ARTICLES PUBLISHED IN THE "GIORNALE ITALIANO DI ENDODONZIA" FROM 1987 TO 2021: A BIBLIOMETRIC ANALYSIS

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Aim: the "Giornale italiano di Endodonzia" (GIE) is a peer-reviewed journal founded in 1987. It is the official journal of the Italian Society of Endodontics (SIE) and it is currently indexed in Scopus and Embase (years 1990-1991 and from 2011 to now). In order to offer a comprehensive evaluation of the scientific journal production, we carried out a bibliometric analysis of the articles published on GIE.

Methods: we searched the journal website archive for the non-indexed articles and the Scopus and Embase databases for the indexed articles. Relevant data were extracted from each article. Bibliometric analysis was performed using Biblioshiny, Publish or Perish and VOSviewer.

Results: a total of 601 documents were found, 246 (41%) of them were indexed in electronic databases. The annual production ranges from 4 (1987) to 37 (2021) with a mean annual growth rate of 6,76%. The total number of citations was 454. Dabelian 2016 was the most cited document with 29 citations. 1177 different authors contributed with at least 1 article. Gagliani M was the most contributing author with 34 documents. The most important contributing country was Italy, followed by Brazil and Iran. The most contributing institution was the University La Sapienza of Rome, followed by the University of Turin and the University of Naples. The most frequent keywords were "endodontics", "MTA", "CBCT", "cyclic fatigue" and "root canal treatment".

Conclusions: GIE showed an increasing internationalization and a growing impact in the endodontic field. Alongside classic topics of interest, new "hot topics" have emerged concerning innovative materials and technologies.

DENTINAL TUBULE PENETRATION FOLLOWING ULTRASONIC ACTIVATION OF INTRACANAL-HEATED SODIUM HYPOCHLORITE

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Aim: this study investigated the effect of ultrasonic activation of intracanal-heated sodium hypochlorite (NaOCl) on its dentinal tubular penetration.

Methods: in the experiment, mandibular premolars were randomly allocated to three groups (n = 8): group A, ultrasonic activation; group B, ultrasonic activation of intracanal-heated NaOCl and group C, syringe-and-needle irrigation. Penetration of the fluorescent-labelled NaOCl was investigated using light microscopy. Data were statistically analyzed using Kruskal-Wallis and Mann-Whitney tests ($P = 0.05$).

Results: the highest penetration of NaOCl was observed in group B, followed by group A ($P < 0.05$).

Conclusions: dentinal tubule penetration of NaOCl and root canal cleanliness were significantly improved by ultrasonic activation of intracanal-heated NaOCl.

Doi: 10.19256/abstract.cduo.04.2022

ROOT CANALS CLEANING AFTER DIFFERENT IRRIGATION TECHNIQUES: AN *EX-VIVO* ANALYSIS

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Aim: the endodontic space is a complex area, on both micro and macro levels, therefore traditional irrigation techniques may not guarantee a complete cleaning of such a complicated tridimensional system. The presented ex vivo study aimed to evaluate root canal cleanliness, obtained through an equal volume of traditionally applied sodium hypochlorite, compared to ultrasonically activated sodium hypochlorite and ultrasonically activated sodium hypochlorite preceded by intracanal heating.
Methods: totally 60 freshly extracted human mandibular premolars underwent roots samples length standardization (18mm), root canal preparation and, based on the irrigation method employed, were randomly and equally assigned to 3 study groups, composed of root samples treated with ultrasonically activated (group A), ultrasonically activated preceded by intracanal heating (group B) and traditionally applied (group C) sodium hypochlorite. Root Specimens were subsequently fixated with 4% buffered formalin solution and decalcified in Morse liquid. Ten six micron-thick serial cross-sections were obtained, dyed using hematoxylin and eosin and examined through an optical microscope at 40X, 100X, and 200X.
Results: group B showed a significantly less amount of debris compared to group A and C (P value < 0.05).
Conclusions: root canal cleanliness resulted significantly enhanced by ultrasonically activated sodium hypochlorite preceded by intra-canal heating.

CLSM EVALUATION OF ROOTS SUBJECTED TO ACTIVATION PROTOCOL IN ENDODONTIC MICROSURGERY

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Aim: this study evaluated the penetration of the irrigant subject to activation after performing retro-preparation in endodontic microsurgery.
Methods: forty mandibular premolars were prepared and filled. Subsequently, 1 mm from the root apex was cut using a multi-blade bur and the retro-preparation was performed. In group 1, the retro-cavity was cleaned with 2 mL of saline and then with 2 mL of 5.25% NaOCl gel mixed with 0.1% Rhodamine B. In group 2, the retro-cavity was cleaned with 2 mL of saline, 17% EDTA gel was activated ultrasonically for 30 s and 5.25% NaOCl gel was mixed with 0.1% Rhodamine B and activated for 30 s. After 7 days, the roots were cut at 1mm from the apex and the slices were evaluated with confocal laser scanning microscopy.
Results: the samples of group 2 showed statistically better results.
Conclusions: the activation protocol proposed resulted in enhanced irrigant penetration when compared to the traditional.

