



The 4R Operational Diagnosis Protocol: R2 – The 10 ADIs Radiographic Interpretation System (10 ADIs-RIS)

Marwan Abou-Rass*, DDS, MDS, Ph.D.

*USC. Prof Emeritus, Founder of AbouRass Endodontics Academy (www.abourass.com).

Corresponding author: Marwan Abou-Rass, USC. Prof Emeritus, Founder of AbouRass Endodontics Academy (www.abourass.com), Email: mar@abourass.com

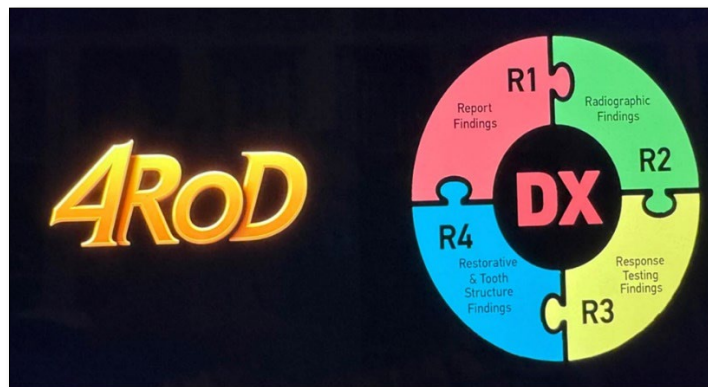
Abstract

Introduction: AbouRass's 4R Operational Diagnosis Protocol (4ROD) integrates systematic physical assessment with the "10 Areas of Diagnostic Interest" (10 ADI-RIS) radiographic interpretation system. This structured approach evaluates anatomical landmarks—from the clinical crown to adjacent structures—to identify endodontic and periodontal pathology. Recognizing that radiographs are diagnostic aids rather than standalone definitive tools, the 10 ADI-RIS minimizes clinical error by grounding imaging in biological reality. It promotes disciplined, consistent interpretation, ensuring treatment planning is evidence-based, preventive, and clinically responsible.

Methods: The 10 ADI-RIS utilizes a systematic, sequential analysis of periapical and bitewing radiographs, focusing on ten specific anatomical landmarks (clinical crown, pulp chamber, root canal, apex, lamina dura, periodontal ligament, periapical bone, periradicular bone, alveolar crest, and adjacent anatomy). This protocol integrates radiographic findings with clinical data from the 4R Operational Diagnosis steps (R1, R3, and R4) to correlate images with biological reality, ensuring diagnostic accuracy and preventing reliance on subjective or isolated imaging.

Conclusion: The 10 ADI-RIS transforms radiographic interpretation from a subjective observation into a disciplined, error-reducing diagnostic science. By acknowledging the biological and technical limitations of two-dimensional imaging, this structured protocol ensures that clinicians look beyond isolated sites to assess the tooth and periodontium holistically. When integrated into the 4R Operational Diagnosis Protocol, the system significantly improves diagnostic reliability, facilitates interdisciplinary treatment planning, and promotes patient-centered, biologically justified decision-making in clinical endodontics and periodontics.

Keywords: 4R Operational Diagnosis Protocol, 10 ADI-RIS, Radiographic Interpretation, Endodontics, Periodontics, Diagnostic Accuracy, Clinical Decision-Making, Biological Reality.



#J Oral Health Dent Res has interviewed Dr. Marwan Abou-Rass regarding 4R Operational Diagnosis Protocol.

INTRODUCTION

The 4R Operational Diagnosis Protocol 4ROD is a clinical diagnostic approach developed by AbouRass (1982)*. It emphasizes a systematic, physical assessment of the tooth, pulp, and supporting tissues. The protocol consists of four steps:

- R1: Patient's Report and Rapport Findings
- R2: Radiographic Findings
- R3: Pulpal and Periodontal Response Testing

- R4: Restorative and Tooth Structure Findings

Findings from these four steps are integrated to develop a problem list, establish a definitive diagnosis, and guide treatment planning.

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This article highlights the R2 step: the 10 ADI Radiographic Interpretation System (10 ADI-RIS). This system uses tooth-anatomy landmarks to assess factors that directly or indirectly influence the clinical and biological health of the tooth and its supporting tissues. It applies to both untreated endodontic teeth (EUT) and endodontically treated teeth (ETT).

The system guides clinicians through 10 sequential Areas of Diagnostic Interest to identify disease, treatment deficiencies, procedural errors, restorative concerns, periodontal complications, and hidden issues involving adjacent teeth or critical anatomical structures.

Q1. Why is Radiographic Interpretation a Critical Component of the 4ROD Protocol?

Clinical visual and tactile examination offers a limited value in the assessment of endodontic and periodontic problems. We all know that radiographic assessment is the standard of care; however, the question is: what is the best way to identify and quantify these problems?

Periodontal surgical research has demonstrated that surgical exploration not only identifies the problem but also allows precise measurement, making surgical measurements the gold standard.

Research has also shown that periapical radiology measurements closely approximate surgical measurements, though they are known to underestimate the presence, extent, size, and severity of dentoalveolar disease. Consequently, I do not treat radiographs as a standalone diagnosis. They are diagnostic aids, not definitive diagnoses. For this reason, in the 4ROD Protocol.

