abstract

Telemedicine has increasingly transformed healthcare delivery by improving access to care and continuity of treatment, particularly in specialties requiring long-term follow-up such as orthodontics. The aim of this literature review was to evaluate the current applications of telemedicine in orthodontics, with a focus on its clinical effectiveness, patient and practitioner acceptance, benefits, and limitations. A narrative review of the literature was conducted using PubMed, Scopus, the Cochrane Library, and Google Scholar databases, including studies published between January 2015 and May 2025 that assessed telemedicine or teledentistry in orthodontic clinical practice. Data extraction was performed according to the PICOT framework, and the methodological quality of observational studies was assessed using the STROBE checklist. A total of 46 articles were included in the analysis, of which 18 met strict PICOT eligibility criteria. The findings indicate that teleorthodontics is particularly effective for remote monitoring of orthodontic treatment, especially in clear aligner therapy and during retention phases, demonstrating high accuracy in the assessment of tooth movement, aligner fit, and appliance integrity. High levels of patient satisfaction and improved treatment compliance were consistently reported, along with positive effects on oral hygiene when remote monitoring was combined with educational reminders. However, teleorthodontics remains limited in its ability to replace in-person clinical examinations, particularly for the diagnosis of caries, periodontal diseases, and complex biomechanical issues, and concerns persist regarding ethical, legal, and data security aspects. In conclusion, telemedicine represents a valuable adjunct to conventional orthodontic care, enhancing monitoring efficiency and patient engagement, but it should be integrated within a regulated, clinician-led framework and not considered a substitute for face-to-face orthodontic treatment.

**Keywords:** Telemedicine; Teleorthodontics; Teledentistry; Remote Patient Monitoring; Orthodontic Treatment

### Introduction

Telemedicine, defined by the World Health Organization and the Haute Autorité de Santé as the provision of healthcare services at a distance through information and communication technologies, has become a key component in the modernization of healthcare systems and in improving access to care, particularly

in underserved and rural areas [1]. In dentistry, this evolution has led to the development of teledentistry, encompassing teleconsultation, tele-expertise, telediagnosis, and telemonitoring, delivered through synchronous or asynchronous modalities [2]. Orthodontics appears particularly well suited to telemedicine integration due to the long duration of treatments and the need

for regular follow-up, as prolonged interruptions may result in clinical complications such as undesirable tooth movements or root resorption [3,4].

Although early applications of modern telemedicine date back to the 1990s, the COVID-19 pandemic acted as a major accelerator for its adoption in orthodontic practice [5,6]. Under pandemic-related constraints, orthodontists rapidly implemented digital tools to ensure continuity of care. Currently, teleorthodontics relies on various platforms, mobile applications, digital monitoring software, and increasingly on artificial intelligence-assisted analysis systems, with clear aligner therapy playing a central role in this transition due to its suitability for remote monitoring [4,7]. Reported benefits include reduced travel, time savings, improved patient compliance, effective triage of orthodontic emergencies, and optimization of care pathways.

Despite these advantages, the limitations of teleorthodontics are well documented. In-person clinical examination remains essential for the diagnosis of dental caries and periodontal diseases, which cannot be reliably detected through remote assessment alone [8,9]. Additional barriers include equipment costs, usability challenges for both patients and practitioners, and the requirement for stable internet connectivity. Beyond clinical and technical considerations, teleorthodontics raises significant ethical and legal issues related to data protection, patient confidentiality, and informed consent, in accordance with international regulations such as HIPAA in the United States and the General Data Protection Regulation in Europe [9]. Furthermore, the increasing availability of direct-to-consumer orthodontic treatments without professional supervision represents a potential risk to patient safety, while the lack of structured training in teleorthodontics remains a concern [5,10].

In this context, the present literature review aims to provide a critical and structured overview of teleorthodontics, addressing its clinical effectiveness, limitations, and acceptance among patients and practitioners.

## Material and Methods

This narrative review was conducted to provide a synthesis of the current evidence regarding the use of telemedicine in orthodontics. A structured and rigorous literature search strategy was implemented to ensure the relevance and quality of the included

studies. Electronic searches were performed in PubMed, Scopus, the Cochrane Library, and Google Scholar, covering publications from January 2015 to May 2025. The search strategy combined keywords and Medical Subject Headings (MeSH), including “telemedicine”, “teledentistry”, “orthodontics”, and “remote patient monitoring”. These terms were applied across all databases searched, both individually and in combination, to identify articles eligible for inclusion. The following search strategies were used:

- (“Remote Patient Monitoring” [MeSH]) AND “Orthodontics” [MeSH]
- (“Orthodontics” [MeSH]) AND “Telemedicine” [MeSH]
- “Orthodontics” [MeSH] AND teledentistry

