ENDODONTIC TREATMENT OF AN EXTERNAL LATERAL ROOT RESORPTION WITH ROOT PERFORATION: A CASE REPORT WITH 4 YEAR FOLLOW-UP

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Aim: to describe the conservative management of severe external inflammatory root resorption with root perforation of tooth 1.1 using calcium hydroxide and bioceramic material.

Methods: a 15-year-old boy presented, who five years earlier had suffered an intrusive post-traumatic dislocation of tooth 1.1. The tooth was repositioned into its socket without endodontic treatment. Examination revealed swelling and pain at tooth 1.1, with increased mobility and sensitivity to percussion. The periodontal examination was normal. A periapical radiograph was taken, showing a large area of resorption at the middle root third, with communication to the alveolar bone at the distal level. The alveolar bone also showed an extensive inflammatory-type resorption area, a CBCT scan confirmed the loss of bone tissue and root resorption. After preparing the access cavity and probing the root canal, periodontal bleeding was observed, preventing completion of the endodontic treatment. After rinsing and irrigation with reduced-concentration NaOCl, an intracanal dressing of calcium hydroxide was applied to control bleeding, allowing obturation of the canal and promoting bone regeneration. Dressings were changed every two months until adequate control of bleeding was achieved, allowing us to complete the root canal filling with bioceramic cement and gutta-percha. The bioceramic material was pushed into the resorption area to promote bone regeneration.

Results: after two years, the Rx image appears normal, and the tooth is asymptomatic. At the four-year check-up, a second CBCT confirmed the repair of the buccal cortical plate and the healing of the bone.

Conclusions: root resorption appears filled with calcified tissue, confirming the effectiveness of the combination of calcium hydroxide and bioceramic materials in halting resorption and stimulating new bone formation.

MULTIPLE PERIRADICULAR RADIOLUCENCIES MIMICKING ENDODONTIC LESIONS IN RENAL OSTEODYSTROPHY OF THE MANDIBLE: A FOUR-YEAR FOLLOW-UP CASE REPORT

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Aim: to report a four-year follow-up of mandibular radiolucent areas mimicking endodontic lesions in a patient affected by secondary hyperparathyroidism.

Methods: in 2021, a 36-year-old Asian woman was referred to Clinica Odontoiatrica of Brescia for a dental visit because of a kidney transplant. The patient's medical hystory included chronic renal failure, hypocalcemia and secondary hyperparathyroidism. Panoramic and periapical radiograph showed periapical radiolucencies associated with mandibular teeth 36, 45 and 46. Elements 45 and 46 were affected by deep cariuos lesions but both were vital and normal responders to electrical test. Medical history and clinical/radiological examination leaded to suppose secondary hyperparathyroidism was the aetiology of periapical radiolucency mimicking endodontic lesions. During carious tissue removal, pulp horn of 46 was exposed; root canal treatment for tooth 46 and direct restoration for tooth 45 were performed. On the other hand, scaling and root planning was performed for tooth 36.

Results: three years later, the patient underwent a kidney transplant. The four-year follow-up revealed an asymptomatic clinical presentation of the element's teeth 36, 45 and 46. A periapical radiograph showed a slight periradicular radiolucency of 36 tooth while completed resolution of radiolucency was established for 45-46 teeth.

Conclusions: secondary hyperparathyroidism can present with periapical radiolucency mimicking endodontic lesions. Kidney transplantation and the resulting improvement in the clinical and haematological parameters are the main prerequisites for resolving the mandibular manifestations of renal osteodystrophy.

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DELAYED REPLANTATION AND ENDODONTIC TREATMENT: DO HOPELESS CASES REALLY EXIST?

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Aim: the aim of this case report is to highlight the possibility of a favorable prognosis even in extreme cases where the timing of both surgical and endodontic treatment plays an unfavorable role.

Methods: a patient presented after a maxillo-facial trauma caused by a horse kick, which occurred approximately 48 h prior to her referral; clinical examination showed extrusive dislocation of elements 1.2, 2.1, 2.2, and traumatic avulsion of 1.1 (the patient reported that dry time was > 15 min). Despite negative prognostic factors, delayed replantation of 1.1 and repositioning of interested teeth were performed. Patient preferred to be followed up by a private practitioner and was referred to our attention only 90 days after, showing an apical bone rarefaction of 1.1 with an associated fistula. Vitality tests confirmed necrosis of the replanted tooth; adjacent teeth resulted as vital instead. Endodontic treatment was performed with emphasis on irrigation phase; the canal was obturated using a master cone and BC sealer in the same session.

Results: fistula completely resolved within one week from treatment. Follow-up radiographs evidenced complete healing of the apical rarefaction, with total absence of internal or external root resorption.

Conclusions: despite delayed replantation and postponed endodontic treatment, at 48-months follow-up tooth did not exhibit any osseous and root resorption or mobility. Considering the complete restitution of function, this case suggests that the preservation of natural teeth should remain the primary objective to be pursued.

EXTERNAL CERVICAL RESORPTION: CLINICAL FEATURES, DIAGNOSIS AND MANAGEMENT OF FIVE CASES

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Aim: to present clinical cases of external cervical resorption (ECR), focusing on diagnostic features, clinical course and treatment strategies to improve early detection and management.

Methods: five ECR cases were evaluated through clinical and radiographic examination. All patients underwent conventional radiographs, while cone beam computed tomography (CBCT) was used when needed to assess lesion extent and treatment feasibility. Treatment options included endodontic therapy, surgical exposure and restoration, monitoring, or extraction with implant rehabilitation, depending on lesion severity and residual tooth structure.

Results: ECR was often asymptomatic and incidentally detected. Typical findings included pink spot and bleeding on probing. Differential diagnosis with root caries may be difficult, especially in elderly patients. Radiographically, root canal visibility through the lesion is a key feature. CBCT improved detection and three-dimensional evaluation, aiding treatment planning. Management depended on lesion extension and pulp involvement. Conservative treatments, including endodontic therapy and MTA- BCR repair, were effective in selected cases, while extensive lesions required extraction.

Conclusions: early diagnosis is crucial to improve prognosis and prevent complications. CBCT plays a key role in detection and classification. Although previously considered rare, ECR is increasingly reported. Awareness of risk factors and accurate radiographic assessment are essential for timely and appropriate management.

DIGITALLY GUIDED CANAL SCOUTING *VERSUS* MANUAL: AN *EX VIVO* STUDY

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Aim: to compare the effectiveness of manual *versus* mechanical reciprocating Ni-Ti canal scouting, evaluating full working length (FWL), operative time, complications, and operator experience.