A NOVEL MODIFIED OBTURATION TECHNIQUE USING BIOSEALERS: AN *EX VIVO* STUDY

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Aim: this research aimed to evaluate the actual temperature of the biosealer during the obturation phase inside the root canal using a new hot technique. In addition, this study evaluated the penetration depth of the biosealer inside dentinal tubules.

Methods: in this study, 42-second mandibular premolars were used, and two experiments were carried out. In the first experiment, two premolars were utilized, and two thermocouples of K-type for each tooth were used. During the second experiment, the penetration depth of the biosealer was examined. In the first experiment, the Bonferroni method was performed to compare the temperature data. The tests used in the second experiment were Shapiro–Wilk's test, Kruskal–Wallis, and Mann–Whitney tests.

Results: the first experiment results showed that the heat does not reach the apical third using the new obturation method. In the second experiment, the results showed in Group B significantly higher biosealer penetration into the dentinal tubules as compared to Group A ($P < 0.05$).

Conclusions: the highest level of penetration of the biosealer in the dentinal tubules was observed in the group of the new obturation method, and the last apical 3 mm remained at 37° using this new technique providing no risk of chemical alteration of the biosealer.

TORSION, STATIC AND DYNAMIC CYCLIC FATIGUE RESISTANCE OF RECIPROCATING AND CONTINUOUS ROTATING NITI

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Aim: the aim of the present study was to evaluate torsion, dynamic and static cyclic fatigue resistance of the new reciprocating One RECI (OR, Micromega, Besançon, France), WaveOne GOLD (WOG, Dentsply Maillefer, Ballaigues, Switzerland), rotary One Curve (OC, Dentsply Sirona, Ballaigues, Switzerland) and ProTaper Next X2 (PTN X2, Dentsply Sirona, Ballaigues, Switzerland) instruments.

Methods: 120 NiTi instruments (25 mm in length; $n = 30$): OR, WOG, OC and PTN X2 were used. Torque and rotation angle until failure and under quasi-static torsion loading were measured according to ISO 3630-1. Fatigue resistance was measured as the time to fracture (TTF) of the instrument rotating in an artificial stainless-steel canal with a 60° angle and a 5-mm radius of curvature. The results were compared statistically with one-way ANOVA. Post-hoc Tukey tests and the alpha-type error was set at 5%. Fracture surfaces of each fragment from torsion and fatigue tests were examined with scanning electron microscope.

Results: OR showed higher static fatigue resistance and rotation angle at fracture than WOG, OC and PTN X2 ($P < .05$). WOG exhibit higher torsion resistance than the other tested groups ($P < .05$). Dynamic cyclic fatigue resistance test showed highest TTF than static cyclic fatigue resistance test for PTN X2 and WOG groups ($P < .05$). OR and WOG showed higher TTF than OC and PTN X2 in the dynamic cyclic fatigue tests ($P < .05$).

Conclusions: OR instruments showed higher static cyclic fatigue resistance and torsion angle at fracture but lower torsion resistance than WOG.

ANALYSIS OF MECHANICAL LOADS DEVELOPED WITH TWO DIFFERENT TECHNIQUES

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Aim: comparison of the mechanical loads stored in an instrument sequence according to the selected instrumentation technique.

Methods: 40 sequences of Fanta Dental (13.03, 20.04, 25.06) were selected. The sequences were divided in 2 groups based on the used instrumentation technique: crown down (CD) and step back (SB). The CD instrumentation technique was performed activating the 25.06 in the first 1/3 of the canals, followed by the 20.04 until the 2/3 of the canals and reaching the working length (WL) with the 13.03. After that the WL was reached with 20.04 and 25.06. The SB technique was performed instrumenting the entire WL with the following sequence: 13.03, 20.04 and 25.06. After the instrumentation of simulated inferior resin molars the sequences of each group were divided in 2 subgroups (A= cyclic fatigue and B= torsional resistance) according to the static test. Cyclic fatigue was measured calculating number of cycles to fracture (NCF) whilst torsional resistance was calculated measuring torque to fracture (Ncm).

Statistical analysis were performed through one-way ANOVA with Bonferroni correction, setting α at 0.05.

Results: both group CD A and CD B showed higher values of NCF and TtF in comparison to SB A and SB B groups with a statistically significant difference ($p < 0.05$), except for instrument 25.06 which showed a lower torsional resistance in case of CD technique.

Conclusions: the CD technique seems to be safer than the SB technique for both cyclic fatigue and torsional resistance, except for the torsional resistance of 25.06 which was the most stressed instrument in CD technique.

APICAL EXTRUSION OF DEBRIS USING THREE DIFFERENT NITI RETREATMENT SYSTEMS

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Aim: to compare the amount of apically extruded debris using three rotary NiTi retreatment systems.