Eligible studies were required to be published in English or French, to involve human subjects undergoing orthodontic treatment, and to evaluate the clinical application of telemedicine or remote monitoring in orthodontic practice. Letters to the editor, editorials, conference abstracts without full-text availability, reviews, systematic reviews, and studies focusing exclusively on other dental specialties were excluded. Study selection was performed through an initial screening of titles and abstracts, followed by full-text assessment of potentially relevant articles. Data extraction and analysis were conducted according to the PICOT framework, considering population, intervention, comparison, outcomes, and duration (time) of follow-up. The article selection process was documented using a PRISMA-inspired flow diagram. Methodological quality of observational studies was assessed using the STROBE [11] checklist, and studies were classified as excellent, good, moderate, or low quality based on adherence scores.

## Results

A total of 46 studies were included in the qualitative synthesis, of which 18 studies fulfilled the PICOT eligibility criteria and were analyzed for clinical outcomes (Figure 1). The included studies addressed various domains of teleorthodontics, including applications during the COVID-19 pandemic, remote monitoring systems, accuracy and clinical reliability of digital tools, patient and practitioner perceptions, and the impact of teleorthodontics on oral hygiene.

Among the included studies, twelve were observational studies and were therefore assessed for methodological quality using the

STROBE statement. Of these, one study achieved an excellent methodological quality score, ten were classified as having average quality, and one was rated as good quality. Detailed data extraction and quality assessment are presented in Table 1 and figure 1.

The majority of studies evaluating remote monitoring technologies, particularly smartphone-based applications and dedicated platforms, reported high clinical accuracy in assessing tooth movement, aligner fit, appliance integrity, and treatment progression, with results comparable to conventional in-office assessments. Studies focusing on patient- and practitioner-reported outcomes consistently demonstrated high levels of patient satisfaction, improved communication, reduced travel time, and enhanced treatment compliance.

In addition, several clinical studies reported a positive effect of teleorthodontics on oral hygiene, especially when remote monitoring was combined with educational feedback and reminder systems.

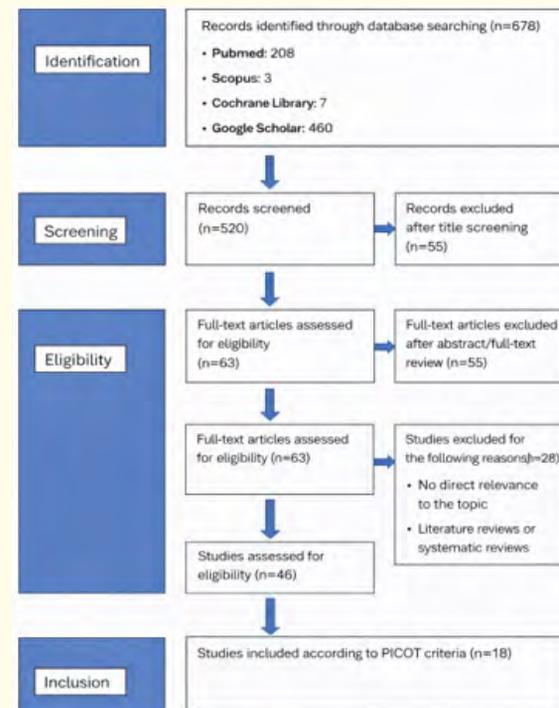


Figure 1: PRISMA inspired flow diagram illustrating study selection process.

	Studies	Supakit Peanchitlertkajorn., et al. (2024) [4]	Abu Arqub., et al. (2024) [7]	Adly., et al. (2020) [12]	Mheisen., et al. (2021) [13]	Moylan., et al. (2019) [14]	Sangalli., et al. (2022) [15]	Kayalar., et al. (2023) [3]	Homsi., et al. (2023) [16]	Sangalli., et al. (2021) [17]	Putrino., et al. 2020 [18]	George., et al. (2021) [19]	Saccomano., et al. (2021) [20]
STROBE ITEM	1-a	1	1	0	1	0	1	1	1	1	0	1	1
	1-b	1	1	1	1	1	1	1	1	1	1	1	0
	2	1	1	1	1	1	1	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1	1	1	1	1
	4	1	1	0	1	0	1	0	0	1	0	1	1
	5	1	1	1	0	1	1	1	1	1	1	1	1
	6-a	1	1	1	1	1	1	1	1	1	1	1	1
	6-b	NA	NA	1	NA	1	1	1	NA	NA	NA	NA	NA
	7	0	0	1	1	1	1	1	1	1	1	1	0
	8	0	0	1	1	1	1	1	1	1	1	1	1
	9	0	0	0	1	0	0	0	0	0	0	0	0
	10	1	1	0	1	0	0	0	0	1	0	0	0
	11	0	0	1	1	0	0	1	0	1	1	1	0

