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Assessment of endodontic case complexity by students and general dental practitioners

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Abstract

Background and objectives: Root canal treatment requires accurate assessment of case difficulty to minimise patient harm. The University of Otago developed an endodontic case difficulty assessment (ECDA) form to support clinicians in recognising cases exceeding their capabilities. This study tested whether final-year dental students and general dental practitioners (GDPs) could validly use the ECDA form to assess endodontic case complexity. **Methods:** Two specialist endodontists assessed six clinical cases using the ECDA form, achieving substantial to near-perfect inter-rater reliability (Cohen's $\kappa = 0.763\text{--}0.932$), with consensus ratings serving as the reference standard. Invitations were sent to approximately 889 New Zealand GDPs; 45 responded, and 41 met the inclusion criteria. Twenty-nine of 94 eligible final-year students (31%) completed the survey. Mean difficulty scores were compared using independent samples t-tests, and individual complexity factors were analysed for cases showing meaningful between-group differences. **Results:** Both groups ranked cases by relative complexity, correctly identifying the most and least complex cases, though both overestimated difficulty by 2–7 points. Four of six cases showed no meaningful between-group differences. Students demonstrated superior diagnostic accuracy (90% vs 78–83%) and recognition of pretreatment needs (45% vs 5%), while practitioners excelled in apex morphology (100% vs 86%) and periodontic-endodontic assessment (76–100% vs 55–72%). Both groups struggled with tooth inclination and resorption recognition. **Conclusion:** Students and GDPs can distinguish between simple and complex endodontic cases using the ECDA form, though variability in specific factors highlights educational priorities. Structured case difficulty assessment tools support deliberate clinical decision-making and protect patients when inexperience meets clinical challenge.

Introduction

Root canal treatment procedures are technique-sensitive, requiring clinicians to carefully evaluate the patient, tooth, and associated factors during treatment planning. Clinicians must assess the complexity of each case to ensure it aligns with their competency and falls within their scope of practice. Assessing case complexity is not only a clinical concern but also vital for training future clinicians. There is no clear definition of a complex case, resulting in inconsistent application. Starting cases that eventually prove too challenging for the clinician may result in poor patient outcomes and expose patients to unnecessary risk, such as instrument breakage or perforation. However, identifying when a case exceeds a clinician's experience or scope can be challenging, particularly for less experienced dentists or students. This raises a critical question: How can dentists or dental students with limited experience accurately determine when a case falls outside their competence?

Some teeth and patients present greater challenges for successful root canal treatment due to a range of anatomical and pathological factors. Posterior teeth, for example, often have multiple roots with greater curvature and are harder to access clinically. Case complexity can be broadly categorised into tooth-related, root-related, and historical or pathological factors. Features such as root curvature, apex size, canal configuration, and root length significantly contribute to technical difficulty (Vertucci and Gegauff, 1979; Ansari and Maria, 2012; Hartmann

et al., 2019). Likewise, prior trauma, existing endodontic treatments, root resorption (apical, internal, or external) (Darcey and Qualtrough, 2016; Patel *et al.*, 2018), and periodontal-endodontic lesions can complicate treatment (Gordon, 2005; Good and McCammon, 2012; Schmidt *et al.*, 2014; Zaleckiene *et al.*, 2014). Together with these structural and historical factors, patient-specific variables such as restricted access, medical status, or the presence of a gag reflex may also play a critical role in determining case complexity (Eliav, 2012; Segura-Egea *et al.*, 2019; Essam *et al.*, 2021). A systematic evaluation of all factors is beneficial for accurately assessing case complexity and guiding treatment planning.