Methods: 200 root canals from 78 extracted teeth were randomly assigned to manual scouting (K-files #08, #10 phase 1; #12, #15, phase 2), PathFile (PTF) 1 (phase 1) and 2 (phase 2), or B4U Starter (phase 1). Anatomical variables, FWL achievement, preflaring, operative time, pecking motion, and complications (instrument damage; blockage, ledge, debris extrusion) were recorded. Statistical analysis was performed ($p < 0.05$).

Results: FWL achievement was similar among groups (phase 1: manual 89.6%, PTF 86.6%, B4U 89.4%, $p = 0.831$; phase 2: manual 92.6%, PTF 92.3%, $p = 0.979$), as well as preflaring (25.4%, 25.4%, 24.2%; $p = 0.985$). Mechanical techniques significantly reduced operative time (phase 1 median: manual 25 s *vs* 12 s PTF/B4U; phase 2: 19 s *vs* 8 s; $p < 0.001$). Manual technique showed higher instrument damage (14.9% *vs* 6.0% PTF, 1.5% B4U; $p = 0.010$) and debris extrusion (32.8% *vs* 11.9% PTF, 19.2% B4U; $p = 0.012$). Anatomical complexity influenced outcomes (failure to reach FWL: 28.6% S-shaped, 29.7% apical curvature; $p < 0.001$). Operator experience affected secondary outcomes only (debris extrusion, $p = 0.007$).

Conclusions: mechanical scouting is as effective as manual techniques but more efficient and safer, reducing operative time and complications. Anatomical variables remain the main determinant of endodontic success, suggesting that technique selection alone is not sufficient to overcome anatomical complexity.

APICAL DEBRIS EXTRUSION DURING NI-TI INSTRUMENTATION: INFLUENCE OF THERMOMECHANICAL PROCESSING AND SHAPING STRATEGY

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Aim: to evaluate the influence of thermal treatment of nickel-titanium (Ni-Ti) instruments on apical debris extrusion during root canal preparation under standardized *ex vivo* conditions.

Methods: a total of 400 extracted human single-rooted teeth were randomly assigned to eight groups ($n = 50$) according to the instrumentation system: SlimShaper, SlimShaper Pro, Excalibur, Excalibur Pro, OneShape, One Curve, Reciproc, and Reciproc Blue. Apically extruded debris was collected using a modified Myers and Montgomery model and quantified with an analytical balance. Data were analyzed using one-way ANOVA and Tukey post hoc tests ($\alpha = 0.05$).

Results: significant differences were observed among groups ($p < 0.001$). No differences were found between SlimShaper and SlimShaper Pro or Excalibur and Excalibur Pro ($p > 0.05$). One Curve extruded less debris than OneShape, and Reciproc Blue less than Reciproc ($p < 0.01$). Multi-file systems showed lower extrusion than single-file systems ($p < 0.05$), while Reciproc exhibited the highest values.

Conclusions: thermal treatment influences debris extrusion, but effects depend on the extent of metallurgical differences. More flexible instruments and multi-file strategies may reduce extrusion, highlighting the multifactorial nature of this phenomenon.

IMMUNOMODULATORY EFFECTS OF THREE ENDODONTIC SEALERS ON MACROPHAGE POLARIZATION: AN *IN VITRO* STUDY

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Aim: this study aimed to compare the effects of three endodontic sealers, namely BioSeal®, AH Plus® and Pulp Canal Sealer® on cell cytotoxicity and macrophagic polarization. The underlying hypothesis was that root canal sealers may modulate periapical tissue healing by influencing the M1/M2 macrophage balance.

Methods: disc-shaped samples of each sealer were prepared and properly sterilized before being used for *in vitro* testing. Cytotoxicity was assessed using L929 murine fibroblasts, while macrophage polarization was evaluated with THP-1 human monocytic cells through gene expression analysis (GAPDH, TNFa, CD206, IL-6, IL-8, IL-10).

Results: Pulp Canal Sealer® showed the lowest biocompatibility, both in terms of intracellular ATP levels and overall metabolic activity. THP-1 cells cultured on BioSeal® exhibited higher expression of genes associated with M2 polarization (CD206), however it expressed also TNFa (M1-related gene) at higher levels compared to the other sealers.

Conclusions: the results of this preliminary study confirmed the biocompatibility of both epoxy resin-based and hydraulic calcium silicate sealers. The faster clinical healing observed with certain materials may be partly attributed to their ability to modulate macrophage polarization, thereby influencing inflammatory, reparative, and regenerative processes.

QUALITATIVE COMPARISON OF CANAL SHAPING BETWEEN RECIPROC AND RECIPROC BLUE USING DIFFERENT PROTOCOLS

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Aim: the aim of the study is to evaluate and compare the canal shaping ability of Reciproc and Reciproc Blue systems, used with and without glide path preparation with R-Pilot, defining four operative protocols.

Materials and methods: thirty-nine extracted human teeth were selected, yielding 60 root canals, randomly assigned to four groups (n = 15). Canal morphology was assessed by comparing pre- and post-instrumentation micro-CT scans. Quantitative analysis was performed using dedicated softwares (DataViewer, CTAn). Statistical evaluation was conducted through pairwise comparisons (6 combinations).

Results: out of 50 comparisons, 5 showed statistically significant differences. The R-Pilot + Reciproc Blue protocol demonstrated lower volumetric increase in the middle third, better preservation of canal shape in the apical third, and improved bucco-lingual centering in the transition area between the middle and apical thirds compared to R-Pilot + Reciproc. Additionally, it showed reduced canal transportation in the mesio-distal direction (middle third) and bucco-lingual direction (coronal third) compared to Reciproc.

Conclusions: all protocols allowed safe and predictable root canal shaping without clinically relevant alteration of canal anatomy. However, the R-Pilot + Reciproc Blue combination appears to provide better control and centering ability, making it particularly suitable for less experienced operators.

TEMPORARY RESTORATIVE MATERIALS AND CORONAL SEALING: DOES THE SUBSTRATE MATTER?

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Aim: coronal sealing is essential to prevent microbial contamination during endodontic treatment. Temporary materials such as IRM and Clip Flow are widely used, but their performance may vary depending on the substrate. The adjunctive use of flowable composite has been proposed, although its effectiveness without adhesive procedures remains unclear. This study evaluated the influence of substrate on sealing ability and its clinical implications.

