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Integrating Oral Medicine and Dentomaxillofacial Radiology into Orthodontic Diagnosis and Treatment Planning for Pediatric and Adolescent Patients: A Narrative Review

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Abstract

Background: Orthodontic treatment in children and adolescents occurs within a dynamic biological environment influenced by craniofacial growth, eruption, root development, periodontal support, local pathology, and systemic factors. Conventional records remain fundamental; however, selected cases require interdisciplinary assessment and, when justified, three-dimensional imaging.

Aim: To critically examine the role of oral medicine and dentomaxillofacial radiology in orthodontic diagnosis and treatment planning for pediatric and adolescent patients and to explore how biological and radiological findings may inform biomechanical decision-making.

Review Methodology: A narrative synthesis was developed from literature addressing cone-beam computed tomography (CBCT), orthodontic imaging, root resorption, dentoalveolar boundaries, local pathology, and biological determinants of orthodontic tooth movement. Evidence was critically appraised according to study design, findings, limitations, and relevance to the review objectives.

Results: The literature consistently supports selective interdisciplinary assessment and indication-based CBCT rather than routine volumetric imaging. Systematic reviews demonstrate improved three-dimensional visualization for selected problems, particularly impacted teeth and associated root resorption; however, evidence that additional imaging or formal interdisciplinary pathways reduce long-term orthodontic complications remains limited. Evidence on orthodontically induced external apical root resorption (OIEARR) confirms multifactorial etiology, substantial methodological heterogeneity, and generally low certainty for many proposed predictive factors.

Conclusion: An interdisciplinary approach has an important but selectively indicated role in complex or high-risk cases; however, the proposed framework remains conceptual because

prospective evidence linking structured interdisciplinary assessment to improved patient outcomes is lacking.

Keywords: adolescent; cone-beam computed tomography; dentomaxillofacial radiology; interdisciplinary care; orthodontics; pediatric dentistry; root resorption

Introduction

Orthodontic diagnosis in children and adolescents extends beyond description of tooth alignment and skeletal discrepancy. Treatment is undertaken during periods of growth, eruption, root maturation, and continuing adaptation of periodontal and alveolar tissues. Dentomaxillofacial radiology (DMFR) refers to the radiological specialty concerned with imaging and interpretation of the teeth, jaws, craniofacial structures, and related maxillofacial tissues; in this review, the term is used consistently to distinguish radiological expertise from general imaging use. Consequently, comprehensive pre-treatment assessment must incorporate local disease, previous trauma, root morphology, periodontal support, anatomical boundaries, systemic influences, and developmental abnormalities. The clinical relevance of these factors encompasses not only the detection of conditions requiring management before orthodontic treatment, but also the determination of whether planned tooth movement is biologically and anatomically appropriate.

Conventional clinical examination, photographs, dental casts or digital scans, panoramic radiography, and cephalometric radiography remain central to orthodontic assessment. Nevertheless, two-dimensional imaging is limited by projection geometry, superimposition, distortion, and incomplete representation of complex three-dimensional relationships. Cone-beam computed tomography (CBCT) can overcome some of these limitations; however, superior visualization in selected situations should not justify routine use. The American Academy of Oral and Maxillofacial Radiology recommends that CBCT use in orthodontics be individually justified according to the clinical presentation and anticipated diagnostic benefit.

Pediatric evidence supports this position. A systematic review by Tsolakis et al. (2019) evaluated 37 articles using structured assessment methods and concluded that CBCT should not be considered standard diagnostic methodology. Clinical defensibility was greatest when conventional imaging could not provide necessary diagnostic information, particularly for impacted teeth, associated root resorption, condylar morphology, and certain presurgical assessments, although evidence quality varied considerably across indications.

A related issue concerns translation of diagnostic information into orthodontic mechanics. Orthodontic tooth movement is mediated biologically through periodontal ligament responses and alveolar bone remodeling; however, the presence of a radiological or systemic finding does not automatically establish a specific force prescription. Current evidence more strongly supports individualized risk assessment and monitoring than universal rules linking isolated imaging findings to predetermined force magnitudes or treatment protocols; therefore, such findings should be interpreted as inputs to clinical judgment rather than as stand-alone prescriptions.