Although case assessment is included in dental training, most existing guidelines are primarily designed for clinical use rather than for educational development. Despite their common purpose, these tools differ considerably in the types and weighting of case factors that they prioritise, complicating their consistent use in the teaching environment. They include the American Association of Endodontics (AAE) Case Difficulty Assessment Form and Guidelines (American Association of Endodontics, 2022); the Canadian Academy of Endodontists (CAE) Treatment Classification System and Assessment Form (Canadian Academy of Endodontics, 2017); the Dutch Endodontic Treatment Index (DETI) and Endodontic Treatment Classification (ETC) forms (Ree *et al.*, 2003); and the Restorative Dentistry Index of Treatment



Need (RIOTN; Falcon *et al.*, 2001). In contrast, tools such as the Endodontic Complexity Assessment Tool (E-CAT) (Essam *et al.*, 2021) and EndoApp (Shah and Chong, 2018) were developed with both educational and clinical utility in mind. However, regardless of their intended purpose, these tools vary considerably in the complexity factors they assess and how those factors are weighted. This lack of standardisation creates challenges for the consistent application in educational settings, where students require clear, reliable frameworks to develop their clinical judgment.

Knowledge of the effectiveness of resources to assess case difficulty is scarce. Recognising the limitations of existing tools for educational use, the University of Otago developed an Endodontic Case Difficulty Assessment (ECDA) form designed for standardised evaluation of case difficulty in undergraduate training. Studies have suggested that routine and structured case assessment is recommended to improve endodontic treatment outcomes. Furthermore, the revised New Zealand and Australian undergraduate endodontic guidelines now highly recommend assessing case difficulty as part of the educational curriculum (Sadr *et al.*, 2021). Despite this, there is considerable variation in reported RCT success rates among students; some have reported poor success rates, while others have reported higher success rates after introducing a more comprehensive pre-clinical endodontic education program. Notably, more challenging cases have been associated with poorer treatment outcomes for students (Alsulaimani *et al.*, 2015; Haug *et al.*, 2018). Accurate assessment of case difficulty must be carried out in student clinics to protect patients from unnecessary clinical mishaps. Generating an effective form requires careful consideration of meaningful content and rigorous testing in the clinical environment. This study tested the hypothesis that final-year dental students and general dental practitioners (GDPs) could use the ECDA form to assess endodontic case difficulty, thereby evaluating its readiness for broader implementation in undergraduate education.

Methods

Ethics approval for the study was obtained from the University of Otago Human Ethics Committee (ref: D22/348). Māori consultation was submitted, and approval was gained from the Ngāi Tahu Research Consultation Committee. The proposed ECDA form was implemented into an electronic questionnaire in Qualtrics XM (SAP Provo, UT), along with details of the clinical scenario. Photographs and radiographs of the cases were provided as needed, but there was no control over how participants viewed the cases. Some may have used PCs or monitors, while many likely used mobile devices. Before data collection, the survey instrument and case presentations were pilot tested with five final-year dental students and one endodontist. Participants provided feedback on the clarity of questions, adequacy of case information, image quality, and survey functionality. Minor modifications were made to image presentation and question wording based on this feedback before recruitment of the study cohort commenced.

Table 1. Endodontists' reference scores and inter-rater reliability

Case	Consensus score	Cohen's Kappa	Case description
1	30.5	0.823	Multi-rooted premolar
2	31.0	0.872	Fixed prosthesis requiring pretreatment
3	25.5	0.921	External resorption
4	20.5	0.932	Straightforward case
5	29.0	0.763	Periodontally compromised tooth
6	32.5	0.881	Complex periodontic-endodontic lesion

Gold standard assessment

Two specialist endodontists independently assessed all six cases using the ECDA form. Inter-rater reliability was assessed using Cohen's Kappa coefficient, with the values ranging from 0.763 to 0.932, indicating substantial to near-perfect agreement (Table 1). After the independent assessment, the endodontists met to discuss the cases where ratings differed and reached consensus on all complexity factors and difficulty scores. These consensus ratings were then used as the reference standard for comparison with student and GDP assessments.

Participant recruitment

Participants were informed that the study aimed to evaluate endodontic case difficulty assessment; however, they remained blinded to the expert consensus scores (reference standard) and the specific complexity factors being analysed until all assessments were completed. This ensured that participant ratings were based on their independent clinical judgment rather than knowledge of the expected 'correct' difficulty level.