- I prioritize obtaining the highest-quality radiographs, as they are the most valuable diagnostic tools for endodontic and periodontal disease. The key principle is that imaging must be grounded in biological reality and validated through other diagnostic stages—R1, R3, and R4 of the protocol.
- This approach minimizes diagnostic errors, prevents overreliance on images, and supports the clinician in making decisions that are both biologically and clinically justified.

Q2. What are the Ten Areas of Diagnostic Interest – 10 ADIs

An area of diagnostic interest is an anatomical landmark or zone that directly or indirectly influences the biological or clinical treatment of the tooth and its supporting structures. To identify these areas effectively in clinical practice, I rely on periapical radiographs as the most efficient and accurate imaging method for this system, supplementing with CBCT when needed.

The 10 key areas include the clinical crown, pulp chamber, main root canal, root apex, lamina dura, periodontal ligament space, periapical bone, periradicular bone, alveolar bone crest, and neighboring teeth or critical anatomy.

This method applies to both Endodontically Untreated Teeth (EUT) (Figure 1) and Endodontically Treated Teeth (ETT) (Figure 2). The 10 ADI system promotes a disciplined diagnostic approach.

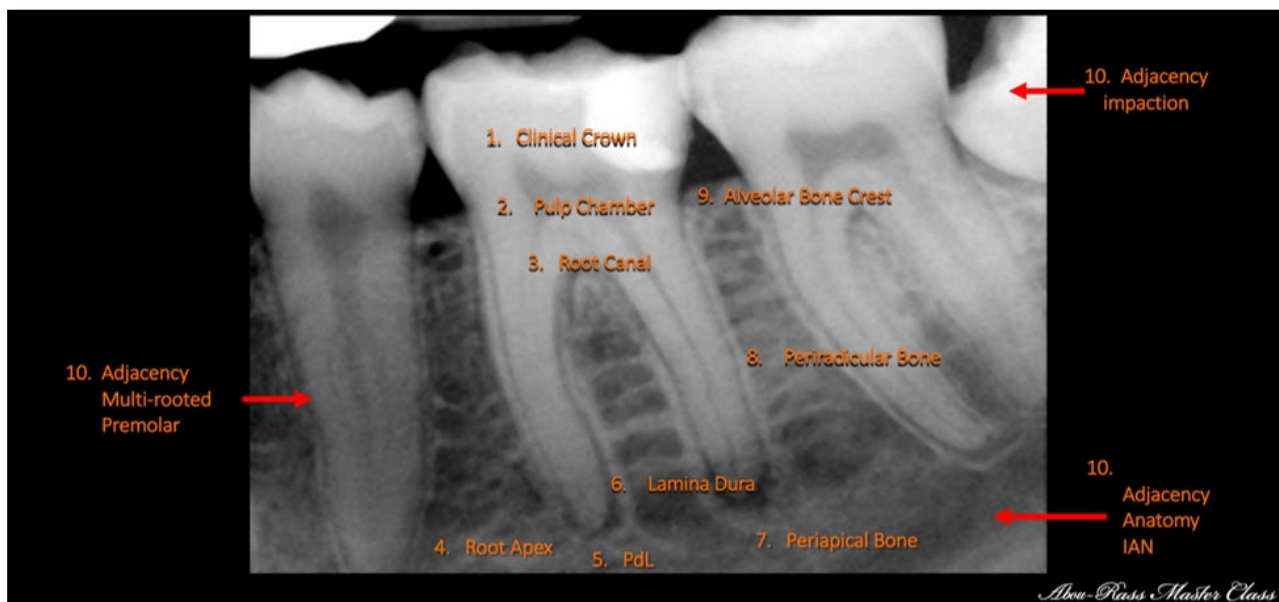


Figure 1. The 10 ADIs Radiographic Interpretation System for an EUT with Initial Apical Periodontitis.

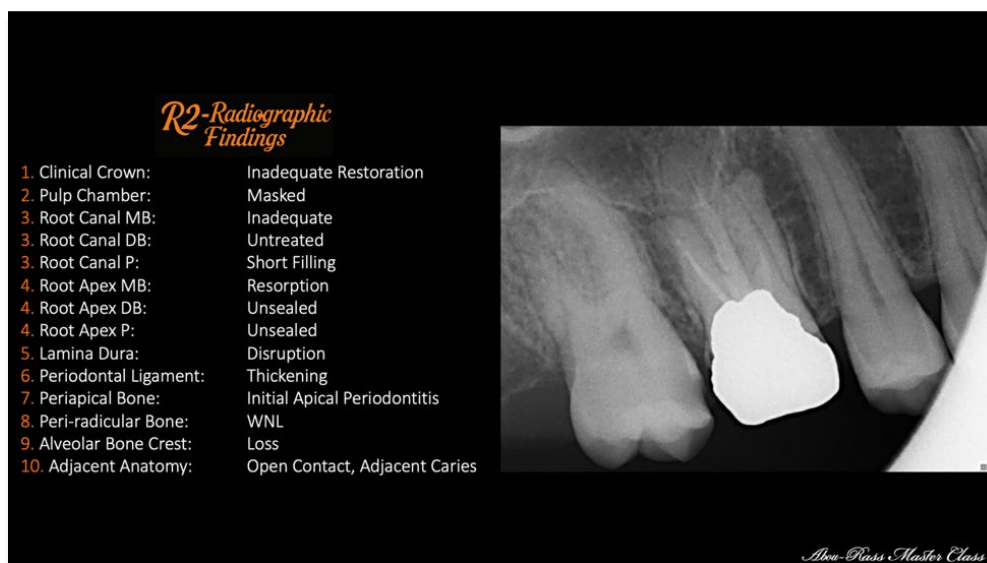


Figure 2. The 10 ADIs Radiographic Interpretation System for an inadequate ETT planned for retreatment and new restoration.