The literature remains fragmented across specialties. Imaging research typically evaluates diagnostic performance; orthodontic research focuses on mechanics and outcomes; and oral medicine or pathology research addresses disease detection and management. Comparatively few studies investigate whether integrating these domains through a structured pre-treatment pathway improves clinically important outcomes. An integrated interdisciplinary framework is therefore needed to connect clinical examination, biological and pathological assessment, radiological interpretation, and orthodontic biomechanics without assuming that an imaging finding automatically dictates treatment mechanics. This framework is particularly relevant in children and adolescents, in whom growth, eruption, root development, and radiation considerations change the balance between diagnostic benefit and potential burden. The present review critically synthesizes available evidence and distinguishes established findings from biologically plausible but insufficiently tested clinical assumptions.

Aim and Objectives

The aim of this narrative review is to critically examine the potential role of oral medicine and dentomaxillofacial radiology in orthodontic diagnosis and treatment planning among pediatric and adolescent patients.

- To evaluate how systemic, biological, and local oral conditions may influence orthodontic assessment in growing patients.
- To critically assess the contribution and limitations of radiological findings, including selectively indicated CBCT, in orthodontic treatment planning.
- To examine how diagnostic information may inform biomechanical decision-making without overstating causal or predictive evidence.
- To identify patterns, contradictions, methodological limitations, and knowledge gaps in interdisciplinary orthodontic care.

Review Methodology

This narrative review synthesizes literature relevant to interdisciplinary orthodontic diagnosis in growing patients. Searches were conceptually structured using PubMed, Scopus, and Google Scholar databases, with combinations of search terms related to orthodontics, pediatric and adolescent patients, CBCT, root resorption, alveolar bone, oral medicine, DMFR, impacted teeth, pathology, and orthodontic tooth movement. Reference lists of key reviews and guidelines were also screened. Priority was given to systematic reviews, evidence-based guidelines, position statements, and clinically relevant primary studies. The source manuscript did not prospectively record a formal search start/end date, a reproducible database-by-database search string, or a study-flow count; these details have therefore not been retrospectively invented. Likewise, no language restriction was prespecified in the available review record. For transparency, the synthesis focused on English-language publications that were directly relevant to pediatric/adolescent orthodontic

diagnosis, CBCT justification, root resorption, local pathology, alveolar boundaries, or biological determinants of tooth movement, while excluding reports that were not relevant to these clinical questions. Because the objective was interpretive and integrative rather than quantitative, no meta-analysis was performed. Each body of evidence was critically appraised according to research question, methods, principal findings, limitations, and contribution to the research problem. A principal limitation of this approach is inherent selection-bias risk associated with narrative synthesis; therefore, the interdisciplinary framework proposed here should be interpreted as conceptual rather than validated.

Critical Synthesis of the Literature

1. CBCT and Three-Dimensional Diagnostic Assessment

The strongest directly relevant evidence concerns selective CBCT use. The American Academy of Oral and Maxillofacial Radiology (AAOMR) position statement (2013) was developed through expert consensus informed by clinical efficacy and radiation-dose concepts. Its principal contribution is establishment of an indication-based rather than technology-driven approach: CBCT justification should reflect individual clinical problems rather than routine implementation. A limitation is that position statements necessarily combine available evidence with expert interpretation and do not themselves provide direct evidence that CBCT improves long-term orthodontic outcomes.

Tsolakis et al. (2019) provide formal systematic synthesis. Their review of 37 articles using QUADAS and GRADE-based assessment found that CBCT was reliable for selected applications, including assessment of impacted canines, root resorption, and condylar morphology. However, they concluded that CBCT is justified only when conventional radiography provides inadequate diagnostic information or when additional information is expected to improve management. This directly addresses the present review objective by demonstrating a consistent pattern: enhanced visualization is clinically useful in selected circumstances, but routine CBCT lacks justification. Principal limitations included heterogeneity among included studies and variation in reference standards.

Abdelkarim (2019) similarly reviewed CBCT applications in orthodontics, highlighting usefulness for complex anatomical assessment. Alshomrani (2024) further discussed CBCT-based diagnosis of dental bone defects, reinforcing volumetric imaging's capacity to depict structures difficult to assess on two-dimensional radiographs. Importantly, most studies evaluating CBCT detection of dental bone defects are observational or diagnostic-accuracy studies and therefore do not establish that improved defect visualization or CBCT-guided planning improves long-term periodontal or orthodontic outcomes. Improved defect depiction does not itself prove that CBCT-guided planning prevents periodontal or alveolar complications. This distinction between diagnostic efficacy and patient-outcome efficacy remains central.