New Zealand GDPs and final-year dental students participated in this study. A convenience sampling strategy was employed. GDPs were invited from the Dental Council register list of oral health professionals who had registered interest in research participation. After filtering for practitioners with current GDP scope of practice and available email addresses, invitations were sent to approximately 889 New Zealand GDPs. Included were practitioners currently practising in New Zealand who performed at least five root canal treatments per year; those performing fewer were excluded.

Demographic information collected from GDP participants included years since graduation, training background (New Zealand or foreign-trained), practice location within New Zealand, and practice type (private or public).

The entire cohort of final-year dental students at the University of Otago was invited to participate via email. All student participants had completed the required undergraduate endodontic curriculum, including pre-clinical simulation training and supervised clinical experience. At the time of data collection, fifth-year students had typically completed 1-4 root canal treatments during their clinical training, fewer than the GDP inclusion minimum of 5 treatments per year. All survey responses were stored confidentially. Both GDPs and student participants were

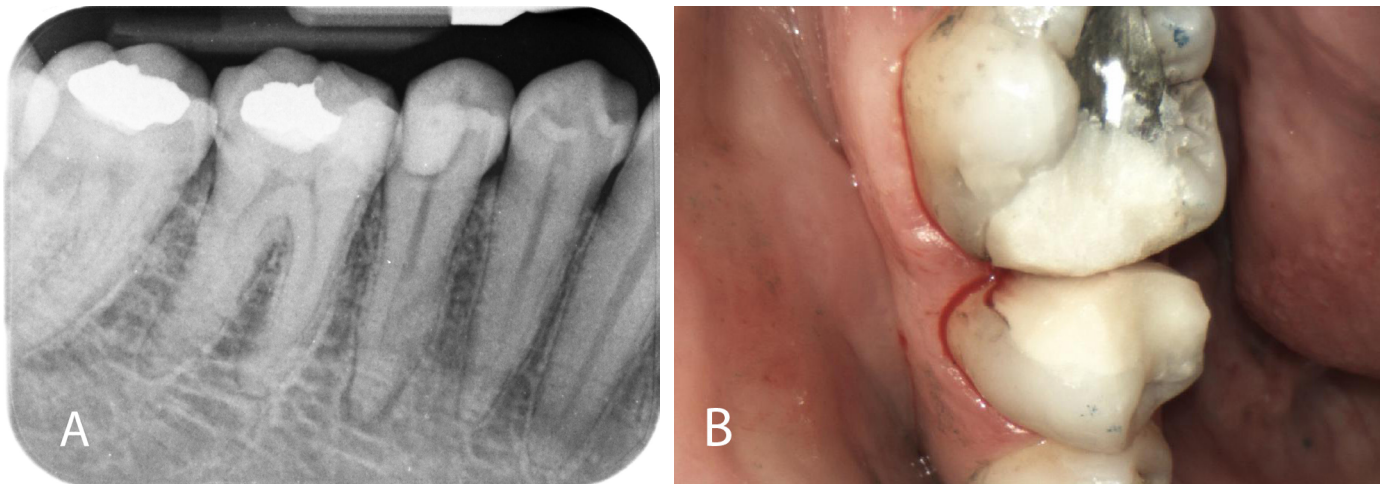


Figure 1. Example case presentation provided to participants. Patient: 45-year-old with poorly controlled non-insulin-dependent diabetes mellitus, anxious but cooperative, with previous difficulty with radiographs. Tooth 45: pulp necrosis with symptomatic apical periodontitis. (A) Periapical radiograph. (B) Clinical photograph.

entered into a prize draw sponsored by the New Zealand Society of Endodontics, with winners selected at random.

Study procedures

Participants evaluated six clinical cases of different complexity in endodontics. For each case, supplemental information was provided. The relevant patient medical history, radiographs, clinical photographs, presenting symptoms, and diagnosis were included (Figure 1). Participants completed the University of Otago ECDA form for each case. Upon completing all six assessments, a total difficulty score was calculated for each case based on the participant's responses.