By following a consistent pathway, I reduce the risk of missing important findings. For me, the 10 ADI-RIS is a structured, systematic, preventive, and error-reducing system for radiographic interpretation.

Q3. What is the Significance of Radiographic Findings within the 4ROD Protocol?

The 10 ADI-RIS is founded on a key principle: *Radiographic findings are valuable but not sufficient on their own.* While a radiograph can reveal structural changes, it cannot fully assess the biological condition of the tooth's endodontium or the health of its periodontium.

Diagnostic errors often happen when clinicians rely too heavily on images beyond their biological or technical limitations. Importantly, the absence of radiographic evidence does not mean the disease is not present.

I base the 10 ADI system on five core principles:

1. Radiographs are supportive tools, not definitive diagnoses.
2. All imaging methods have inherent biological and technical constraints.
3. Normal radiographs do not exclude pathology.
4. The 10 ADI findings should be integrated with R1, R3, and R4 findings.
5. Radiographic interpretation must follow a structured, systematic protocol rather than subjective judgment.

These principles direct my application of the 10 ADI system within the 4R operational diagnosis protocol. The goal is to correlate radiographic images with the patient's biological reality and disease processes, ensuring interpretation is meaningful, grounded in biology, and minimizes errors.

Q4. Why do you rely on Periapical Radiographs when CBCT is Typically Considered the more Advanced Imaging Standard?

I rely on periapical and bitewing radiographs because they remain essential tools in routine dental diagnosis, particularly in endodontics, periodontics, and prosthodontics. When obtained with proper technique and high image quality, they offer valuable information that aids in diagnosis and treatment planning.

The advantages of periapical radiographs include:

- **Diagnostic validity:** shows sensitivities of 55–77% and specificities of 96–100%, with an overall accuracy of about 71%. Brynolf's 1967 cadaver study found a consistent correlation between radiographic and histologic findings in advanced apical periodontitis, though this was not observed in the early or initial stages of the disease.
- **Radiation safety:** These radiographs expose patients to relatively low radiation doses, often comparable to a few hours of natural background radiation.
- **Clinical efficiency:** They are straightforward to obtain, easy to correct if errors occur, simple to interpret, and economical. They also integrate smoothly into the daily digital workflows used in practice.

I do not view periapical radiographs and CBCT as competitors but as complementary tools. CBCT is advantageous when conventional radiographs are inadequate or when three-dimensional information is clinically necessary. The key is to use CBCT selectively, not routinely, since more imaging does not automatically improve diagnosis.

The main caution is that clinicians must understand both the technical and biological limitations. While technical issues can usually be corrected, neglecting biological constraints can lead to misdiagnosis, unnecessary treatments, and professional negligence. Therefore, I rely on periapical radiographs within a structured diagnostic protocol rather than as standalone images.

Q5. What are the Biological and Technical Limitations of Periapical Radiographs?

Technically, conventional intraoral radiography compresses three-dimensional anatomy into a two-dimensional image, so anatomical structures and disease patterns may be superimposed, distorted, obscured, or missed entirely.

Biologically, radiographs show mineralized tissue changes only after the disease has produced enough structural alteration or damage to become visible. This means that a normal-looking image does not always represent biological health. Classic histologic-radiographic correlation studies highlight several key limitations:

- Significant mineral bone loss may be required before a lesion becomes radiographically visible.
- Cancellous bone destruction can remain undetected on intraoral radiographs.
- Buccal and lingual lesions are often masked by surrounding anatomy.
- Radiographs commonly underestimate lesion size and disease extent.
- Histopathologic disease may exist despite a normal radiographic appearance.

For that reason, I do not interpret intraoral radiographs in isolation. In the 4ROD model, the 10 ADIs system provides a structured way to consistently review the image, accounting for R1, R3, and R4 findings.

Q6. Do all 10 ADIs Carry Equal Weight when Reviewing a Radiograph?

The significance of each ADI depends on how much it deviates from what I define as Within Normal Limits (WNL). Therefore, understanding what is considered normal is essential for accurate interpretation. This information is detailed in the PowerPoint presentation for each ADI in the Academy curriculum. For example, the importance of certain ADIs varies:

- ADI-2, the pulp chamber, is crucial in pulp testing, diagnosing tooth structure cracks, removing caries, evaluating pulp exposure risk, assessing a tooth’s suitability for vital pulp therapy, and during endodontic access preparation.
- ADI-3, the main root canal, has particular importance radiographically in cases of internal resorption, severe curvatures, endodontic treatment errors, or when examining untreated root canals. However, physical exploration during treatment offers more direct insights than a radiograph, so I combine imaging (R2) with clinical exploration (R4) to obtain an accurate diagnosis.
- ADI-5 and ADI-6, the lamina dura and periodontal ligament space, are especially useful in asymptomatic patients or when symptoms are unclear or clinical signs are conflicting. These areas often provide more informative findings due to their sensitivity to pulpal, periodontal, occlusal, and periapical changes.
- ADI-10, Adjacency, is more relevant when diagnosing a tooth in a heavily restored quadrant than when all intact adjacent teeth surround the tooth with excellent periodontal health.