Overall, the imaging literature is internally consistent: CBCT provides clinically important three-dimensional information in selected cases. The contradiction lies not in whether CBCT effectively visualizes anatomy, but in translating additional information into improved outcomes. Available evidence therefore supports selective escalation from clinical and conventional assessment to advanced imaging when a clearly defined diagnostic question remains unanswered.

2. Root Resorption: Evidence, Risk Factors, and Uncertainty

Orthodontically induced external apical root resorption (OIEARR) represents one of the most clinically important complications relevant to interdisciplinary assessment. Segal et al. (2014) systematically reviewed radiologically determined OIEARR in Class II Division 1 treatment. Eight studies of moderate methodological quality were included. The review reported high prevalence of radiographically detectable resorption, generally mild-to-moderate in severity, and weak-to-moderate positive associations between greater incisor displacement, longer treatment duration, and root resorption. This demonstrates that treatment-related exposure and movement extent may be relevant; however, heterogeneity and moderate study quality limit strong causal conclusions.

Dawood and colleagues (2023) examined mechanisms and risk factors for orthodontically induced inflammatory root resorption, synthesizing 118 eligible articles across in vitro, animal, and human evidence. The review supported an association between orthodontic forces and orthodontically induced inflammatory root resorption while identifying modifiers such as previous trauma, malocclusion, and certain medications. Importantly, the review also emphasized substantial methodological heterogeneity, confounding, and variable risk of bias. This is highly relevant because it cautions against translating mechanistic plausibility directly into fixed clinical prescriptions.

The limitations were further demonstrated during evidence-based clinical practice guideline development for EARR. The guideline process used systematic searches and GRADE assessment; however, much evidence for proposed patient-related predictive factors was rated low or very low certainty, and final recommendations were necessarily weak in several areas (Smit et al., 2020). This creates an important contradiction: although numerous factors have been historically described as “risk factors,” the certainty supporting many associations is comparatively low. The literature therefore supports baseline assessment, individualized risk communication, and appropriate monitoring more strongly than precise prediction of which individual patient will develop clinically significant resorption.

Recent umbrella-level evidence comparing clear aligners with fixed appliances has suggested lower OIEARR incidence or severity with aligners; however, evidence certainty remains limited by primary study overlap and moderate methodological quality. These findings illustrate a broader pattern: statistically significant differences between approaches may exist, yet confounding by case selection, treatment objectives, and mechanics prevents simplistic attribution of root outcomes to appliance type alone.

3. Oral Medicine and Local Pathology in Orthodontic Planning

Oral medicine's contribution to orthodontic planning is most apparent when clinical or radiological findings suggest active disease, developmental abnormalities, unexplained radiolucencies, periapical pathology, mucosal disease, or systemic conditions potentially influencing oral tissues. In these circumstances, interdisciplinary assessment's primary value is diagnostic clarification and underlying condition management before or alongside orthodontic care. Current literature does not support the assumption that every patient requires routine specialist consultation; rather, consultation should be triggered by clinical complexity or diagnostic uncertainty.

A critical evidence limitation is that many publications describe pathology management without directly studying subsequent orthodontic outcomes. Thus, a biologically reasonable recommendation—for example, establishing diagnosis and treating active pathology before tooth movement—should not be confused with proof that a particular interdisciplinary protocol reduces root resorption or treatment failure. This distinction is essential for rigorous synthesis and prevents extrapolation beyond the evidence base.

4. Pediatric-Specific Considerations: Growth, Radiation Sensitivity, and CBCT Justification

Pediatric and adolescent patients require an additional layer of risk–benefit assessment because diagnosis occurs during active craniofacial growth, tooth eruption, root maturation, and changes in the supporting alveolar tissues. These developmental changes can alter the interpretation of tooth position, root morphology, and skeletal relationships over time. Accordingly, imaging findings should be interpreted in the context of developmental stage rather than treated as static anatomical measurements.

Radiation protection is especially relevant in children and adolescents because the justification for ionizing imaging should be proportionate to the clinical question and the expected management benefit. The available pediatric orthodontic evidence supports selective rather than routine CBCT. Tsolakis et al. (2019) concluded that CBCT should not be considered standard diagnostic methodology and that its clinical justification is strongest when conventional imaging cannot answer a specific question, including selected cases of impacted teeth, suspected root resorption, condylar assessment, or presurgical planning. The AAOMR position statement similarly supports individualized justification. Radiation protection should also follow the ALADAIP principle (As Low As Diagnostically Acceptable, Indication-oriented, and Patient-specific), meaning that exposure parameters and field of view should be tailored to the diagnostic task and individual patient. Thus, the presence of a complex clinical problem alone is not sufficient; the clinician should be able to state what additional three-dimensional information is required and how it is expected to alter management.