Methods: thirty extracted single-root permanent human teeth were selected among those presenting a straight root. The root canals were prepared up to size 30 using the ProTaper Next system (Dentsply Sirona, Ballaigues, Switzerland), filled with gutta-percha and AH Plus sealer (Dentsply De Trey, Konstanz, Germany) using the continuous wave of condensation technique and they were randomly divided into three retreatment groups (n = 10) after a storage period of thirty days. The root fillings were removed with the following systems: ProTaper Universal Retreatment (Dentsply Sirona, Ballaigues, Switzerland), HyFlex Remover (Coltene/Whaledent AG, Altstätten, Switzerland) or VDW. Rotate Retreatment (VDW, Munich, Germany). Final apical preparation up to size 40 was obtained in each group using the respective shaping files. Apically extruded debris was collected in Eppendorf tubes, which were weighed with a microbalance (10^{-5} g) before and after retreatment procedure. The statistical analysis of data was performed using the Kruskal–Wallis test with a significance level set at 5%.

Results: the highest amount of extruded debris was associated to Hyflex Remover (0.85 ± 0.82 mg), followed by VDW. Rotate Retreatment (0.78 ± 0.41 mg) and ProTaper Universal Retreatment (0.62 ± 0.28 mg). However, no significant differences were detected amongst the three retreatment techniques concerning apically extruded debris ($p > .05$).

Conclusions: all the three studied retreatment systems were associated with apical extrusion of debris, with no significant differences between them.

WEAR ANALYSIS OF TWO SIMILAR INSTRUMENTS BEFORE AND AFTER 4 USES IN SIMULATED ROOT CANALS

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Aim: the aim is to assess surface alteration of EdgeOne Fire (EOF) and WaveOne Gold (WOG) before and after 4 canals uses.

Methods: 30 instruments were selected: 15 EOF and 15 WOG. The only difference of those instruments is their heat-treatments. Each instrument was inspected through a scanning electron microscope (SEM) to detect any manufacturing alterations of the surface. The micrographs were acquired at the tip, 4, 8 and 12mm from it to analyzed microfractures, metal defects (metal flash, metal strips), deformations, blunt and disruption of cutting edges, debris, pitting, tip flattening. Both NiTi instruments were used on resin molars up to 4 canals with a reciprocating motion (300rpm and 180°/60°). Then, the SEM observations were repeated and the results were analyzed by Chi square test performed to verify homogeneity of defects distribution and GLM to evaluate the differences of RMS at baseline and after use for both groups (α level 0.05).

Results: before the use, EOF instruments showed metal defects on the tip and debris on their entire length, while the WOG presented disruption of cutting edge on their entire length. After instrumentation, the EOF showed some of the above-mentioned alterations in different parts of the instruments, with a significant difference in comparison to WOG. No instrument fractured, spiral distortions in 6 EOF instruments and microfractures in 2 EOF instruments and in 3 WOG instruments were observed.

Conclusions: EOF instruments are more affected by clinical use than WOG in terms of blunt of cutting edge, distortion and debris accumulation.

EVALUATION OF PULP TISSUE DISSOLUTION THROUGH DIFFERENT ROOT CANAL IRRIGATION PROTOCOLS

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Aim: the aim of this study is to evaluate *in vitro*, using artificial lateral canals, the rate of dissolution of the pulp tissue through different protocols of canal irrigation.

Methods: one hundred artificial canals provided with lateral canals have been used. Each lateral canal was filled with pulp tissue and calibrated to 0.002 mg. All canals were irrigated using five different protocols. Five groups have been used for the experiment: Group A, distilled water (control); Group B, preheated NaOCl; Group C, NaOCl heated inside the canal; Group D, NaOCl ultrasonically activated; and Group E, NaOCl heated inside the canal with ultrasonic activation. All samples were weighed through professional microbalance in three different phases: before insertion of the pulp tissue into the lateral canal, after insertion of the pulp tissue and, finally, after different protocols of irrigation. A statistical analysis with Kruskal-Wallis test and Mann-Whitney test was performed.

Results: the partial dissolution of the pulp tissue inside the artificial lateral canal occurs only using the protocol with NaOCl heated inside the canal with ultrasonic activation. Other irrigation protocols are not able to dissolve the pulp tissue.

Conclusions: the main objective of endodontic therapy is the removal of damaged tissues and bacteria. Modern literature highlights that it is impossible to remove all the pulp tissues and bacteria from the whole endodontic space. Hence, to achieve excellence and get positive results in the short and long term, it is necessary to use techniques and technologies that may increase the degree of root canal detersion.