Q7. Please Explain How to Use Each of the 10 ADIs.

ADI 1: Clinical Crown

Clinical Crown assessment is categorized into three groups: radiographically unrestored crowns, radiographically restored crowns, and crowned teeth. In these three categories, the assessment of the interproximal contact his biologically and clinically most important.

- In radiographically restored teeth, I focus on restoration contour, marginal integrity, recurrent caries, overhangs, open margins, interdental bone, and the relation of the restoration to the pulp chamber.
- In radiographically unrestored teeth or intact teeth, the focus is on the pulp chamber criteria **Figure 3**.

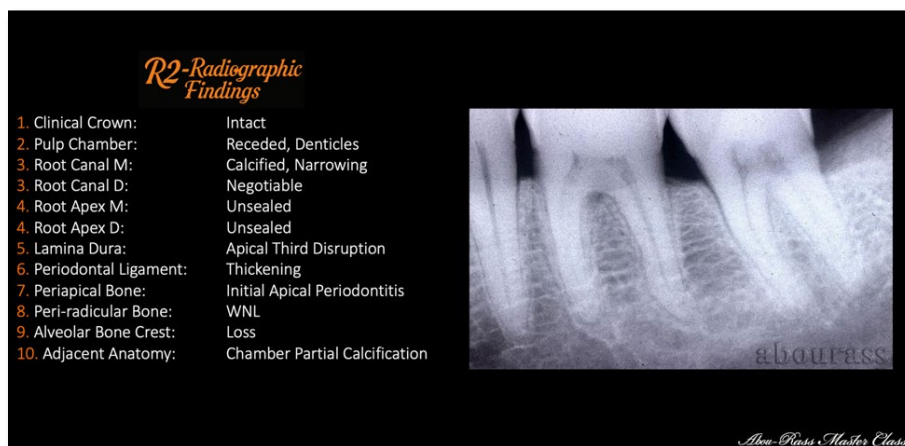


Figure 3. Shows a radiographically intact clinical crown. The 4ROD protocol diagnosis identified a Contributory Line Crack hidden within the central groove. The patient was symptomatic, with a nonresponsive pulp. Note how each A.D. is involved, yet the crown remains intact.

In crowned teeth, the periapical radiograph is of limited usefulness because the crown obscures the prepared crown structure and the pulp chamber. To overcome this limitation, I use bitewing radiographs, which precisely show crown margins and their proximity to the alveolar bone crest. Additionally, I pay attention to what I term the 'halo effect,' which I clinically verify using a sharp explorer to detect recurrent caries, decalcification, or open margins.

ADI 2: Pulp Chamber

Biologically, the pulp chamber acts as an indicator of pulp health. ADI 2 reviews the factors related to the pulp chamber before, during, and after endodontic treatment.

Radiographically, seven criteria are used to evaluate the pulp chamber:

- Outline sharpness (Walls and Pulp Horns)
- Outline integrity (Pulp Exposure, Restoration contact)
- High Density (Calcification, Atrophy)
- Low Density (Caries, Resorption, Space)
- Size
- Chamber Constriction
- Content (Stones, Denticles, Calcification)

These criteria are essential for diagnosis and endodontic procedures and apply to both untreated and treated teeth. They inform decisions regarding vital pulp therapy, crown preparation, and orthodontic movements. **Figures 4 and 5** illustrate images of teeth in which the seven criteria have been affected.



Figure 4. The 10 ADI of tooth #8, showing typical signs of advanced endodontic disease. Note how radiographs demonstrate the biological issues of pulp necrosis, pulp calcification, apical periodontitis, and external root resorption.

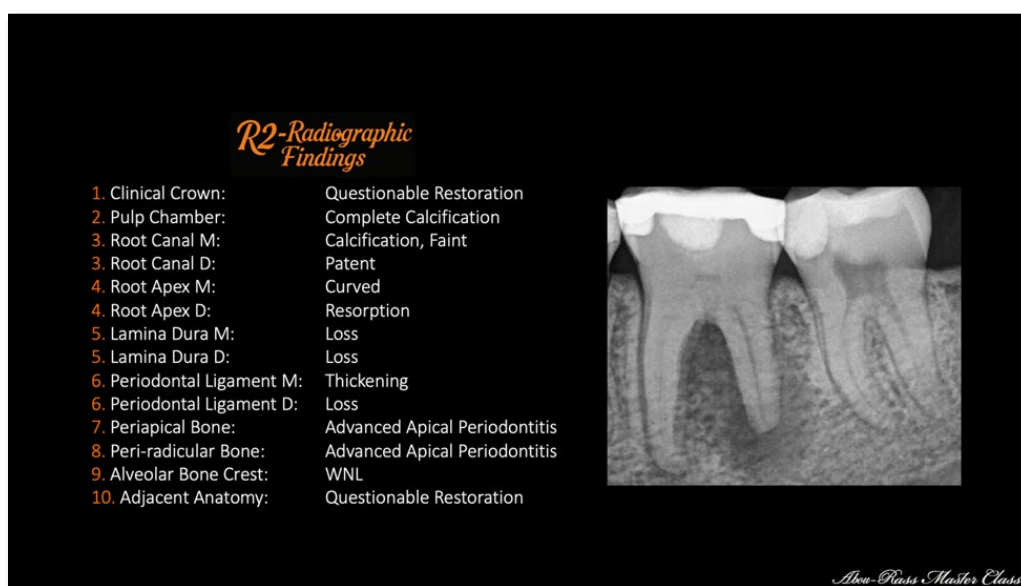


Figure 5. An image of a fully compromised 10 ADIs, alongside a radiographically normal pulp chamber in an adjacent tooth.