For growing patients, the decision to obtain CBCT should therefore follow a stepwise process: establish the clinical question, review existing conventional records, determine whether additional three-dimensional information is necessary, select the smallest appropriate field of view and

exposure consistent with the diagnostic task, and document the anticipated management benefit. This approach reduces unnecessary exposure while preserving access to three-dimensional information when it is clinically consequential. Importantly, improved visualization should not be equated with improved long-term outcomes; evidence directly linking pediatric CBCT use to fewer orthodontic complications remains limited.

5. Alveolar Boundaries and Biomechanical Planning

Three-dimensional imaging has renewed interest in the relationship between planned tooth movement and anatomical alveolar limits. CBCT can depict root position and cortical anatomy more clearly than many two-dimensional techniques in selected cases. However, much of this literature is cross-sectional. Associations between thin cortical bone, dehiscence, fenestration, and tooth position do not necessarily establish that a specific movement caused a defect or that particular imaging measurements predict future periodontal deterioration.

The most defensible clinical inference is individualized anatomical assessment when treatment involves substantial movement and conventional imaging is insufficient. Findings should inform treatment objectives, movement direction, and monitoring necessity; however, current evidence does not provide universally validated numerical thresholds for "safe" movement or standard force reduction for every patient with reduced alveolar thickness. This represents a major translational gap between radiological measurement and evidence-based biomechanics.

Table 1. Radiological and Clinical Findings Requiring Interdisciplinary Consideration

Finding	Potential Significance	Planning Implication
Abnormal periapical or lamina dura appearance	Possible inflammatory or pathological process requiring correlation	Establish diagnosis and manage underlying condition before moving the affected tooth when clinically indicated
Pre-existing root shortening or root resorption	Reduced remaining root structure may increase concern about further resorptive loss during treatment	Document baseline root status, discuss the potential risk, and individualize monitoring
Complex impaction or uncertain root relationships	Two-dimensional imaging may not adequately establish three-dimensional anatomy	Consider CBCT only when additional information is expected to alter management
Reduced alveolar thickness or suspected cortical defects	May indicate anatomical limitations relevant to planned movement	Reassess treatment objectives and movement; avoid assuming a single imaging measurement dictates a fixed force protocol

Condylar asymmetry or structural irregularity	May reflect developmental variation or pathological remodeling	Clinical correlation and specialist evaluation should guide management; imaging alone should not dictate treatment
Suspected odontogenic lesion	May require definitive diagnosis and management	Coordinate with appropriate specialty care before or during orthodontic treatment

Discussion: Patterns, Contradictions, and Knowledge Gaps

The present synthesis reveals three consistent patterns. First, comprehensive diagnosis is more important than routine use of increasingly sophisticated technology. Second, three-dimensional imaging has clear diagnostic advantages in selected situations but must be justified by a specific clinical question. Third, biological and anatomical factors can influence orthodontic risk, although individual predictive value is often uncertain.

The principal contradiction is between diagnostic capability and demonstrated patient benefit. Studies frequently show that CBCT identifies anatomical details or alters diagnostic confidence, yet few studies demonstrate that these changes consistently reduce root resorption, periodontal complications, treatment duration, retreatment, or relapse. A similar discrepancy exists in root-resorption research: although numerous potential predictors have been proposed, systematic guideline development has found certainty of evidence for many patient-related predictors to be low or very low.

The most important knowledge gap is not simply abnormality detection but whether structured interdisciplinary processes change management and improve patient outcomes. Future research should prioritize prospective, multicenter comparative studies with predefined eligibility criteria and standardized diagnostic pathways. Studies should compare standard orthodontic assessment with clearly defined risk-based interdisciplinary pathways and should report standardized outcomes including treatment-plan changes, clinically significant OIEARR, periodontal and alveolar outcomes, radiation exposure, treatment duration, patient-reported outcomes, adverse events, and cost-effectiveness. Where CBCT is used, investigators should also report indication, field of view, exposure parameters, and whether the imaging result actually changed treatment management.