Methods: standardized cavities were prepared on eighty specimens (natural tooth or composite build-up), irrigation with 5% NaOCl was performed. Four materials were tested: IRM, Clip, IRM+Flow, Clip+Flow. After thermocycling, microleakage was assessed by evaluating dye penetration. Two-way ANOVA was performed; dichotomous outcomes were further analyzed with Fisher's exact test.

Results: two-way ANOVA demonstrated a significant role of substrate, material, and their interaction ($p < 0.001$). On natural tooth, Clip showed lower leakage than IRM, with no benefit from flowable composite. On composite build-up, IRM showed complete leakage, whereas IRM+Flow achieved complete sealing; Clip was effective regardless of flow.

Conclusions: sealing ability is strongly substrate-dependent, with direct clinical implications. On natural tooth, adding flowable composite without adhesion does not improve sealing. On composite build up 1 mm flow application without adhesive is enough to prevent coronal microleakage. These findings support a scenario-based material selection rather than a standardized approach. Additionally, despite repeated irrigation with 5% NaOCl no detrimental effect on marginal sealing was observed. Future studies should investigate the mechanical stability of thin flowable composite layers and their potential use as standalone sealing materials.

INFLUENCE OF DIFFERENT RECIPROCATION ANGLES AND POST-CURVE SEGMENTS ON THE CYCLIC FATIGUE RESISTANCE OF NICKEL-TITANIUM INSTRUMENTS: AN *IN VITRO* STUDY

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Aim: to evaluate the cyclic fatigue resistance of two Ni-Ti instruments in artificial canals with different curvature locations, using three reciprocation angles.

Methods: a total of 120 instruments (ProFlex N.H.A. and Plex V, size 30.04) were tested using a dynamic cyclic fatigue at 35°C, with a customized testing device. Instruments were operated in reciprocation using different angles (90° CW-30° CCW, 120° CW-30° CCW and 150° CW-30° CCW). Tests were performed in artificial canals with same curvature (60°, radius 3 mm) but different distances from the canal entrance to the beginning of curvature (DOC: 10 and 6 mm). The cyclic fatigue resistance was expressed as time to fracture. Data were analyzed by two-way ANOVA and Bonferroni post hoc tests ($p < 0.05$).

Results: instruments at 10 mm DOC exhibited higher cyclic fatigue resistance than those at 6 mm ($p < 0.001$), across all angles. Plex V instruments showed higher fatigue resistance at 90° CW-30° CCW with a 10 mm DOC ($p < 0.001$), whereas no differences were observed at 6 mm ($p > 0.05$). ProFlex N.H.A. showed no differences among reciprocation angles ($p > 0.05$). Overall, Plex V showed higher fatigue resistance than ProFlex N.H.A. at 90° CW–30° CCW in both DOCs ($p < 0.001$).

Conclusions: curvature location significantly influences cyclic fatigue resistance, with shorter DOC associated with reduced fatigue resistance for both Plex V and ProFlex N.H.A. The effect of reciprocation angles depends on instrument type and curvature location. Plex V showed higher fatigue resistance under most tested conditions compared with ProFlex N.H.A.

MICROCT EVALUATION OF ENDODONTIC SEAL IN MINIMALLY SHAPED CANALS OBTURATED WITH DIFFERENT MATERIALS AND TECHNIQUES

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Aim: the quality of root canal obturation represents a key factor for the success of endodontic therapy. An ideal obturation should ensure a three-dimensional filling free of voids, with proper adaptation of the material to the canal walls. The aim of this *in vitro* study was to compare the quality of obturations achieved using the continuous wave of condensation technique and the single-cone technique with bioceramic sealer, as evaluated by Micro-CT.

Methods: forty extracted single-teeth were selected and instrumented using a standardized protocol with rotary and reciprocating instruments. The samples were randomly divided into four experimental groups of ten specimens each:

Group 1 – Protaper Ultimate/warm vertical condensation (WVC and BioRoot Flow);

Group 2 – Protaper Ultimate/single-cone technique (SC and BioRoot Flow);

Group 3 – Reciproc Minima warm vertical condensation (WVC and BioRoot Flow);

Group 4 – Reciproc Minima/single-cone technique (SC and BioRoot Flow).

All samples were analyzed using micro-computed tomography scans with standardized parameters.

Results: the vertical condensation technique showed fewer voids and better three-dimensional filling. The single-cone technique with bioceramic sealer appeared clinically acceptable but exhibited more residual porosity. Statistically significant differences between the two groups were observed.

Conclusions: within the limitations of this study, it can be stated that both groups achieved a satisfactory level of three-dimensional obturation, consistent with scientific literature. The continuous wave of condensation technique demonstrated greater reliability and reproducibility compared to obturation performed with a bioceramic sealer. However, the latter still represents a valid clinical option, although it appears to be more influenced by operator skill.

COMPARISON OF RECIPROC BLUE AND RECIPROC MINIMA IN CURVED ROOT CANALS: A MICRO-CT STUDY

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Aim: to evaluate, by means of micro-computed tomography, the impact of two reciprocating Ni-Ti systems: Reciproc Blue and the novel Reciproc Minima in severely curved roots of mandibular molars.

Methods: twenty-four mesial canals of mandibular molars with severe curvature (>35°) were selected and randomly assigned to two groups (n = 12 each) according to the R25 shaping instrument used: Reciproc Blue (RB) and Reciproc Minima (RM). All samples underwent pre- and post-instrumentation scanning using high-resolution micro-CT. Canal transportation, centering ratio, changes in canal volume and surface area, and dentin thickness were quantified at different root levels (3, 6, 9 mm from the apex). Data normality was assessed using the Shapiro-Wilk test. Parametric tests were applied for normally distributed data and non-parametric tests for non-normal distributions. The level of significance was set at $p < 0.05$.

Results: no statistically significant differences between Reciproc Blue and Reciproc Minima were observed in canal transportation or centering ratio at any root level. Reciproc Blue produced greater canal volume increase than Reciproc Minima in the coronal third (79 ± 44% *vs* 50 ± 32%; $p < 0.05$), whereas no differences were detected in the apical and middle thirds. Changes in surface area did not differ significantly between the two systems.

Conclusions: the reciprocating systems demonstrated comparable shaping performance. While Reciproc Blue resulted in greater canal enlargement, Reciproc Minima showed a more conservative shaping pattern, which may be advantageous for dentin preservation.