ADI 3: Root Canal

With ADI 3, I assess the main root canal space, recognizing that lateral canals, fins, and isthmuses are not visible either because of their microscopic nature or because of the two-dimensional nature of the radiograph.

During the evaluation of the EUT, I assess the integrity of the root structure, its length and curvature, danger zones and safety zones, the radiolucency or opacity of the root canal, and signs of resorption.

When assessing ETT, I analyze the relationship between the root canal and the pulp chamber, including the chamber seal or posts, filling, canal flow, filling density, the seal, width, material type, stripping, and perforation. (Figure 6) The primary advantage of ADI 3 is that it reminds me that radiographic canal anatomy is a guide, not an exact map. I verify my interpretation clinically through canal negotiation and exploration.

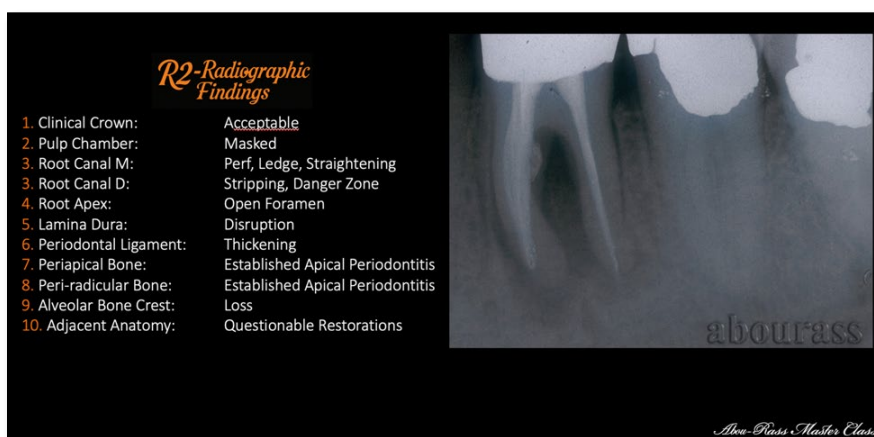


Figure 6. Illustrates the 10 ADI of inadequate and iatrogenic endodontic treatment. Notice how the absence of The Anticurvature Filing method resulted in root canal ledging, stripping, and perforation. It also caused straightening of the root canal, which led to treatment failure and the development of advanced apical periodontitis.

ADI 4: Root Apex

Regarding the earlier question about the weight of each ADI, the root apex exemplifies a critically important ADI. Biologically, the shape of the apex and the condition of the apical foramen influence both clinical and radiographic signs.

Anatomically, the shape affects root canal preparation procedures, determining the size and termination of the preparation.

Biologically, the root apex can display five different radiographic profiles: developmental, pathological,

iatrogenic, adequate, and inadequate endodontic treatment. The PowerPoint presentation provides detailed clinical examples of these profiles. Of particular importance is the relationship between the filling and the apex.

A gap over 3 mm or material extruded beyond the apex may suggest endodontic treatment failure, especially when associated with symptoms, clinical signs, or periapical changes.

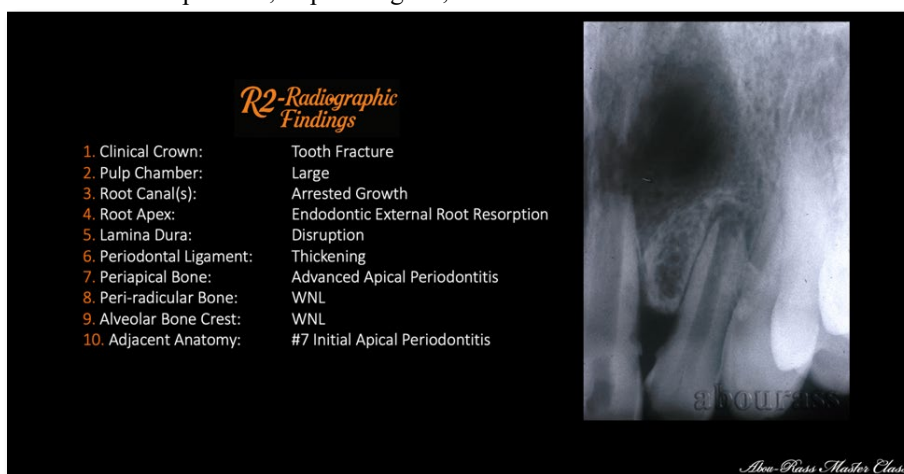


Figure 7. The ADIs of a typical root apex pathologic profile resulting from advanced apical periodontitis and endodontic external root resorption. The pathology is linked to dental trauma and delayed treatment.