INFLUENCE OF DENTINAL AGING ON THE INTRACANALAR ADHESION STRENGTH OF FIBER POSTS: *EX VIVO* STUDY

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Aim: the aim of the present study is to determine the bond strength and the micro-morphological characteristics of the interface between root dentin and two resin cements (self-etch and self-adhesive) in endodontically treated elements and re-treated elements with a real endodontic history.
Null ipothesis: the treatment of the root substrate, the topography (coronal vs apical) and the type of cement used (self-etch vs self-adhesive) do not influence, in terms of adhesive strength and morphology of the interface, the adhesion.
Methods: 16 vital mono-rooted elements and 16 treated were selected, mechanically shaped with ProTaper Next up to X3. The canals were sealed with gutta-percha cones and cement. After 48h, fiber posts were cemented. All the samples were therefore divided into two groups according to the cement used (iCem or Clearfil), then sectioned perpendicularly to the long axis; push-out test was subsequently performed on each section. After the test the samples were analyzed under a stereomicroscope to identify the types of failure.
4 vital permanent molars and 4 RCT molars were selected and processed as described above. In these teeth the adhesive system (Clearfil) was pigmented with fluorescein and the cements (Clearfil and iCEM) with rhodamine. The sections obtained with the procedure described above were examined under confocal microscopy.
Results: adhesion is greater in newly treated teeth than in those with older endodontic treatment.
Most of the failures in each group are of the adhesive type: between dentin and resin cement.
Hybrid Layer is thicker in newly endodontically treated teeth. Self-adhesive cement produces a thinner HL than self-etch. The coronal half of the post space shows more penetrated tubules than the apical portion.
Conclusions: aging has a negative effect on the bond strength: since there is no significant difference between self-adhesive cements and traditional cements and that the use of self-adhesives, on complex substrates, such as endodontically retreated post-spaces, it may be considered an appropriate choice.

UNDERGRADUATE ENDODONTIC TEACHING IN ITALIAN DENTAL SCHOOLS

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Aim: we conducted a survey to evaluate the teaching of Endodontics in the Italian dental schools.
Methods: the questionnaire firstly proposed by Al Raisi et al. (2019) was modified and translated into Italian. The endodontic course owner in each Italian dental school was contacted and invited to participate in the survey using Google Form.
Results: twenty-eight out of 36 schools (78%) responded. In most schools, Endodontics is taught in the fifth year to 15-29 students. All schools planned pre-clinical endodontic training and in 3 schools clinical endodontic training was not provided. The average number of hours spent for pre-clinical and clinical training was 34,3 ± 23,6 and 84,1 ± 76,7, respectively. The course program varied among schools. All schools used rotary NiTi files in the clinical training and the vertical compaction of hot gutta-percha was the most frequently taught obturation technique. In 60.7% of the schools there was a clinical area specifically assigned to Endodontics. The academic qualification of the course owner (full or associate professor *Vs* other figures) has a significant impact on some of the considered variables (years in which the course is held, number of teaching collaborators, number of students, mean number of hours for teaching of some specific topics).
Conclusions: endodontic teaching is not homogeneous among Italian dental schools. Clinical training should be implemented in many schools. Teachers should strive to better fulfill the ESE Undergraduate Curriculum Guidelines. Endodontic courses held by a full or associate professor seem to be better structured.

EVALUATION OF SERUM INFLAMMATORY MARKERS IN SUBJECTS AFFECTED BY CHRONIC APICAL PERIODONTITIS

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Aim: to investigate if chronic Apical Periodontitis (AP) could play a role in the sustaining of systemic inflammation by raising the serum levels of pro-inflammatory cytokines such as IL-8; moreover, to evaluate the effect of the endodontic therapy on IL-8 levels.

Methods: eleven patients diagnosed for AP and 8 control subjects were assessed at the baseline and six months after root canal treatment in a case-control study. A medical anamnesis was conducted before the study, and all subjects were asked about their demographic and behavioral background. Both groups subjects presented the following inclusion criteria: BMI < 25 Kg/m^2 and an age between 18 and 55 years, excluding patients with periodontal disease, any declared disease or drug therapy. The diagnosis of apical periodontitis was performed radiographically. All subjects enrolled underwent blood sampling at the baseline and six months after root canal therapy (patients group) or six months after baseline (control group) in order to evaluate serum glucose and IL-8, whose levels were measured conducting ELISA tests. The endodontic treatment was performed according to the guidelines of the state of the art. The wound healing of endodontic lesions was assessed radiographically. The comparison of IL-8 levels between groups was analyzed statistically with variance analysis (One-Way ANOVA) and Tukey test.

Results: there were no differences for demographic and behavioral variables within the groups. At the baseline, the AP group showed increased IL-8 levels (81,8 ± 9,1 pg/ml) than control group (36,7 ± 4,6 pg/ml) ($p < 0,001$). Nevertheless, six months after root canal treatment, IL-8 levels were similar between patients and controls ($p = 0,3886$), emphasizing an initial efficacy of endodontic therapy in the decrease of inflammatory serum markers.

Conclusions: the root canal treatment showed early evidence in ameliorating the systemic inflammation by reducing the levels of inflammatory markers such as IL-8.

CONSERVATIVE SHAPING COMBINED WITH THREE-DIMENSIONAL CLEANING CAN BE A POWERFUL TOOL: CASE SERIES

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Aim: the purpose of this case series was to report on the outcome of root canal treatments following a conservative canal preparation, followed by three-dimensional cleaning technique.