CYCLIC FATIGUE RESISTANCE OF NEXT-GENERATION NICKEL-TITANIUM INSTRUMENTS COMPARED WITH CONVENTIONAL NICKEL-TITANIUM INSTRUMENT

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Background: cyclic fatigue resistance of nickel-titanium (Ni-Ti) files remains a major concern, particularly in curved canals.
Methods: six contemporary Ni-Ti file systems were evaluated, comprising four rotary and two reciprocating. Instruments were tested in a standardized artificial canal with severe curvature (90° angle, 3-mm radius). Time to fracture, number of cycles to failure, and the lengths of coronal and apical fragments after fracture were recorded. Fracture surfaces were examined by scanning electron microscopy.
Results: reciprocating instruments showed significantly higher cyclic fatigue resistance than rotary instruments ($p < 0.001$). Mean time to fracture was 6.3 ± 2.0 s for rotary instruments and 47.5 ± 23.0 s for reciprocating instruments, while mean revolutions to failure were 52.7 ± 24.1 and 395.4 ± 221.0, respectively. Procodile Q 25/.06 showed the highest fatigue resistance (70.2 ± 22.2 s), whereas Mtwo 25/.06 showed the lowest (3.6 ± 0.3 s). Among rotary instruments, B-4U 23/.05 showed the highest fatigue resistance (13.9 ± 3.1 s). Rotary instruments fractured with longer coronal fragments, whereas reciprocating instruments showed longer apical fragments.
Conclusions: in-strument kinematics, taper, and tip diameter significantly influence the cyclic fatigue resistance of Ni-Ti endodontic instruments. Under severe curvature, reciprocating files demonstrated superior fatigue resistance compared with rotary instruments.

FINITE ELEMENT ANALYSIS OF THE MECHANICAL BEHAVIOR OF ENDODONTIC POSTS

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Aim: this study aimed to evaluate the influence of different post materials on stress distribution in endodontically treated premolars. Particular attention was given to post stiffness and adhesive interface behavior to improve treatment outcome and reduce fracture risk.
Methods: two-dimensional Finite Element Analysis, both radial and circumferential, were developed using an advanced software platform (COMSOL Multiphysics v5.6, COMSOL Inc., USA) for simulating a restored premolar subjected to vertical and tangential loading. Materials such as titanium, Ni-Cr, Au-Pd, zirconia, and fiber posts were analyzed. The models incorporated refined meshing in critical areas and modelled the periodontal ligament using Winkler's foundation theory to better reflect clinical conditions. The main materials were assumed as homogeneous, isotropic, and linearly elastic, except for fiber posts, which were considered orthotropic.
Results: the finite element analysis shows that the stress distribution varied according to the post material. Fiber posts exhibited higher stress values, whereas metallic and zirconia posts showed lower stress levels. Stress was mainly concentrated in the coronal and cervical regions, exhibiting a more uniform distribution in fiber and zirconia posts.
Conclusions: post material significantly influences stress distribution. Fiber and zirconia posts promote a more homogeneous stress pattern. In contrast, metallic posts increase cervical stresses, supporting the use of materials similar to dentin to reduce stress concentration and root fracture risk.

CENTERING ABILITY COMPARATIVE ANALYSIS OF HYFLEX EDM-OGSF AND PROTAPER GOLD IN J- SHAPED ENDO PRACTICE BLOCKS

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Aim: to compare the centering ability, resin removal and post-shaping width of HyFlex EDM-OGSF and ProTaper Gold in standardized J-shaped simulated root canals.

Methods: forty Endo Practice Blocks were allocated to HyFlex EDM-OGSF (n = 20) or ProTaper Gold (n = 20). One ProTaper Gold sample was excluded because of ledge formation and image overlap, leaving 39 specimens. Pre- and post-instrumentation images were superimposed and analysed by 2D longitudinal imaging at 11 levels from the apex. Group comparisons were performed with the Mann-Whitney U test and Bonferroni correction.

Results: HyFlex EDM-OGSF removed significantly less resin on the inner side in the middle third, with differences at 3 and 8 mm ($p < 0.05$), 4 and 7 mm ($p < 0.01$), and 5 and 6 mm ($p < 0.001$). On the outer side, resin removal was lower than ProTaper Gold at almost all levels: $p < 0.001$ from 1 to 8 mm, $p < 0.01$ at 9 mm, and $p < 0.05$ at 10 mm. Width was lower with HyFlex at all levels except 1 mm; after Bonferroni correction, differences remained at most levels except 1, 10 and 11 mm. Centering ability showed differences only at levels 2 ($p < 0.01$) and 3 ($p < 0.05$) before correction, but no significant differences after Bonferroni adjustment.

Conclusions: HyFlex EDM-OGSF and ProTaper Gold showed similar centering ability, but HyFlex was more conservative in resin removal and canal enlargement. HyFlex may therefore be preferable in severely curved canals where dentin preservation is critical.

TREATMENT OF AN ENDO-PERIO LESION WITH SEVERE RESORPTION OF THE BUCCAL CORTICAL BONE DUE TO IATROGENIC PERFORATION: A CASE REPORT WITH AN 18-MONTH FOLLOW-UP

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Aim: iatrogenic perforations and subsequent endo-perio lesions pose significant clinical challenges, often leading to extensive bone loss. This case report demonstrates the successful management of a root perforation with severe buccal cortical bone loss using calcium-silicate based (CSB) sealers.

Methods: a 50-year-old male patient was referred to our clinic with a chief complaint of pain in the right maxillary region. Clinical examination revealed a 14 mm probing depth extending to the root apex, along with swelling and a sinus tract in the upper right lateral incisor. Periapical radiographs using a gutta-percha (GP) cone into the sinus tract revealed inadequate prior endodontic treatment, a radiolucent defect at the middle third of the root and distal root perforation. Cone Beam Computed Tomography (CBCT) scans showed extensive buccal cortical bone resorption. The clinical approach involved endodontic retreatment starting by removing the previous filling material followed by thorough irrigation. Calcium hydroxide was placed as an intracanal medicament for two weeks to control bleeding, reduce inflammation and promote bone regeneration. Subsequently, the canal was sealed with a single GP cone of appropriate size and taper in conjunction with a flowable CSB sealer up to the perforation level. The perforation itself was later repaired using a CSB Root Repair Material (RRM). Tooth was restored with bulk-fill and hybrid resin composites.

Results: follow-up examinations at 6 and 12 months showed progressive healing of the periodontal damage with probing depth reduced from 14 to 4 mm. At 18 months, a new CBCT confirmed complete regeneration of the buccal cortical bone and periradicular lesion.