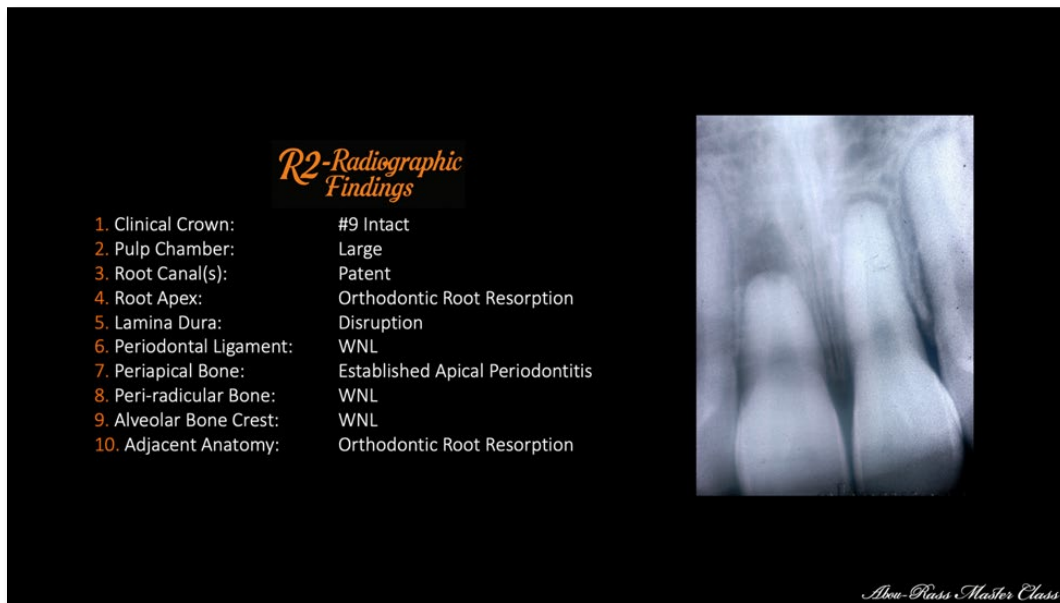


Figure 8. The ADIs of a typical root apex iatrogenic profile resulting from orthodontic treatment, complicated with pulp necrosis, and apical periodontitis.

ADI 5 and ADI 6: Lamina Dura and Periodontal Ligament

With ADI 5 and ADI 6, I examine the lamina dura and periodontal ligament space, which are among the most sensitive radiographic indicators of pulpal, periodontal, occlusal, and periapical biologic and pathologic changes.

Loss of lamina dura continuity, widening of the periodontal ligament space, or loss of these features helps me identify

disease and distinguish between endodontic and periodontal involvement.

Generally, intact lamina dura indicates health, while disruptions may signal pathology, trauma, occlusal stress, periodontal disease, or systemic factors.

I also view ADI 5, ADI 6, and ADI 9 as interconnected because the lamina dura extends upward into the alveolar crest **Figure 9.**



Figure 9. Radiographic image of molars showing a normal lamina dura and periodontal ligament space. Note the continuous lamina dura aligning with the alveolar bone crest.

ADI 7: Periapical Bone

Using ADI 7, I assess the periapical bone surrounding the root apex for radiolucent changes associated with factors such as microbial toxins, inflammation, immune response,

or host defense. On X-rays, these changes may appear as a loss of normal bone around the apex or alterations in trabecular bone structure, ranging from severe radiolucency to opacity. This ADI helps me categorize the size and scope of periapical disease:

- Small 2-5 mm radiolucencies confined to the apical third indicate Initial Apical Periodontitis (IAP);
- Moderate 5-12 mm radiolucencies that involve the socket partially or fully suggest Established Apical Periodontitis (EAP); and
- Large >12 mm radiolucencies affecting the periapical and periradicular bone, or extending beyond the socket, indicate Advanced Apical Periodontitis (AAP). This extensive radiolucency, also called a critical-size bone defect (CSBD), represents advanced pathology that requires complex surgical procedures and bone augmentation, **Figure 10**.

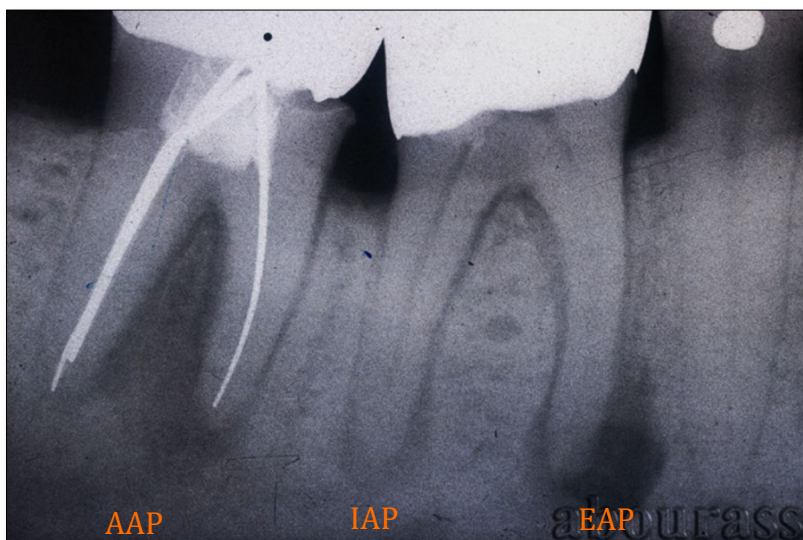


Figure 10. Illustrates a rare radiograph featuring three radiolucencies of different sizes. These size variations serve as the foundation for the AbouRass size-based apical periodontitis classification (ARSAP).