Methods: three clinical cases were reported. For each case, 3D cleaning technique (intracanal heating and ultrasonic activation of NaOCl) was performed.

Results: healing of periapical disease was achieved in the reported cases following conservative root canal preparation, irrigation with 17% EDTA, and intracanal heating and ultrasonic activation of NaOCl.

Conclusions: conservative endodontics has been introduced about a decade ago. Since then, it has been demonstrated that less canal preparations lead to more dentin preservation resulted in decreased stress on tooth structure, mainly in the coronal third of the root, and potentially a higher resistance to fracture. In addition, smaller and larger canal preparations were comparable with regard to the cleanliness of the root canal.

EVALUATION OF SEALING ABILITY OF PREMIXED BIOCERAMIC ROOT CANAL SEALER IN APICOECTOMY

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Aim: premixed bioceramic sealers are a group of materials available in endodontics used, among other things, as filling materials for root canal system. The aim of this study is to analyze the sealing ability of Fill Root ST (Dental World SRL) in teeth subjected to apicoectomy.

Methods: in 2021, three patients were referred to the Complex Operating Unit of Oral Pathology and Surgery, University of Bari "Aldo Moro", for an occasional RX-OPT finding that showed a round radiolucency in the first quadrant. No pain was reported. Two of the patients presented a root residue that represented likely the cause of the round radiolucency. The other one referred a trauma in 2011. Vitality test was performed on teeth involed that showed the negative response of some of them. Endodontic therapy was performed in ten teeth and the root canal system were filled completely with Fill Root ST. No guttaperca cone was used. Then surgery and apicoectomy were performed without using any ultrasonic devices and retro-filling materials. Five roots apex were analyzed with microscope and coloured with methylene blue

Results: the analysis of the five roots apex under high magnification showed no gaps between the Bioceramic sealer and the dentin walls.

Conclusions: premixed Bioceramic sealer (Fill Root) used as the only filling material during endodontic treatment seems to have a good sealing ability. Furthermore it permits to perform apicoectomy in an easy way, with no need of ultrasonic tips and retro-filling materials.

TREATMENT OF AN ENDO-PERIO LESION: CASE REPORT

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Aim: treatment of endo-perio lesion is a highly challenging task to dentist because differentiating between periodontal and endodontic problems can be difficult.

In this work we present a clinical case of a patient in which endodontic treatment was planned before than periodontal one.

Methods: this is a case report of a 40-year-old male patient, current smoker, complaining of pain and pus discharge from the third quadrant.

He has positive familiar anamnesis for periodontal disease, pain localized on 3.7 tooth, M1 mobility; there is purulent exudate and spontaneous gingival bleeding on the same element. The presence of deep periodontal pocket measuring 10mm on the distal root was observed and there is furcation involvement. Radiograph shows an endo-perio lesion, with enlargement of the periodontal space and a large area of radiolucency of the periapical area of the distal root, extended to the furcation.

The cold test and the cavitary test confirmed the pulpal necrosis of the affected element. It was immediately treated with Ni-Ti rotary instruments and warm vertically compacted gutta percha obturation technique. Subsequently, 2 sessions of scaling and root planing and topical application of antibiotic in the periodontal pocket are carried out.

Results: after 1 year a periapical radiograph shows the healing of the lesion, with mineralization of the bone defect; the periodontal probing depth is improved and there is no longer involvement of the furcation.

Conclusions: the correct diagnosis and therapy of the endo-perio lesion led to successful resolution of a complex dental problem.

THE IMPORTANCE OF ADEQUATE KNOWLEDGE OF THE ENDODONTIC ANATOMY IN IATROGENIC COMPLICATIONS

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Aim: the purpose of this study is to describe the use of innovative technologies for the functional restoration of dental elements that undergone iatrogenic perforation.

Methods: the clinical case presented is related to a young woman who was referred to our attention because of endodontic access difficulties by the previous dentist. Endoral X-rays and CBCT (Cone Beam Computer Tomography) showed besides an important periapical lesion, a perforation of the coronal portion of the root in the disto-lingual direction. Then we proceeded to the rectification of the endodontic access, to the detection and the shaping of the canal. The obturation phase was carried out using the vertical condensation technique with gutta-percha up to the perforation, which was obturated with Root Repair Material. The clinical procedure was performed using the operative microscope, which allowed a precise management of the detection of the canal and the obturation of the perforation.

Results*:* a six-month follow-up, performed by endoral X-ray, showed a reduction of the periapical lesion. Moreover, the CBCT confirmed the success of the endodontic treatment and the bone remodeling.

Conclusions: the literature supports the management of iatrogenic perforations and the missed anatomy using innovative techniques, such as the use of RRM and cutting-edge technologies such as operative microscope and CBCT.

ENDODONTIC TREATMENT OF A CENTRAL INCISOR WITH A SEVERE POST-TRAUMATIC CALCIFICATION

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Aim: the purpose of this study is to focus on concepts, technologies and operating sequences that may help clinicians to face teeth with severe dystrophic calcifications.