Data analyses

Participant data were exported from Qualtrics XM (SAP, Provo, UT) to Microsoft Excel (Version 16.98, Microsoft 365; Microsoft Corporation, Redmond, WA, USA). Mean difficulty scores and standard deviations were calculated for each case by participant group (students versus GDPs). Independent samples t-tests were conducted using SPSS (Version 29.0; IBM Corp., Armonk, NY, USA) to compare mean scores between the two groups. Data were screened for outliers and assessed for adherence to the assumptions of normality and homogeneity of variance before analysis. To determine the magnitude of the difference for significant findings, effect sizes were calculated using Cohen's *d*. Statistical significance was set at $p < 0.05$. Where significant differences between two groups were observed, we analysed individual complexity factors to determine which specific assessments diverged from the endodontist reference standard.

Results

Participant recruitment

A total of 45 GDPs responded to the recruitment invitation; 41 (91%) met the inclusion criterion of performing at least five root canal treatments per year. The GDP cohort primarily consisted of New Zealand-trained graduates practising in private settings across both the North and South Islands (Table 2).

Table 2. Demographic characteristics of general dental practitioner participants (n=41)

Characteristic	n	%
Training background		
New Zealand graduate	27	65.9
Foreign graduate	14	34.1
Practice location		
North Island (Auckland, Wellington, Hamilton)	15	36.6
North Island (other)	9	21.9
South Island (Christchurch, Dunedin)	10	24.4
South Island (other)	7	17.1
Practice type		
Private	40	97.6
Public	1	2.4

Twenty-nine final-year students (31% of the 94-student cohort) completed the survey. All student participants had completed the required undergraduate endodontic curriculum, including pre-clinical simulation training and supervised clinical experience.

Overall case difficulty assessment

Mean difficulty scores for both groups generally aligned with endodontist reference rankings, identifying Case 6 as the most complex and Cases 3 and 4 as the least complex (Table 3). Both groups tended to overestimate difficulty, with mean scores typically 2-7 points higher than the reference. This trend was most pronounced in Case 6 and coincided with greater scoring variability (SD) for the more complex cases (Table 3).

Between-group comparisons

Student and GDP mean scores were closely aligned for Cases 1, 3, 5, and 6, with no meaningful differences between groups for these cases (Table 3). Differences were observed for Cases 2 and 4, where students assigned higher difficulty scores than GDPs.

Individual complexity factor analysis

To identify sources of divergence in Cases 2 and 4, individual complexity factor assessments were examined by calculating the percentage of participants whose ratings matched the endodontist reference for each factor.

Analysis of individual complexity factors for Case 2 revealed divergent strengths (Table 4). Students demonstrated

Table 3: Mean difficulty scores by participant group

Case	Endodontist reference	Students (n=29) M (SD)	GDPs (n=41) M (SD)	p-value*	Effect Size (d)
1	30.5	28.7 (4.8)	29.7 (5.1)	0.431	-
2	31.0	34.5 (5.7)	31.4 (4.1)	0.009	0.65
3	25.5	25.3 (3.1)	25.8 (2.9)	0.487	-
4	20.5	25.6 (4.0)	23.3 (2.6)	0.006	0.70
5	29.0	31.8 (4.8)	30.0 (3.2)	0.053	-
6	32.5	39.9 (6.3)	39.0 (7.1)	0.553	-

*Independent samples t-test comparing student and GDP mean scores. *d* = Cohen's effect size for significant differences. Italics indicate $p < 0.05$.

Table 4. Agreement with reference standard for individual complexity factors (Case 2)

Complexity factor	Endodontist reference	Students % correct	GDPs % correct
Diagnosis	Consistent odontogenic symptoms	90	78
Tooth inclination	No unusual inclination	17	34
Tooth isolation	Extensive pretreatment needed before dental dam placement*	45	5
Apex size	Closed apex (<0.8 mm)	86	100
Periodontic-endodontic condition	None or mild periodontal disease	55	76

*Case 2 involved a compromised fixed partial denture with clinical evidence of recurrent caries requiring removal prior to endodontic treatment.