Conclusions: extensive bone loss does not necessarily preclude conservative endodontic treatment and may result in complete *restitutio ad integrum*.

MICRO-CT EVALUATION OF AIR VOID VOLUME AND PENETRATION DEPTH: A COMPARATIVE STUDY OF HOLLOW *VERSUS* SOLID QUARTZ FIBER POSTS

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Aim: to evaluate and compare the volume of air voids within the luting resin and the penetration depth achieved by hollow quartz fiber posts *versus* conventional solid posts.

Methods: twenty extracted single-rooted human teeth with straight canals were randomly assigned to two equal groups of 10. The first group was restored using radiopaque quartz fiber hollow posts (HP), with the luting composite injected directly through the internal tube of the post. The second group received solid posts (SP) luted conventionally. Two micro-CT scans - performed pre- and post-restoration - were superimposed to calculate the percentage of air voids in the cement and the maximum apical penetration of the posts.

Results: hollow posts generated a significantly smaller volume of air voids in the adhesive layer compared to solid posts (approximately 4.4% *vs* 17.3%, $p < 0.01$). Furthermore, the HP group demonstrated a statistically significant superior ability to reach the full depth of the prepared post space ($p < 0.05$).

Conclusions: the internal luting technique facilitated by hollow posts minimizes air void formation and ensures a more complete adaptation within the root canal. This optimized fit can enhance retention, potentially leading to better long-term clinical outcomes for post-endodontic restorations.

EX VIVO EVALUATION OF DIFFERENT ROOT CANAL IRRIGATION TECHNIQUES USING A NOVEL DEVICE FOR ROOT CANAL CLEANING

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Aim: the present study aimed to analyze *ex vivo* the effectiveness of different root canal irrigation protocols using the Endocator system and the confocal laser scanning microscopy (CLSM).

Methods: 32 single-rooted single-canal teeth were instrumented and irrigated with 5.25% NaOCl and 17% EDTA. Then, 1 mL of sterile water was introduced into the root canals, aspirated and transferred into the Endotester to evaluate the ATP levels. Subsequently, the samples were divided into four groups according to the irrigation protocol used: conventional syringe, Laser EdgeEndo, SmartLite Pro EndoActivator, and iVac system. At the end of the irrigation, a second measurement with the Endotester was performed. 8 dental elements were irrigated using methylene blue to evaluate irrigant penetration through (CLSM). Statistical analysis was performed using t-test, ANOVA test, and post-hoc test ($p < 0.05$).

Results: the iVac system achieved the best cleaning performance, with a significant reduction in ATP levels. Laser EdgeEndo showed a significant ATP reduction, with statistically better results than conventional syringe irrigation and EndoActivator, and comparable results to iVac. At the CLSM observation, iVac had the best penetration ability, followed by EndoActivator and Laser EdgeEndo.

Conclusions: the iVac and Laser EdgeEndo systems proved to be the most effective protocols, ensuring a significantly greater reduction in ATP levels. EndoActivator, although superior to syringe irrigation alone, showed intermediate effectiveness and good penetration into dentinal tubules.

MICRO-CT ANALYSIS OF ROOT CANAL SHAPING USING ROTARY PROTAPER ULTIMATE AND RECIPROCATING RECIPROC MINIMA NI-TI INSTRUMENTS

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Aim: root canal shaping is a main step in endodontic treatment, aimed at cleaning and shaping the root canal system while preserving the original anatomy. The development of Ni-Ti instruments with different kinematics has improved the efficiency of canal preparation. The study is based on the use of micro-CT, the shaping ability of rotary Protaper Ultimate and reciprocating Reciproc Minima Ni-Ti systems in single-rooted teeth.

Methods: twenty extracted single-rooted teeth with similar canal anatomy were selected and randomly assigned to two groups: Group 1 instrumented with Protaper Ultimate and Group 2 with Reciproc Minima. All samples were scanned using micro-CT before and after instrumentation. The evaluated parameters included canal volume increase, percentage of dentin removal, canal transportation and centering ability in different root canal thirds. Data were analyzed using dedicated software and statistical tests.

Results: both systems significantly increased canal volume and demonstrated shaping ability while maintaining the original canal anatomy. Protaper Ultimate showed greater cutting efficiency, resulting in increased dentin removal and faster canal enlargement, particularly in the apical third. Reciproc Minima demonstrated superior centering ability and better canal anatomy preservation, with reduced canal transportation, especially in middle and coronal thirds. No significant differences were observed in the percentage of uninstrumented canal surfaces between the groups.

Conclusions: both systems provided safe canal preparation. Protaper Ultimate exhibited higher shaping efficiency, whereas Reciproc Minima ensured improved control of canal anatomy and centering ability. The differences observed were mainly related to shaping dynamics rather than overall shaping performance.

MICRO-CT EVALUATION OF AHTD (ACCUMULATED HARD TISSUE DEBRIS) REMOVAL USING LASER (PIPS) AND SONIC ACTIVATION (ENDOACTIVATOR) IN MINIMALLY SHAPED CANALS

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Aim: smear layer removal is a critical objective in root canal therapy, because its presence promotes bacterial survival and compromises the correct obturation with cements. The activation of the irrigating solutions represent an efficient tool to improve the disinfection of root canal compared to the conventional passive irrigation. The aim of this *in vitro* study was to evaluate the removal of AHTD (Accumulated Hard Tissue Debris) using the Micro-CT in minimally Shaped single-rooted teeth using PIPS (Photon Induced Laser activation) and Sonic Activation (Endo Activator).

Material and methods: twenty extracted single-rooted teeth were selected and instrumented using Reciproc Minima endodontic System. The Samples were randomly divided into two experimental groups: 10 teeth with PIPS laser activation (Group 1) and 10 teeth with sonic activation with EndoActivator (Group 2). In both groups Sodium hypochlorite (NaOCl) and EDTA were used as irrigating solutions. Micro-CT analysis was performed before and after the irrigation protocol. 3D Images were analyzed using dedicated software to quantify the residual AHTD in the three root canal thirds (coronal, middle and apical).

Results: the Micro-CT analysis demonstrated a statistically significant removal of AHTD in Group 1 (Laser) when compared to Group 2 (Sonic).

Conclusions: within the limitations of this *in vitro* study, PIPS Er:YAG laser activation showed to be more efficient in the removal of AHTD when compared to sonic activation with EndoActivator in Minimally Shaped canals. These outcomes suggest that laser may represent an effective activation method of irrigating solutions to be adopted in protocols of endodontic therapy.