	12-a	1	1	1	0	1	1	1	1	1	1	1	1
	12-b	0	1	0	0	1	1	1	0	1	1	1	NA
	12-c	0	1	0	0	0	0	1	0	0	NA	0	0
	12-d	0	1	0	0	0	0	1	0	0	NA	0	0
	12-e	0	0	0	0	0	0	1	0	0	NA	0	NA
	13-a	1	1	1	1	1	1	1	1	1	1	1	1
	13-b	NA	0	0	1	0	0	1	1	0	1	NA	0
	13-c	0	0	1	1	0	0	1	1	0	0	0	0
	14-a	1	1	1	1	1	1	1	1	1	1	1	1
	14-b	0	0	1	1	0	0	1	1	0	1	0	0
	14-c	NA	NA	1	1	0	1	1	NA	1	NA	NA	NA
	15	1	1	1	1	1	1	1	1	1	1	1	1
	16-a	1	1	1	1	1	1	1	1	1	1	1	0
	16-b	1	1	1	1	1	1	1	0	0	0	0	0
	16-c	0	NA	1	1	1	1	0	0	0	0	0	0
	17	NA	NA	0	1	0	0	1	0	1	0	1	NA
	18	1	1	1	1	1	1	1	1	1	1	1	1
	19	1	1	1	1	1	1	1	1	1	1	1	1
	20	1	1	1	1	1	1	1	1	1	1	1	1
	21	1	1	0	0	0	0	0	0	0	0	0	1
	22	0	1	1	1	1	1	1	1	1	1	1	1
	Total	18	22	23	26	20	23	29	20	23	20	21	16
	Percent	52,92%	64,75%	67,64%	76,47%	58,82%	67,64%	85,29%	58,82%	67,64%	58,82%	61,76%	47,05%
	Methodological quality grade	Average	Average	Average	Good	Average	Average	Excellent	Average	Average	Average	Average	Average

**Table 1:** Quality assessment using the Strobe tool (Strengthening the reporting of observational studies in epidemiology).

**Discussion**

The objective of this work was to conduct a literature review on telemedicine in orthodontics using a structured and comprehensive methodology in order to evaluate the impact of its integration into orthodontic care. A research strategy was adopted to ensure adequate sensitivity and specificity, based on predefined keywords and Boolean equations across multiple databases (PubMed, ScienceDirect, Google Scholar, Scopus, and the Cochrane Library). This approach enabled the identification of relevant evidence with a preference for studies providing higher levels of scientific proof. Nevertheless, interpretation of the findings must consider several limitations, including restricted access to some full-text articles and the inclusion of publications limited to English and French. Furthermore, as the aim was not to conduct a systematic review, rather, the intention was to provide a structured and exhaustive narrative overview of telemedicine in orthodontics.

**Teleorthodontics in the context of the COVID-19 pandemic**

Although teleorthodontics has existed conceptually since the 1990s, the COVID-19 pandemic acted as a major catalyst, transforming a relatively marginal practice into a widespread clinical necessity. The pandemic forced a rapid transition toward remote care to ensure continuity of treatment while minimizing infection risk, leading to the accelerated adoption of teledentistry on a global scale [8]. The nature of dental practice, involving close contact with patients and aerosol generation, placed oral healthcare professionals at particularly high risk of infection [3]. Consequently, many health authorities mandated the suspension of non-urgent dental and orthodontic procedures, resulting in temporary closure of numerous practices [21].

This abrupt interruption posed significant challenges for patients undergoing orthodontic treatment, as prolonged treatment discontinuation may lead to complications such as unwanted tooth movements, root resorption, or cortical bone perforation [4]. In this context, teleorthodontics emerged as a valuable tool for maintaining patient follow-up, managing emergencies, and providing reassurance. During the pandemic, many practitioners relied on readily available communication tools such as phone calls, video calls, and instant messaging platforms. Studies conducted in different countries demonstrated that these solutions enabled orthodontists to manage emergencies, monitor treatment progress, and maintain patient contact under unprecedented conditions. Saccomanno, *et al.* [20] reported that voice calls and applications such as WhatsApp® were among the most commonly used means of communication for orthodontic emergencies. The pandemic also served as a major driver of adoption, Abu Arqub, *et al.* [7] found that a majority of orthodontists who used teleorthodontics began doing so during the first months of the pandemic.