Table 5. Agreement with reference standard for individual complexity factors (Case 4)

Complexity factor	Endodontist reference	Students % correct	GDPs % correct
Diagnosis	Consistent odontogenic symptoms	90	83
Tooth inclination	No unusual inclination	66	73
Tooth isolation	Routine dental dam placement	72	93
Apical resorption	None	59	61
External resorption	None	83	95
Periodontic-endodontic condition	None or mild periodontal disease	72	100

higher agreement with the reference standard for diagnosis and identified the need for extensive pretreatment for tooth isolation. Conversely, GDPs showed higher agreement for apex size and periodontic-endodontic assessment. Both groups showed poor agreement regarding tooth inclination.

In the more straightforward case 4, students again showed superior diagnostic accuracy (Table 5). However, GDPs demonstrated higher agreement across practical treatment factors, including tooth isolation, resorption assessments, and periodontal condition. Both groups struggled to recognise the absence of apical resorption or assess tooth inclination correctly.

Discussion

Accurately determining the complexity of endodontic cases is a challenging task that requires both systematic training and clinical experience. This study evaluated whether the University of Otago's ECDA form supports dentists and dental students with limited clinical experience in recognising when cases exceed their competence and scope of practice. The ECDA form was designed to provide a standardised framework for case assessment, with emphasis on supporting undergraduate dental education. Case difficulty assessment is now highly recommended in Australian and New Zealand endodontic guidelines (Sadr *et al.*, 2021).

Both final-year students and GDPs showed an ability to rank cases by relative complexity using the ECDA form. Participants correctly identified Case 6 as the most difficult and Cases 3 and 4 as the least complex. This finding suggests the form provides a reliable structure for distinguishing between straightforward and challenging cases. However, both groups regularly overestimated case difficulty compared to the endodontist reference, with mean scores typically 2-7 points higher across all cases. This may reflect endodontists' recalibrated perception of complexity based on their routine management of challenging cases that would exceed most practitioners' experience. Encouragingly, inexperienced students' tendency to overestimate potential difficulty represents a valuable safety margin for their future practice.

The ECDA form produced broadly consistent assessments across both groups, though differences in Cases 2 and 4 revealed important patterns in how diagnostic knowledge and clinical expertise influence specific aspects of case assessment. Students demonstrated superior diagnostic accuracy in both Cases 2 and 4 (90% correct in each case compared to 78% and 83% for GDPs). The advantage likely represents recent didactic training and familiarity with current diagnostic terminology and classification systems. Prior research in clinical reasoning has shown that students' systematic approach to diagnosis, reinforced by recent studies and deliberate practice with cases, can outperform the pattern recognition strategies that experienced practitioners develop over time (Norman, 2005). Our findings support the value of structured diagnostic frameworks in undergraduate education and suggest that the ECDA form effectively reinforces systematic case evaluation.

An unexpected finding arose in the assessment of tooth isolation requirements for Case 2. Students (45%) significantly outperformed GDPs (5%) in identifying the need for extensive pretreatment, contradicting the expected pattern where clinical experience enhances judgment. Case 2 involved a compromised fixed partial denture with radiographic and clinical evidence of recurrent caries. Removal of restorations is recommended before endodontic treatment, as clinical examination and periapical radiographs may not provide sufficient information to accurately assess the tooth's prognosis (Abbott, 2004). In contrast, for Case 4 (a straightforward presentation requiring routine isolation), GDPs demonstrated superior accuracy (93% vs 72%), suggesting that clinical experience enhances efficiency in routine cases, while systematic assessment tools help identify complex situations requiring additional steps (Norman, 2005).

GDPs consistently outperformed students in experience-dependent assessments. In apex size evaluation, 100% of GDPs correctly identified a closed apex compared to 86% of students, reflecting experiential knowledge of typical apical morphology. Similarly, GDPs demonstrated superior accuracy in recognising the absence of external resorption in Case 4 (95% vs 83%) and in assessing periodontic-endodontic conditions in both cases (76-100% vs 55-72%). GDPs' higher accuracy likely reflects greater clinical exposure to these presentations. Diagnosing periodontic-endodontic lesions remains complex and critical, as true combined lesions carry uncertain prognoses and demand different treatment strategies (Al-Fouzan, 2014; Sunitha *et al.*, 2008; Herrera *et al.*, 2018).