ADI 8: Periradicular Bone

ADI-8 was added to the system to distinguish between endodontic and periodontic pathology. ADI 8 covers the periradicular, furcal, and interdental bones, which may present as periodontal problems. The pathology of concern is called an Isolated Periodontal Pocket (IPP)

Many lesions in the periradicular bone in both EUT and ETT are due to pulpal or endodontic issues, such as pulp necrosis, tooth structure cracks, untreated root canals, and root perforations. These are often mistaken for periodontal diseases.

A key difference between IPP and periodontal pathology is that the isolated periodontal pocket heals after addressing the endodontic cause.



Figure 11. It shows a 12mm buccal isolated periodontal pocket (IPP) with radiolucency. During exploratory surgery, an apical buccal root fracture was discovered and subsequently removed. The image is a follow-up taken 6 months later.

ADI 9: Alveolar Bone Crest

The alveolar bone crest (ABC) is a part of the socket lamina dura, and its loss can negatively impact the tooth's pulp and periodontal health.

The most common cause of ABC loss is interproximal restorative discrepancies, including inadequate restoration contours, overhangs, and open margins. Additionally, ABC loss is linked to systemic diseases.

The advantage of ADI 9 is that it relates radiographic findings to periodontal health status, serving as a marker of periodontal health. Bitewing radiographs typically provide the clearest view of the alveolar crest, making them especially useful for assessing crestal bone levels and interdental changes.

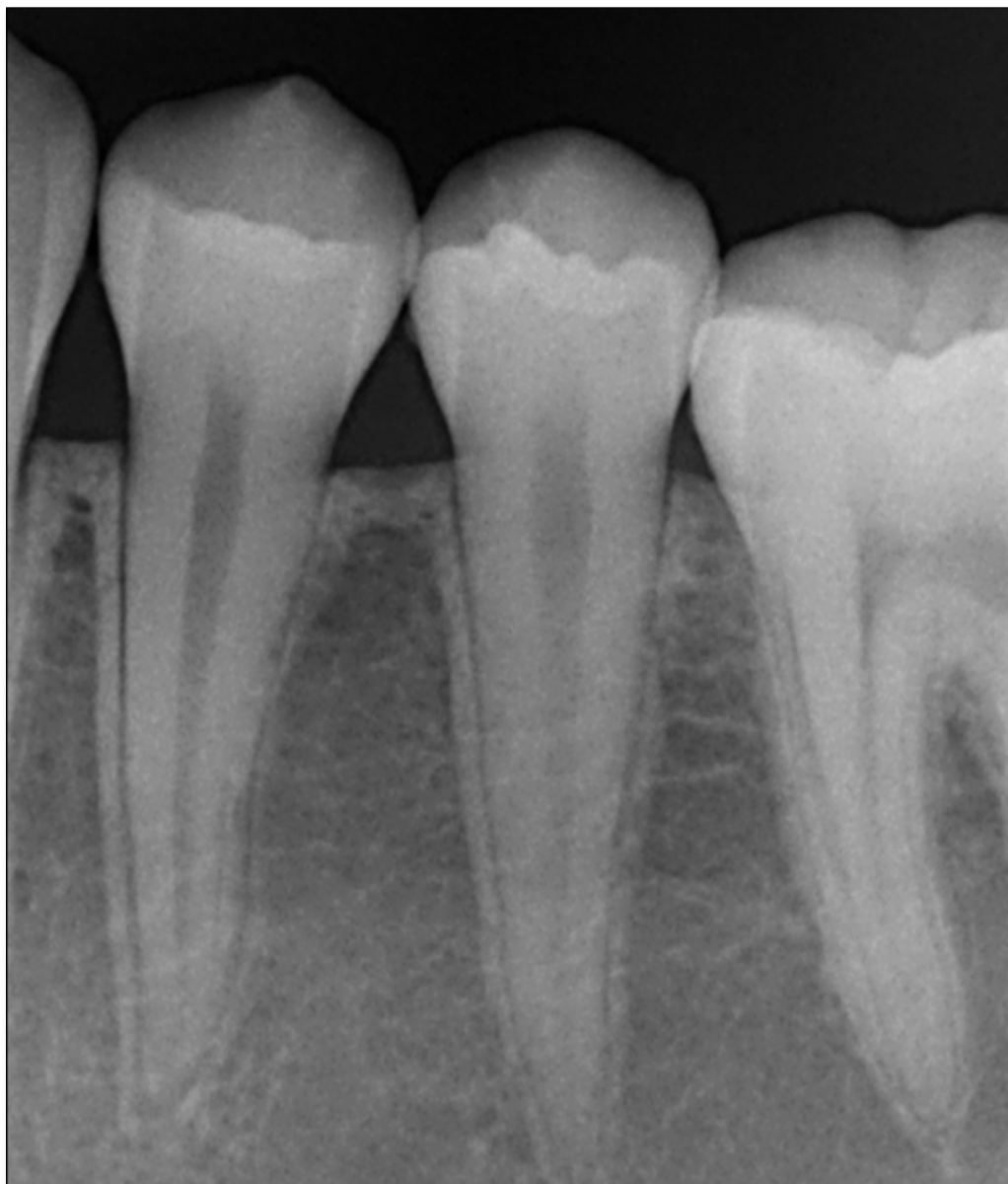


Figure 12. Radiographic image of posterior teeth showing a normal lamina dura and periodontal ligament space. Note the continuous lamina dura aligning with the alveolar bone crest.