The present review proposes a conceptual model of selective diagnostic escalation: (1) comprehensive clinical examination and conventional orthodontic records; (2) targeted assessment of biological, pathological, or anatomical concerns; (3) specialist consultation when findings exceed routine orthodontic assessment scope; and (4) CBCT only when a specific three-dimensional diagnostic question remains unanswered and the results are likely to alter management. Implementation should also be evaluated for feasibility, interdisciplinary

coordination requirements, patient burden, resource use, and cost-effectiveness, particularly in settings where access to specialist radiological or oral-medicine assessment is limited. This deliberately risk-based rather than universal model should be prospectively validated before adoption as a standardized protocol.

Figure 1. Conceptual model of selective diagnostic escalation in pediatric and adolescent orthodontic assessment.

1. Comprehensive clinical examination and conventional records	2. Targeted biological, pathological, and anatomical assessment	3. Specialist consultation when indicated	4. CBCT only when a specific three-dimensional question remains unanswered and may alter management

Limitations: This review is limited by its narrative design, the heterogeneity of the available evidence, and the absence of a formal risk-of-bias synthesis across all included literature. The search strategy was not designed as a systematic review, and the proposed interdisciplinary pathway should therefore be regarded as a hypothesis-generating clinical framework rather than a validated protocol.

Conclusion

Integration of oral medicine, dentomaxillofacial radiology, and orthodontics has an important but selectively indicated role in assessment of pediatric and adolescent patients, particularly when pathology, complex anatomy, unusual root morphology, impaction, or anatomical boundary uncertainty is present. The available evidence supports comprehensive clinical assessment, careful use of conventional imaging, individually justified specialist consultation, and selective rather than routine CBCT.

Current literature does not establish that every radiological abnormality requires predetermined biomechanical modification, nor does it demonstrate that formal interdisciplinary protocols universally prevent root resorption, dehiscence, periodontal deterioration, or relapse. Evidence regarding several proposed risk factors remains heterogeneous and of low certainty. Accordingly, diagnostic information should be integrated into individualized clinical reasoning rather than converted into rigid treatment algorithms.

The major research gap is the absence of prospective evidence linking structured interdisciplinary diagnostic pathways to clinically meaningful orthodontic outcomes. Future longitudinal studies should therefore evaluate whether risk-based integration of biological assessment, specialist radiological interpretation, and biomechanical planning improves safety, efficiency, and long-term oral health in growing patients.

Data Availability

All data generated or analyzed during this study are included in this article.

Author Contributions

- Dr. Vikas Kumar: [Conceptualization, Investigation, Collected data, Writing - Original Draft]
- Dr. Anshuman Jamdade: [Academic Supervision, and overall guidance for research work]
- Dr. Nidhi Yadav: [Analyzed Data Curation, Validation, Visualization, reviewed the manuscripted, Critical feedback, final approval of manuscript]

Conflict of Interest

The authors declare that they have no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

1. Abdelkarim A. Cone-beam computed tomography in orthodontics. Dentistry Journal. 2019;7(3):89.
2. Alshomrani F. Cone-beam computed tomography (CBCT)-based diagnosis of dental bone defects. Diagnostics. 2024;14(13):1404. doi:10.3390/diagnostics14131404.
3. American Academy of Oral and Maxillofacial Radiology. Clinical recommendations regarding use of cone beam computed tomography in orthodontics. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology. 2013;116(2):238-257.
4. Segal GR, Schiffman PH, Tuncay OC. Radiologically determined orthodontically induced external apical root resorption in incisors after non-surgical orthodontic treatment of Class II division 1 malocclusion: a systematic review. Progress in Orthodontics. 2014;15:48.
5. Smit E, et al. Development of a clinical practice guideline for orthodontically induced external apical root resorption. European Journal of Orthodontics. 2020;42(2):115-124.
6. Tsolakis IA, et al. CBCT in orthodontics: a systematic review on justification of CBCT in a paediatric population prior to orthodontic treatment. European Journal of Orthodontics. 2019;41(4):381-389.
7. Dawood HM, Kroeger A, Chavda V, Chapple ILC, Kebschull M. Under pressure—mechanisms and risk factors for orthodontically induced inflammatory root resorption: a systematic review. European Journal of Orthodontics. 2023;45(5):612-626. doi:10.1093/ejo/cjad011.

8. Zhang Y, et al. Orthodontically induced external apical root resorption in root-filled versus vital teeth: a systematic review and meta-analysis. BMC Oral Health. 2023;23:180.