Methods: a 40-year-old female patient had suffered trauma to her maxillary incisors two years before coming to our attention. Initially, she observed only discolouration of the 2.1 element and no pain. Later, the symptoms of painful apical periodontitis with an abscess appeared. The previous dentist tried to drain the abscess, but when he realized that the tooth was calcified, he chose to refer the patient to our practice. The CBCT (Cone Beam Computed Tomography) showed a deviation of the access cavity, confirmed the severity of the calcification, the presence of a periapical radiolucency and erosion of the vestibular cortical bone. After rectifying of the endodontic access, identifying the canal and probing it, it was shaped with reciprocating Ni-Ti instruments. Then it was obturated with vertically condensed thermoplasticized gutta-percha, using the continuous wave technique.

Results: at 8 months follow-up, periapical radiography showed the healing of the peri-apical radiolucency. In agreement with the patient, a CBCT was performed which confirmed bone healing. The 3D reconstruction of the vestibular cortical, after 8 months, appeared perfectly normal.

Conclusions: the use of CBCT, operating microscope, ultrasonic tips and the excellent operator experience allows the achievement of therapeutic success in the treatment of severe post-traumatic calcification.

PRINT AND TRY TECHNIQUE: 3D-PRINTING PREVIEW OF TEETH EXTERNAL RESORPTIONS

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Aim: the purpose of this report is to evaluate the applicability of a novel Print and Try technique in the presence of external resorptions (ECR) and to achieve a predictable treatment with improved outcome. The difficulties in interpreting three-dimensionally the ECR defect with conventional intra oral radiography have been overcome with the use of CBCT. The knowledge of the ECR morphology and its frequent variations is a basic requirement to correctly manage the ideal clinical approach and material choice.

Methods: three molars with presence of external resorptions have been selected for testing the predicability of the Print & Try technique. The defects were asymptomatic with a different extension and location. For all cases a CBCT has been requested. From CBCT it has been obtained a file that was transformed in an STL and printed after with a high definition 3d printer. First case was an upper asymptomatic second molar with external resorption located distally at the interproximal area. A root canal treatment and a contextual defect seal with a bioceramic putty material represented the treatment of choice. The second case reported treatment of a necrotic lower first molar with ECR at the coronal level of the mesio buccal root. The defect has been treated in a single visit with a surgical approach and flow composite seal of the defect and contextual root canal treatment. The last case was a lower first molar with ECR located in disto buccal area close to the pulp chamber. A pulp capping after ECR management with putty bioceramic material and composite restoration represented the treatment plan of choice.

Results: a clear 3D-plastic tooth model including its root canal system represents an ideal training ground for both the expert clinician facing a complex endodontic case with ECR lesion. A Print and Try approach has a clinical and educational value as it allows to decide the best treatment plan and to practice each operative stage.

Conclusions: in complex ECR lesions, patient-specific 3D-models seem to facilitate treatment planning and, subsequently, they seem to make the actual therapy extremely precise, increasing the comfort for clinicians and patients and positively influencing the outcome.

GUIDED ENDODONTIC MICROSURGERY: A DEFINITIVE APPROACH

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Aim: the diagnostic-therapeutic software has expanded becoming an increasingly efficient tool in implantology. We have been using this software to improve performance in surgical endodontics, trying every day to optimize its use. Guided Endodontic MicroSurgery (GEMS) aims to reach the lesion site of the apical root and excise it, making endodontic microsurgery an easy and safe process in accurate way.

Methods: the bone-supported surgical guides have been designed to directly access the apex of the infected tooth, refining their accuracy in reaching the target apex and assisting in the movement of tissues during the surgical procedure. Previously, GEMS accuracy was evaluated in a human cadaver study. Fifty-eight patients regardless of the dental district (excluding third molars) were treated with GEMS by two different operators. Correct identification of the apex and its subsequent removal was considered the success of the procedure. Endodontic success was also evaluated after 12 months.

Results: the success consisted in the actual reaching of the root affected by the pathology and in its direct removal with the drills used for the access procedure. In 54 patients this was achieved; in the remaining 4 cases the objective was partial even if it was possible to complete the intervention without damaging the anatomical structures adjacent to the lesion. The 12-month success of surgical endodontics was 96.5%

Conclusions: GEMS showed an optimal success rate, a relevant percentage of safety and precision and a remarkable adaptability regardless of the position of the treated dental elements.

ORTHODONTIC MANAGEMENT OF TRAUMATIZED TEETH WITH CORTICOTOMY AND ROOT SEPARATION

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Aim: corticotomy is a surgical procedure aiming to shorten orthodontic treatment time. Cortical bone that strongly resists orthodontic forces is removed, maintaining bone tissues vascularization and continuity. This leads to a necrosis risk reduction and tooth movement facilitation. We herein report a rare presentation of successful orthodontic treatment in a root-sectioned 1.2 during corticotomy procedures. Despite this, the tooth remained viable and stable in the new position. Two-year follow-up revealed no signs of tissue pain, and patient never complained any symptoms, so that endodontic therapy was not necessary.