Several practical benefits were highlighted during this period. Saccomanno, *et al.* confirmed that teleorthodontics was particularly useful for resolving orthodontic emergencies during lockdowns [20], a finding supported by studies using simple photo and video exchange [18,22]. Kayalar, *et al.* [3] demonstrated that “teletriage” identified only 21.25% of patients as requiring urgent in-office visits, highlighting its role in reducing unnecessary travel and cross-infection risk. Beyond emergencies, remote follow-up ensured continuity of treatment, including interceptive care, as illustrated by Caruso, *et al.* [21], who reported that remote monitoring allowed treatment continuation during growth and prevented potentially severe consequences later in life. Moreover, remote communication often reassured patients and strengthened the patient–practitioner relationship, with studies reporting high levels of perceived care and connection despite physical distance [16,22]. Overall, the pandemic acted as a large-scale proof of concept for teleorthodontics, demonstrating its feasibility and benefits beyond crisis management [23], with evidence suggesting its continued use in routine practice after the pandemic [22,24].

### Remote monitoring in orthodontics

Remote monitoring represents one of the most developed applications of telemedicine in orthodontics. It enables orthodontists to interpret patient-generated data remotely and

make clinical decisions regarding follow-up and management, primarily through smartphones and dedicated applications [23]. Before widespread clinical implementation, several studies validated the technical accuracy of remote monitoring tools, particularly Dental Monitoring® (DM). Morris, *et al.* [25] compared 3D digital models generated by (DM) with those obtained using a high-precision intraoral scanner and found clinically non-significant discrepancies, supporting the reliability of DM-generated models for clinical use. Similarly, Moylan, *et al.* [14] demonstrated that linear measurements obtained via (DM) in patients undergoing maxillary expansion were equivalent to those measured on plaster models, with differences considered clinically negligible [14].

Clinically, remote monitoring has demonstrated multiple benefits. One of the most consistently reported advantages is the reduction in the number of in-office visits, particularly for clear aligner therapy. A meta-analysis by Torres, *et al.* showed a significant reduction in the number of clinical appointments (mean –2.75 visits) associated with the use of remote monitoring [26,27]. The same analysis reported a reduction in the time required to reach the finishing phase of treatment (mean –1.21 months). Other studies have shown that communication-based interventions can improve treatment efficiency; for example, Li, *et al.* [27] reported that reminders sent via WeChat reduced missed appointments and bracket debonding, leading to shorter treatment duration. Remote monitoring has also proven useful during the retention phase and in interceptive treatments, reducing appliance adjustment issues and enabling continued care during lockdowns [17,21]. Additionally, remote monitoring played a key role in emergency triage during the pandemic, confirming that only a minority of patients required urgent in-person care [3].

Advanced monitoring platforms increasingly rely on artificial intelligence to automate image analysis and patient guidance. AI-based systems can detect clinical events such as bracket debonding, gingival inflammation, or aligner non-tracking and can support patient coaching. Thurzo, *et al.* [28] demonstrated that an AI-supported application improved patient performance and compliance through structured decision-making processes. However, despite these advances, AI remains an assistive tool and cannot replace comprehensive clinical judgment.

Acceptance of remote monitoring is generally high among both patients and practitioners. Homs, *et al.* [16] reported high levels

of patient satisfaction and ease of use, with many patients feeling more personally connected to their orthodontist. Abu Arqub, *et al.* [7] found that orthodontists who used teleorthodontic tools had significantly more positive perceptions of their impact on communication, patient education, and reduction of unnecessary visits, whereas non-users expressed greater concerns regarding confidentiality and compliance [8]. Nevertheless, important practical limitations persist, particularly related to image quality and usability. Sangalli, *et al.* [15] reported a high rejection rate of submitted images and described the system as not fully user-friendly in routine practice, highlighting the need for patient training and technical support.

### Teleorthodontics and oral hygiene

Maintaining optimal oral hygiene remains a major challenge in orthodontic treatment, especially with fixed appliances. Several clinical studies have demonstrated that teleorthodontic interventions can effectively improve patient compliance and oral hygiene outcomes. Sangalli, *et al.* [17] reported significant improvements in plaque control among patients monitored remotely via Dental Monitoring®, with no new carious lesions detected in the monitored group compared with controls. Scheerman, *et al.* [29] showed that a behavior-change based mobile application significantly reduced gingival bleeding and plaque accumulation compared with usual care. Importantly, simpler interventions have also proven effective: they demonstrated that a short educational video delivered via messaging platforms improved plaque index and bleeding on probing compared with conventional oral instructions [30]. These findings suggest that remote reinforcement, whether sophisticated or simple, can positively influence oral hygiene behavior.