CAN THE FILLING TECHNIQUE INFLUENCE THE FORMATION OF VOIDS AND GAPS WHEN USING BIODENTINE XP IN VITAL PULP THERAPY? A M-CT AND SEM ANALYSIS

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Aim: this study aims to assess the occurrence of voids and gaps associated with different application techniques of Biodentine™ XP.

Materials and methods: Standardized Class I cavities (6 mm depth, 4 mm mesiodistal, 4 mm buccolingual) were prepared in 20 extracted mandibular molars and randomly assigned to two restorative protocols (n = 10). In the BioBulk&Go (BBG) group, Biodentine™ XP was placed in a single 4-mm increment and allowed to set for 15 min after that a restoration was performed with bulk-fill composite. In the BioBulk&Flow (BBF) group, Biodentine™ XP was immediately covered with a self-adhesive flowable composite, followed by the same restorative procedure. Voids and gaps at the Biodentine-dentin (B-D) and Biodentine-composite (B-C) interfaces, as well as within the materials, were evaluated by micro-CT and SEM ($p < 0.05$).

Results: in the BBG group, the B-D interface showed the highest mean number of voids (2.55) and mean void volume (0.17 ± 0.31 mm^3), whereas the B-C interface showed lower values (0.82; 0.06 ± 0.05 mm^3). In the BBF group, the Biodentine–flowable composite interface exhibited the highest mean number of voids (1.80) and mean void volume (0.08 ± 0.12 mm^3), while the B-D interface showed lower values (1.40; 0.03 ± 0.03 mm^3). Intramaterial void counts were comparable between groups, although larger void volumes were mainly detected within Biodentine™ XP. SEM revealed no macroscopic gaps in either group.

Conclusions: the BBF protocol reduced interfacial void formation compared with BBG, supporting the use of a flowable composite layer over Biodentine™ XP. Careful material handling remains essential to minimize voids and improve long-term restorative stability.

CENTERING ABILITY OF HYFLEX EDM-OGSF WITH AND WITHOUT GLIDE PATH IN J-SHAPED SIMULATED ROOT CANALS: AN *IN VITRO* STUDY

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Aim: to evaluate whether glide path preparation influences centering ability during root canal shaping with the HyFlex EDM-OGSF sequence in J-shaped simulated canals.

Methods: an *in vitro* study was conducted on 40 J-shaped Endo Practice blocks allocated to a Glide Path group (GP, n = 20) and a no-Glide Path group (no-GP, n = 20). All blocks were scouted with a 10 K-file; GP received the full OGSF sequence, whereas no-GP was shaped with shaper and finisher only. Pre- and post-instrumentation images were superimposed and analysed by 2D longitudinal imaging at 11 levels from the apex. Resin removal on the inner and outer canal sides, canal width and centering ability were compared with Mann-Whitney U tests and Bonferroni correction.

Results: six no-GP samples were excluded because of ledge formation and image overlap, leaving 34 analysable specimens. Inner resin removal was comparable between groups after correction. On the outer canal side, no-GP showed significantly lower resin removal at level 8 after Bonferroni correction ($p < 0.05$). Width differences seen at levels 2, 3, 8 and 10 before correction lost significance after adjustment. Centering ability tended to favour no-GP in the apical and coronal thirds and GP in the middle third, but no between-group differences remained significant after Bonferroni correction.

Conclusions: in this *in vitro* model, glide path preparation did not significantly improve centering ability with HyFlex EDM-OGSF. However, the higher number of aberrations in the no-GP group suggests a possible role in improving shaping safety and reproducibility.

COMPARISON OF RECIPROC AND RECIPROC MINIMA IN CURVED ROOT CANALS: A MICRO-CT STUDY

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Aim: to evaluate, by means of micro-computed tomography, the impact of two reciprocating Ni-Ti systems: Reciproc and the novel Reciproc Minima in severely curved roots of mandibular molars.

Methods: twenty-four mesial canals of mandibular molars with severe curvature (>35°) were selected and randomly assigned to two groups (n = 12 each) according to the R25 shaping instrument used: Reciproc (R) and Reciproc Minima (RM). All samples underwent pre- and post-instrumentation scanning using high-resolution micro-CT (85 kVp and 90 µA) at an isotropic resolution of 8 µm. Canal transportation, centering ratio, changes in canal volume and surface area, and dentin thickness were quantified at different root levels (3, 6, 9 mm from the apex). Data normality was assessed using the Shapiro-Wilk test. Parametric tests were applied for normally distributed data and non-parametric tests for non-normal distributions. The level of significance was set at $p < 0.05$.

Results: RM showed significantly lower canal transportation in the middle and coronal thirds (0.11 ± 0.07 mm and 0.14 ± 0.06 mm; $p < 0.05$), whereas R exhibited higher transportation values and greater coronal dentin reduction (21 ± 17%). Both systems demonstrated comparable increases in canal volume and surface area, with no significant differences in apical volumetric changes (62 ± 31% *vs* 57 ± 35%).

Conclusions: R resulted in greater dentin removal and canal transportation, while RM produced more conservative coronal enlargement and reduced transportation in the middle and coronal thirds, related to differences in taper and flexibility.

CUTTING EFFICIENCY OF NEW AND USED NICKEL-TITANIUM INSTRUMENTS AT DIFFERENT INCLINATION ANGLES: AN *IN VITRO* STUDY

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Aim: to evaluate the cutting efficiency of Orodeka Plex V and Dental World Proflex N.H.A. Ni-Ti instruments under repeated use and different inclination angles, simulating clinical conditions encountered in multirooted teeth.

Methods: forty-eight new 30/0.04 files of Orodeka Plex V and Dental World Proflex N.H.A. were tested at 90°, 70°, and 45° inclinations (n = 8) in continuous rotation (400 rpm) against standardized type IV gypsum plates using a customized testing device. Each file was tested up to five times using a new sample for each test. Cutting efficiency was assessed by measuring weight loss and cutting depth. Data were analyzed using two-way ANOVA and Bonferroni post-hoc tests ($P < 0.05$).

Results: Plex V showed reduced performance from the third use at 90° and from the second use at 45° ($P < 0.001$), remaining stable at 70° ($P > 0.05$). Proflex N.H.A. maintained stable performance at 90° and 70° ($P > 0.05$), with a slight reduction at 45° at the fifth use ($P < 0.001$). Both instruments demonstrated higher cutting efficiency at 45° ($P < 0.001$). Proflex N.H.A. outperformed Plex V at all angles from the third use onward ($P < 0.001$). Weight loss results mirrored cutting depth trends.