Methods: since orthodontic forces was not enough to bring 1.2 into the archway, corticotomy was the only way to achieve the treatment goal. During the bone section, the root was dissected with root canal involvement, but the orthodontic treatment and tooth maintenance were not compromised.

Results: 1.2 gone back to the arch, without signs or symptoms of necrosis and weak vitality in the first 6 months. Two years follow-up revealed increased vitality, although reduced.

Conclusions: the orthodontic treatment didn't compromise the maintenance of the root-amputated tooth, but allowed its stabilization in the new bony structure, according to the primary orthodontic treatment goals. Therefore, this case demonstrates not only orthodontic, but also endodontic success. Tooth vitality was not compromised and no inflammatory reaction occurred although unconventional roots morphology.

SURGICAL ENDODONTIC RETREATMENT: A CASE REPORT

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Aim: the purpose of this case report is to describe a modified surgical endodontic retreatment protocol for immature teeth when the MTA apical plug technique doesn't give the expected results.

Methods: a 18-years old patient was referred to our attention in May 2020, due to an acute apical abscess in the left maxillary anterior region. Endoral X-ray and CBCT (Cone Beam Computed Tomography) showed the presence of a radiolucency around the central incisors. Consequently, an endodontic access and calcium hydroxide medication were performed. Then, the canal was shaped and obturated using the apical plug technique with MTA. At 6-month follow-up, the patient presented increased mobility of tooth 2.2 and clinical evidence of a fistula. It was decided to perform an apicectomy of the element. A subperiosteal flap with preservation of the papilla was elevated between areas 1.1 and 2.3. The vestibular cortical bone was intact, but really thin, so it was removed with a microsurgical curette. The lesion was excised and the apical 3 mm of the root was abraded with a StartX #2 ultrasonic tip. Later, resorbable membrane was applied and the flap was sutured.

Results: the 9-month follow-up it showed almost complete healing, which is an excellent result considering the initial condition of the patient. Another CBCT is scheduled in 1 year.

Conclusions: surgical endodontic retreatment could be the best choice which guarantee right tissue healing and bone regeneration.

HEATING OF SODIUM HYPOCHLORITE AND MAINTENANCE OF INTRACANAL TEMPERATURE: AN *EX VIVO* STUDY

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Aim: the objective of the present study was to compare the effectiveness of several methods of sodium hypochlorite (NaOCl) heating in terms of temperature values obtained at different levels of the root canal.

Methods: five thermocouples were positioned at different levels of the root canal system (apical foramen, 5 mm from the apex, 10 mm from the apex, at external surface 3 mm from the apex, within the root canal at the cervical third level) of 12 extracted human premolars. NaOCl solution was heated extraorally (until 50 °C, 60 °C, and 70 °C, respectively) or intracanally using F-06, XF-30/04, and ML-12 pluggers at 100 °C, 150 °C, and 180 °C, respectively.

Results: extraoral heating and ML-12 plugger were similarly unable to provide a significant temperature increase at the root apex, even though the latter provided slightly better outcomes when set at 180 °C. Conversely, F-06 and XF-30/04 pluggers showed any differences in terms of temperature maintenance across the root. XF-30/04 provided the highest time intervals when set at 180 °C.

Conclusions: within the limitation of the present *in vitro* study, it was demonstrated the effectiveness of intracanal heating by System B plugger providing a better temperature persistence in the middle third of the root canal system. Only ML-12 plugger showed comparable outcomes to extraoral heating demonstrating to be ineffective to produce a significant temperature increase within the root canal system.

CORRELATION BETWEEN ROOT CANAL TAPER AND RESIDUAL RESISTANCE OF RESTORED MAXILLARY PREMOLARS

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Aim: to investigate the effect of canal taper on the residual cervical dentin volume and the fracture resistance of maxillary premolars restored with and without fiber post and with full-crown preparation.

Methods: thirty maxillary premolars were selected, micro-Computed Tomographic (micro-CT) scanned and divided into three groups. In the group TN shaping was achieved with TruNatomy up to Prime Shaping File (#26, .04), in the group B4U with .05 taper instruments up to #23 while in the group PTN ProGlider and ProTaper Next were used up to X2 (#25, .06). Afterwards specimens were obturated with a single cone and bioceramic sealer and micro-CT scanned. Then a MOD cavity was prepared. In the subgroup FP a fiber post (FP) was luted in the palatine root followed by a composite restoration while in the subgroup NFP no FP was used. Afterwards all specimens were prepared for a full-crow restoration and micro-CT scanned. The volume of removed dentin in the cervical third was analyzed in the preoperative, post-shaping and post-restoration micro-CT scans. Specimens were submitted to static fracture resistance test.