Both groups struggled with certain complexity factors. Tooth inclination was poorly recognised (17% students, 34% GDPs correct), likely due to reliance on visual interpretation without objective measurement guidance. Similarly, both groups struggled with resorption recognition (59-61% correctly identifying absent apical resorption), possibly due to confusion with apical radiolucency. Since treatment decisions vary significantly by resorption type, accurate recognition is crucial (Fuss *et al.*, 2003; Darcey and Qualtrough, 2013).

This study has several limitations. Both endodontists who established the reference standard were from the University of Otago, and this may have influenced their consensus ratings. However, they achieved substantial to near-perfect inter-rater reliability ($\kappa = 0.763-0.932$). Participants assessed virtual cases on various devices rather than in clinical settings, which may have affected the evaluation of visual factors like resorption and tooth inclination. The modest student response rate (31%) and self-selected GDP convenience sample may introduce selection bias; observed differences between groups should therefore be interpreted cautiously and cannot be generalised to the broader New Zealand GDP workforce.

Future research should employ targeted recruitment strategies to improve GDP participation and enable more robust between-group comparisons. These could include direct recruitment through professional networks such as the New Zealand Dental Association, follow-up reminders to non-respondents, and incentivising participation beyond

prize draws. Collaboration with regional dental societies or embedding data collection within continuing professional development events may also improve response rates and yield a more representative sample.

These findings have direct implications for improving endodontic education and clinical decision-making. To enhance the utility of the ECDA form, educational interventions must prioritise visual calibration for high-variability factors, such as tooth inclination and resorption, by developing standardised radiographic reference galleries. Furthermore, the ECDA form should be refined to include objective measurement prompts for tooth inclination, moving beyond the limitations of subjective visual interpretation. For practitioners, these findings indicate that systematic assessment tools can prompt the consideration of factors that clinical experience alone may overlook, particularly regarding restorative-endodontic protocols. Finally, developing the ECDA into a digital tool with embedded reference guides could reduce user confusion and support more accurate assessment of case complexity across diverse clinical settings.

Conclusion

Both students and GDPs can distinguish between simple and complex endodontic cases using the ECDA form, though distinct assessment patterns emerged reflecting different strengths in diagnostic versus experiential knowledge. These findings support the integration of structured case difficulty assessment tools in dental education to develop systematic clinical decision-making. Future research should validate the ECDA across multiple institutions and explore longitudinal effects on student clinical outcomes.

Author contributions

Conception and design of the study – all authors
Data collection – SCY
Data analysis and interpretation – SCY
Drafting the article – all authors
Critical revision of the article – FG, LF, PC
Final approval of the version to be published – all authors

Conflict of interest statement

The authors declare no conflicts of interest related to this study.

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The details of the endodontic case difficulty form are available on request from the corresponding author.

References

- Abbott PV. (2004) Assessing restored teeth with pulp and periapical diseases for cracks, caries and marginal breakdown. *Aust Dent J* 49:33-39.
- Al-Fouzan KS. (2014) A new classification of endodontic-periodontal lesions. *Int J Dent* 2014:919173.
- Alsulaimani RS, Al-Manei KK, Alsubait SA, AlAqeely RS, Al-Shehri SAM, Al-Madi EM. (2015) Effects of clinical training and case difficulty on the radiographic quality of root canal fillings performed by dental students in Saudi Arabia. *Iran Endod J* 10:268-273.