Conclusions: Proflex N.H.A. showed greater stability than Plex V under repeated use, possibly related to its nanoparticle coating, which may contribute to enhanced durability. Both instruments showed higher efficiency at 45°. Clinically, these findings suggest that repeated use and access angle should be considered when shaping multirooted canals.

CUTTING EFFICIENCY OF NI-TI INSTRUMENTS UNDER REPEATED USE AND AUTOCLAVE STERILIZATION: AN *IN VITRO* STUDY

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Aim: to evaluate the cutting efficiency of ProTaper Gold F3 instruments by assessing the effects of repeated use and autoclave sterilization under controlled and reproducible conditions.

Methods: ten ProTaper Gold F3 files (25 mm, ISO 30, 0.09 taper) were divided into two groups (n = 5): non-autoclaved files, and autoclaved files after each use (134 °C for 44 min). Each file performed five tests against type IV gypsum plates at 90° inclination in continuous rotation (400 rpm) using a customized testing device. Cutting efficiency was measured by weight loss and cutting depth. Data were analyzed using two-way ANOVA and Bonferroni post hoc tests (P <0.05).

Results: autoclaved instruments showed significantly higher mean cutting depth and weight loss than non-autoclaved files (P <0.05) and maintained stable cutting efficiency across all uses (P > 0.05). Non-autoclaved files showed a significant reduction in both cutting depth and weight loss from the third use onward (P <0.05).

Conclusions: autoclaved files maintain the cutting depth and weight loss, with no significant differences across uses. In contrast, non-autoclaved files show a significant reduction in cutting efficiency from the third cycle onward. These findings indicate that autoclave sterilization preserves the cutting performance of Ni-Ti instruments, supporting their safe and efficient reuse in clinical practice.

IN VITRO EVALUATION OF THE CYTOTOXICITY OF ROOT CANAL SEALERS: A COMPREHENSIVE SYSTEMATIC REVIEW

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Aim: to systematically evaluate the *in vitro* cytotoxicity of commercially marketed root canal sealers and to analyze the factors influencing their biological response.

Methods: a systematic review was conducted according to PRISMA guidelines and preregistered on the Open Science Framework. PubMed, Scopus, and the Cochrane Library were searched up to November 2025. *In vitro* studies assessing cytotoxicity of marketed root canal sealers using validated cell viability assays were included. Data on material composition, setting condition, extraction protocols, concentration, exposure time, and cell models were extracted. Due to heterogeneity, findings were qualitatively synthesized.

Results: ninety-eight studies were included. All sealer categories showed some degree of cytotoxicity, especially in freshly mixed conditions, at higher extract concentrations, and after longer exposure. Bioactive and calcium silicate-based sealers generally exhibited a more favorable profile, particularly after setting and at diluted concentrations. Resin-based sealers showed condition-dependent toxicity, while zinc oxide-eugenol and glass ionomer sealers tended to display higher cytotoxic potential. Outcomes varied according to cell type and assay method.

Conclusions: the cytotoxicity of root canal sealers is influenced by material composition and testing conditions. Bioactive sealers generally show improved biological performance, which may be clinically relevant in cases of sealer extrusion. Standardized protocols are needed to support evidence-based material selection.

COMPARISON OF THE EFFICACY OF GEL-BASED AND SOLUTION-BASED OF IRRIGANTS IN ROOT CANAL TREATMENT: A SYSTEMATIC REVIEW OF *IN VITRO* AND CLINICAL STUDY

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Aim: this systematic review evaluated the comparative effectiveness of gel- and solution-based formulations used during root canal shaping, focusing on smear layer and debris removal, instrument separation, file fatigue, bacterial reduction, debris extrusion, and postoperative pain.

Methods: following PRISMA 2020 guidelines, five electronic databases (PubMed, Scopus, Web of Science, Lilacs, and Google Scholar) and grey literature were searched up to February 2025. Randomized controlled trials, clinical, *in vitro*, and *ex vivo* studies comparing gel-based formulations (e.g., EDTA, NaOCl, CHX gels) with solution-based formulations were included. Thirty-seven studies met the eligibility criteria. Owing to heterogeneity, data were narratively synthesized.

Results: *in vitro* and *ex vivo* studies showed that gels improved lubrication and, in some models, reduced apical extrusion. However, they were also associated with greater dentinal debris retention, increased torsional/cyclic fatigue, and higher risk of file separation, likely due to dense dentine-gel sludge formation. Solution-based formulations showed superior smear layer removal, cleaning ability, and antimicrobial activity. Clinical studies found no significant advantage of gels in reducing bacterial load or postoperative pain, while sodium hypochlorite solutions provided better antimicrobial outcomes. Pain scores were generally comparable between groups.

Conclusions: although gel-based formulations may offer procedural benefits, their overall clinical performance appears inferior to solution-based formulations, particularly in cleaning efficacy, instrument safety, and antimicrobial action. Their routine use during root canal shaping should therefore be considered with caution.

DIAGNOSTIC ACCURACY OF TWO ARTIFICIAL INTELLIGENCE SYSTEMS IN COMPARISON TO UNDERGRADUATE AND POST GRADUATE MASTER STUDENTS. A COMPARATIVE EVALUATION

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Aim: to compare the diagnostic accuracy of two artificial intelligence systems (AI) (ChatGPT version 5.2 and Gemini version 3) with undergraduate students and postgraduate master operators in analyzing radiographic images across different endodontic conditions.

Methods: a total of 50 radiographic cases were evaluated and divided in five diagnostic groups: healthy teeth (n = 10), deep caries not reaching the pulp (n = 10), pulp necrosis with apical lesion (n = 10), teeth with healthy previous endo-treatment (n = 10), and chronic periapical lesions in endo-treated teeth (n = 10). Each case was assessed in both full-size of a standard periapical radiograph or focusing on only one tooth (cropped formats). AI were instructed using a standardized prompt. Diagnostic performance was measured in terms of accuracy (percentage of correct answers) for each group.

Results: overall accuracy was highest among postgraduate clinicians (n = 25) (84.9%), followed by undergraduates (n = 25) (78.7%), Gemini (72% full-size; 82% cropped), and ChatGPT (68% full-size; 50% cropped). ChatGPT showed optimal performance in healthy teeth (100%) but demonstrated reduced accuracy in teeth with a previous root canal treatment (30% full-size; 10% cropped). Gemini performed better than ChatGPT in chronic periapical lesions (100%) and strong performances in pulp necrosis (up to 100% in cropped images).