Perceptions among practitioners and patients align with these clinical findings. Abu Arqub, *et al.* [7] reported that orthodontists, particularly users of teleorthodontic tools, agreed that teleorthodontics acts as a reminder promoting oral hygiene practices, while George, *et al.* (2021) [19] found that a large proportion of orthodontists viewed teledentistry as beneficial for oral health education. However, Li, *et al.* [27] did not observe significant differences in plaque or gingival indices despite improved appointment adherence, and Al-Shammery, *et al.* [9] suggested that in-person visits may remain more reliable for monitoring oral hygiene than remote photo or video exchange alone. These findings

emphasize that teleorthodontics is an effective motivational adjunct but does not replace clinical examination.

### Teledentistry and practitioner training

The integration of teledentistry into orthodontic practice highlights a clear need for practitioner training. Digital tools often evolve more rapidly than clinicians' ability to effectively integrate them into practice, and structured education in teleorthodontics remains largely absent from undergraduate curricula and continuing professional development [4]. This lack of training contributes to resistance related to perceived software complexity, insufficient technical support, and uncertainty regarding ethical and legal responsibilities [31]. To overcome these barriers, structured educational programs should address technical skills (teleconsultation workflows, remote monitoring, and emergency management), communication competencies specific to remote care, and regulatory requirements related to data protection and informed consent. A blended pedagogical approach combining online learning, practical workshops, simulations, and progressive assessment appears particularly suitable. Importantly, experience itself is formative: clinicians who already use teleorthodontic tools tend to report more positive perceptions of their benefits, while non-users remain more reserved. Training and practice must therefore evolve together to ensure safe and effective integration of teleorthodontics [4].

### Limits of telemedicine in orthodontics

Despite its advantages, teleorthodontics presents significant clinical, technical, ethical, and relational limitations. The most fundamental limitation is its inability to replace comprehensive in-person clinical examination. Remote assessment relies primarily on two-dimensional representations of three-dimensional structures, which may compromise diagnostic accuracy. Dunbar, *et al.* [32] showed that reliance on digital records alone affected treatment planning reproducibility compared with clinical examination. Teleconsultations also preclude palpation, probing, and instrument-based assessment, limiting the detection of caries, periodontal disease, systemic risk factors, and other conditions requiring in-office clinical assessment to ensure safe orthodontic care.

Technical and practical barriers further restrict teleorthodontic effectiveness. The quality of follow-up depends on the quality of

patient-provided images or videos, and several studies report patient difficulty in capturing adequate images [14,22]. Limited digital literacy, especially among older patients, may hinder adoption, while equipment costs and connectivity issues represent additional obstacles.

Ethical and legal challenges are equally important. The electronic transmission of health data raises concerns regarding confidentiality and security, particularly when platforms do not comply with regulations such as HIPAA or GDPR [9]. Informed consent must be specific to teleorthodontic care, addressing data handling and the limitations of remote assessment. Professional responsibility is another critical issue, particularly in the context of direct-to-consumer orthodontic models that lack adequate clinical supervision and may pose risks to patient safety. Regulatory uncertainty remains a barrier to adoption, with many practitioners expressing concern regarding the legal status of teleorthodontic practice [7]. Finally, relational aspects must be considered, as many patients continue to prefer face-to-face consultations, and the perceived ease of remote monitoring may encourage unsafe self-managed treatment approaches.

### Conclusion

Telemedicine and its orthodontic extension, teleorthodontics, represent a significant evolution in contemporary orthodontic practice. Current evidence highlights its ability to improve treatment monitoring, facilitate early detection of deviations and orthodontic emergencies, and enhance patient-practitioner communication. For patients—particularly those undergoing clear aligner therapy, teleorthodontics offers greater flexibility and convenience, leading to improved adherence and satisfaction. For practitioners, it supports clinical efficiency by reducing unnecessary chairside visits and promoting the integration of digital competencies, with artificial intelligence-based monitoring systems offering promising perspectives for personalized care.

Despite these advantages, teleorthodontics presents also limitations. Technical constraints, variable image quality, reliance on patient compliance, and the inability to perform comprehensive clinical examinations confirm that it cannot replace in-office care. Ethical and legal issues, including data protection, confidentiality, informed consent, and professional responsibility, together with the lack of standardized protocols, heterogeneous training, and limited high-level evidence, further limit its expanded use.

The future of teleorthodontics relies on its structured integration into clinical practice through clear guidelines, robust regulatory frameworks, and enhanced training across all levels of professional education. Ultimately, teleorthodontics should be considered not as a substitute, but as a complementary tool that improves access to care and enhances efficiency within an increasingly digital orthodontic landscape.

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