- American Association of Endodontics. (2022) AAE Endodontic Case Difficulty Assessment Form and Guidelines.
- Ansari I, Maria R. (2012) Managing curved canals. *Contemp Clin Dent* 3:237-241.
- Canadian Academy of Endodontics. (2017) Standards of Practice. Available at: <https://www.caendo.ca/wp-content/uploads/2017/10/Standards-of-Practice-2017-.pdf> (accessed 21 October 2023).
- Darcey J, Qualtrough A. (2013) Resorption: part 1. Pathology, classification and aetiology. *Br Dent J* 214:439-451.
- Darcey J, Qualtrough A. (2016) Root resorption: simplifying diagnosis and improving outcomes. *Prim Dent J* 5:36-45.
- Eliav E. (2012) Medically complex patients in the dental clinic. *Quintessence Int* 43:7.
- Essam O, Boyle EL, Whitworth JM, Jarad FD. (2021) The Endodontic Complexity Assessment Tool (E-CAT): a digital form for assessing root canal treatment case difficulty. *Int Endod J* 54:1189-1199.
- Falcon H, Richardson P, Shaw M, Bulman J, Smith B. (2001) Developing an index of restorative dental treatment need. *Br Dent J* 190:479-486.
- Fuss Z, Tsesis I, Lin S. (2003) Root resorption: diagnosis, classification and treatment choices based on stimulation factors. *Dent Traumatol* 19:175-182.
- Good ML, McCammon A. (2012) Removal of gutta-percha and root canal sealer: a literature review and an audit comparing current practice in dental schools. *Dent Update* 39:703-708.
- Gordon MP. (2005) The removal of gutta-percha and root canal sealers from root canals. *NZ Dent J* 101:44-52.
- Hartmann RC, Fensterseifer M, Peters OA, de Figueiredo JAP, Gomes MS, Rossi-Fedele G. (2019) Methods for measurement of root canal curvature: a systematic and critical review. *Int Endod J* 52:169-180.
- Haug SR, Solfeld AF, Ranheim LE, Bårdsen A. (2018) Impact of case difficulty on endodontic mishaps in an undergraduate student clinic. *J Endod* 44:1088-1095.
- Herrera D, Retamal-Valdes B, Alonso B, Feres M. (2018) Acute periodontal lesions (periodontal abscesses and necrotizing periodontal diseases) and endo-periodontal lesions. *J Clin Periodontol* 45(S20):S78-S94.
- Norman G. (2005) Research in clinical reasoning: past history and current trends. *Med Educ* 39:418-427.
- Patel S, Foschi F, Mannocci F, Patel K. (2018) External cervical resorption: a three-dimensional classification. *Int Endod J* 51:206-214.
- Ree MH, Timmerman MF, Wesselink PR. (2003) An evaluation of the usefulness of two endodontic case assessment forms by general dentists. *Int Endod J* 36:545-555.
- Sadr A, Rossi-Fedele G, Love RM, George R, Parashos P, Wu MC, Friedlander L, Peters O, Moule AJ, Zimet P, Duncan W, Hanan J, Brunton P. (2021) Revised guidelines for the endodontic education of dentistry students in Australia and New Zealand (February 2021). *Aust Endod J* 47:327-331.
- Schmidt JC, Walter C, Amato M, Weiger R. (2014) Treatment of periodontal-endodontic lesions: a systematic review. *J Clin Periodontol* 41:779-790.
- Segura-Egea JJ, Cabanillas-Balseira D, Jiménez-Sánchez MC, Martín-González J. (2019) Endodontics and diabetes: association versus causation. *Int Endod J* 52:790-802.
- Shah PK, Chong BS. (2018) A web-based endodontic case difficulty assessment tool. *Clin Oral Investig* 22:2381-2388.
- Sunitha VR, Emmadi P, Namasivayam A, Thyegarajan R, Rajaraman V. (2008) The periodontal-endodontic continuum: a review. *J Conserv Dent* 11:54-62.
- Vertucci FJ, Gegauff A. (1979) Root canal morphology of the maxillary first premolar. *J Am Dent Assoc* 99:194-198.
- Zaleckiene V, Peculiene V, Brukiene V, Drukteinis S. (2014) Traumatic dental injuries: etiology, prevalence and possible outcomes. *Stomatologija* 16:7-14.

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