Conclusions: AI models demonstrated promising but variable diagnostic capacities in endodontic radiographic interpretation. Image format significantly influenced AI accuracy, highlighting the importance of input quality.

RADIOGRAPHIC EVOLUTION OF UNTREATED PERIAPICAL LESIONS

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Aim: this prospective study aimed to evaluate the annual surface variation and overall dimensional changes of untreated periapical lesions over time, while also investigating the relationship between dental treatment quality and lesion progression. Furthermore, the study assessed the influence of restorative and prosthetic treatments, performed with or without endodontic posts, on changes in apical radiolucency.

Materials and methods: a total of 180 teeth from 138 patients presenting radiographic evidence of periapical lesions were included. Orthopantomograms acquired between 2013 and 2019 (mean follow-up 2.67 years) were analyzed. Lesion area was calculated using the formula: AREA = $\pi \times (H/2) \times (L/2)$. Longitudinal dimensional changes were assessed and correlated with clinical variables.

Results: a statistically significant increase in lesion size over time was observed. Mean area increments were +2.58 mm² (1 year), +2.14 (2y), +1.60 (3y), +2.88 (4y), +0.60 (5y), and +12.03 (6y). The proportion of lesions showing dimensional reduction progressively decreased with increasing follow-up duration.

Conclusions: untreated periapical lesions tend to enlarge over time (mean increase +2.76 mm²). Root canal treatment is recommended for necrotic teeth. In previously treated teeth with persistent radiolucency, treatment quality should be carefully assessed. A follow-up period of up to 4 years is advisable; persistent or enlarging lesions may require orthograde retreatment or, in selected cases, surgical endodontic management.

ENHANCING PSYCHOMOTOR SKILLS AND EDUCATIONAL ENGAGEMENT IN ENDODONTIC MICROSURGERY THROUGH VIRTUAL REALITY WITH HAPTIC FEEDBACK: A COMPARATIVE STUDY

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Aim: this study explores the use of immersive virtual reality (VR) with haptic feedback in dental training, focusing on its effects on manual skills and learner engagement. Traditional preclinical models often lack realism and limit individualized practice. The aim was to assess performance outcomes and user perceptions among dental students and experienced clinicians using a VR platform for endodontic microsurgery.

Methods: simulated osteotomy and apicoectomy tasks were created from CBCT-based 3D models and delivered via the Virteasy Dental V2 system. Forty participants (20 students, 20 clinicians) completed a structured four-week training program. Feedback and prior VR experience were collected through a two-part questionnaire.

Results: students showed significant improvements in precision and execution in both tasks ($p < 0.05$). Clinicians also improved progressively, indicating adaptation to the virtual system. The VR environment was considered engaging, especially due to safe, repeatable practice. Most participants preferred VR over conventional methods.

Conclusions: VR simulation is an effective tool for enhancing psychomotor skills in dentistry. Its safe and interactive nature increased learner confidence. These findings support integrating VR as a complement to traditional preclinical education.

COMPARATIVE ANALYSIS OF POSTOPERATIVE PAIN FOLLOWING BIOCERAMIC SEALER APPLICATION WITH THREE OBTURATION METHODS: A RANDOMIZED CLINICAL TRIAL

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Aim: to compare postoperative pain (POP) at 6, 12, 24, and 48 hours after root canal treatment performed with three obturation techniques using the same bioceramic sealer (CeraFill RCS): cold lateral compaction (CL), single-cone (SC), and hot-modified (HM). The null hypothesis was that no differences would emerge among the techniques.

Methods: in this single-blind randomized controlled trial, 93 patients with an asymptomatic mandibular molar diagnosed with irreversible pulpitis and no periapical pathology were randomly assigned (1:1:1) to CL, SC, or HM. Treatment was performed in a single visit by the same operator under an operating microscope using standardized protocols. No analgesics or anti-inflammatory drugs were given. POP was assessed using a visual analog scale (VAS) at 6, 12, 24, and 48 hours. Data were analyzed with non-parametric tests and linear regression ($\alpha = 0.05$).

Results: VAS scores significantly decreased over time in the overall sample and in each group ($p < 0.001$). SC and HM showed significantly lower POP than CL at all time points ($p < 0.001$). No significant differences were found between SC and HM at 12 and 24 hours, whereas SC showed lower pain than HM at 48 hours ($p = 0.035$). Obturation technique and sealer extrusion were significant predictors of POP at 6 hours; no association with sex was found.

Conclusions: SC and HM resulted in significantly lower postoperative pain than CL when the same bioceramic sealer was used. SC showed the lowest pain levels at 48 hours, suggesting that contemporary obturation techniques may improve postoperative comfort.

AN EPIDEMIOLOGICAL STUDY OF MANDIBULAR SECOND MOLARS' ANATOMY

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Aim: to evaluate the prevalence of C-shaped canal morphology, root canal configurations, contralateral symmetry, and pulp chamber dimensions in bilateral mandibular second molars using cone-beam computed tomography (CBCT).

Methods: this retrospective cross-sectional CBCT study included 500 patients with bilateral mandibular second molars treated at the Department of Dentistry, IRCCS Ospedale San Raffaele, Milan, Italy, and was reported according to STROBE guidelines. CBCT scans (Hyperion X5; voxel size 0.125 mm) were independently assessed by two endodontists. Canal configurations were classified according to Vertucci in cases with complete bilateral coding, while C-shaped systems were categorized using Fan's classification. Statistical analyses included χ^2 or Fisher's exact tests, parametric or non-parametric tests, and paired comparisons ($p < 0.05$).

Results: complete bilateral Vertucci coding was feasible in 494/500 patients (98.8%), yielding 988 mesial and 988 distal roots. C-shaped morphology was detected in 1.2% of patients (6/500; 95% CI 0.44–2.59%), with no significant sex association ($p = 0.216$). Mesial roots most commonly showed Vertucci Types II (52.0%) and IV (26.5%), whereas distal roots mainly exhibited Types I (62.4%) and III (29.8%). Contralateral symmetry was observed in 27.3% of mesial and 59.1% of distal roots. Mean pulp chamber roof-to-floor distance was slightly greater on the right than the left ($p < 0.001$).

Conclusions: in this cohort, C-shaped morphology was rare, and no evidence of a sex association was found, although the small number of cases limits statistical power. Mesial roots showed more variability than distal roots, and contralateral symmetry was moderate and greater for distal roots than for mesial roots, supporting contralateral anatomy as a helpful — rather than predictive — clinical reference.