ADI 10: Adjacent Teeth and Anatomical Structures

Heavily restored dental quadrants may harbor hidden chronic issues that could flare up during endodontic or restorative procedures on adjacent teeth. Concluding the 10 ADIs assessment with the evaluation of neighboring teeth helps prevent misdiagnosis, treatment complications, and patient dissatisfaction.

This assessment also considers vital nearby structures, including the maxillary sinus, the inferior alveolar neurovascular bundle, the nasal floor, and the incisive canal. The primary advantage of ADI 10 is its preventive nature. Focusing solely on one tooth risks missing other issues. By examining adjacent teeth and surrounding anatomy, I offer a more thorough, patient-centered, and clinically responsible interpretation, **Figure 13.**

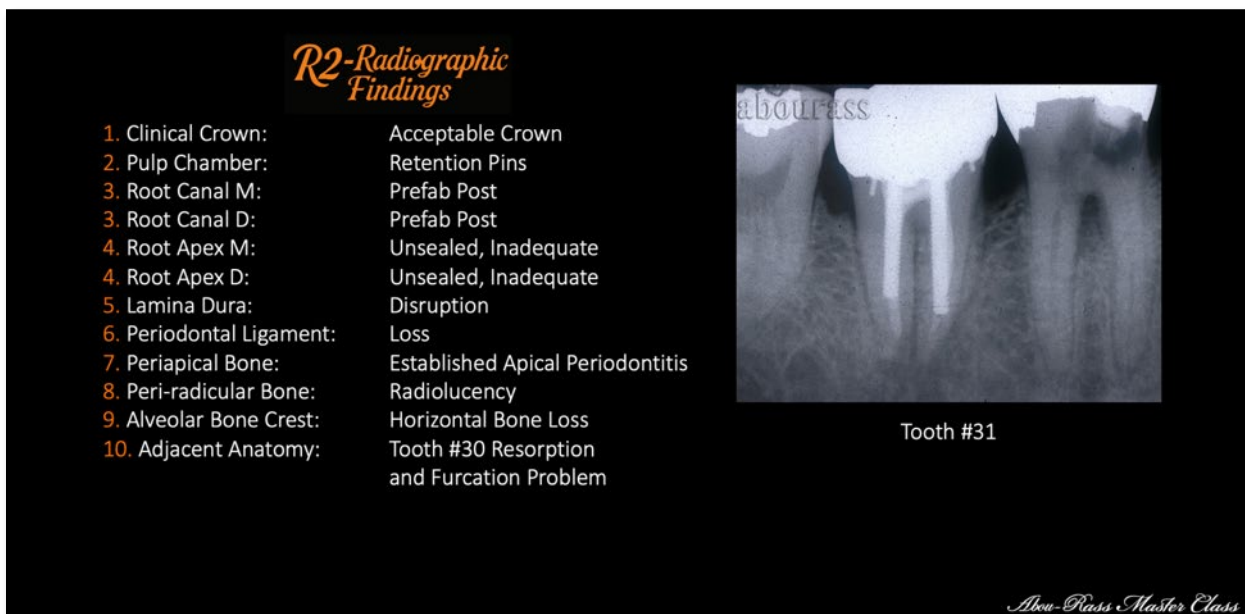


Figure 13. It shows the 10 ADI in a heavily restored quadrant, where the clinician focuses on the periodontal condition of tooth #31 and overlooks tooth #30.

CONCLUSION

The 10 ADI Radiographic Interpretation System (10 ADI-RIS) transforms radiographic interpretation from a subjective observational exercise into a structured, systematic, and biologically based diagnostic process. Rather than focusing on isolated radiographic findings, the clinician evaluates ten sequential anatomical areas that collectively influence the health and disease of the tooth and its supporting tissues.

The greatest strength of the system lies not only in its organization but in its integration within the 4R Operational Diagnosis Protocol. Radiographic findings (R2) are interpreted together with the patient's history and clinical findings (R1), pulpal and periodontal response testing (R3), and restorative and tooth structure assessment (R4). This comprehensive approach minimizes diagnostic errors, improves communication among clinicians, supports interdisciplinary treatment planning, and promotes biologically justified, patient-centered clinical decision-making.

The 10 ADI-RIS is not intended to replace clinical judgment; rather, it provides a disciplined framework that helps clinicians consistently identify significant radiographic findings while recognizing the biological and technical limitations of imaging. Radiographs are indispensable diagnostic aids, but they do not establish the diagnosis on their own.

Ultimately, radiographs demonstrate anatomy, whereas biology explains disease. The purpose of the 10 ADI-RIS is to bridge these two realities, ensuring that radiographic interpretation becomes clinically meaningful, biologically relevant, and an integral part of comprehensive diagnosis through the 4R Operational Diagnosis Protocol.

Radiographs demonstrate anatomy; biology explains disease.