Results: the mean dentin removed volume after full-crown preparation resulted higher than the amount spared with different shaping systems in both groups. For FP and NFP subgroups, the mean dentin removal in the cervical third resulted similar. No significant differences among fracture resistance resulted in both TN and PTN groups.

Conclusions: regardless of the presence of a fiber post the spare of cervical dentin during instrumentation resulted not related to the final cervical dentin volume after full-crown preparation and to tooth fracture resistance.

MECHANICAL BEHAVIOR OF PREMOLARS RESTORED WITH ENDODONTIC COMPOSITE POSTS

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Aim: nowadays the enhanced post-dentin interface and the material placement homogeneity is provided by endodontic hollow posts thanks to the material delivery through the post hole. The aim of the present study was to analyze the mechanical features of continuous glass or carbon fiber endodontic posts to enhance retention and resistance of the tooth-restoration system.

Methods: mechanical properties were determined through bending tests of three types of endodontic posts, a glass fiber compact post, a glass fiber hollow post and a carbon fiber hollow post. Teeth were aged thanks to cyclic fatigue in a water environment at a constant temperature. The compression stiffness of teeth was assessed through static compression test and finally fracture patterns were microscopically analyzed.

Results: mechanical stability of tooth-restoration system with composite posts was increased more than 100% compared to premolars restored only with particulate composite. Among the investigated systems, the highest strength and the potential of tooth re-treatment after fracture had been taken in account. In particular, carbon fiber hollow post presented the highest compression strength with an impracticable tooth re-treatment, while glass fiber hollow post was more compliant with a favorable type of fracture that allowed tooth re-treatment.

Conclusions: the best trade-off between strength and the potential of tooth re-treatment after fracture was achieved by the glass fiber hollow post.

INFLUENCE OF WIRE DIAMETER ON FATIGUE RESISTANCE OF ENDODONTIC FILES AT BODY TEMPERATURE

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Aim: the aim of this study was to compare the fatigue resistance of TS2 prototypes (Micro-Mega, Besançon, Francia) obtained from 1.0 and 1.2 diameter NiTi wire differently thermally treated at room (25° ± 1°C) and body temperature (37° ± 1°C).

Methods: eighty NiTi TS2 1.0 and TS2 1.2 files differently heat treated (Controlled-Memory wire and T-wire) were used at 25 ± 1°C and 37 ± 1°C temperatures for fatigue testing using a customized test device with an artificial channel of 60° angle curvature and 5mm radius. For each file, the number of cycles to fracture was calculated and the length of the fractured fragment was measured. Data were analyzed using 2-way analysis of variance followed by Tukey post hoc test at 5% significance level.

Results: the CM-wire files had the statistically highest fatigue resistance, both at room and body temperature independently from the wire dimensions. Body temperature negatively affected fatigue of all tested prototypes. 1mm wire diameter files made by T-Wire showed higher fatigue resistance than 2mm wire files, while for CM-wire there were no significant differences between the two wire dimensions at both temperatures.

Conclusions: TS2 prototypes made of CM alloy showed higher fatigue strength than TS2 T-Wire files, regardless of wire size.

INFLUENCE OF HEAT TREATMENTS AND TEMPERATURES ON RESISTANCE OF NITI FILES WITH SAME DESIGN

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Aim: this study aimed to evaluate the influence of different temperatures and different heat treatments on cyclic fatigue resistance of 2Shape instruments (Micro-Mega, Besancon, France).

Methods: 80 2Shape TS1 (#25.04) and 80 TS2 (#25.06) instruments with different heat treatment (no treated, C-Wire, T-Wire, CM-Wire) were tested at room (25° ± 1°C) and body (37° ± 1°C) temperatures in 16 mm stainless steel artificial canal with a curvature of 60° and 5 mm of radius. Files were tested in continuous rotation of 300 rpm and 4.1 Ncm in a customized device. Cyclic fatigue resistance was expressed in number of cyclic to fracture (NCF). Surface of each fractured fragment was examined with a scanning electron microscope (SEM). Data were analyzed statistically using 2-way analysis of variance and the Bonferroni multiple comparison post hoc test at 0.05 as level of significance.

Results: all TS1 and TS2 files with CM-Wire showed higher NCF than all the other groups both at room and body temperature ($P < 0.0001$). TS2 C-Wire showed higher resistance than TS2 NHT and TS2 T-Wire files ($P < 0.0001$), with no significant differences between the last two files ($P > 0.05$).
Body temperature significantly decreased cyclic fatigue of all tested files ($P < 0.05$) except for TS1 no treated and T-Wire.

Conclusions: within the limitations of this *in vitro* study, body temperature negatively affected cyclic fatigue resistance of C-Wire and CM-Wire TS1 and of all TS2 files. In addition, all the instruments produced with CM-Wire heat-treatment exhibited the highest cyclic fatigue resistance among all the tested files.

IN VITRO CYTOTOXICITY OF DIFFERENT BIOCERAMIC ROOT CANAL SEALERS

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Aim: this investigation assessed *in vitro* the cytotoxic properties of different bioceramic sealers on human gingival fibroblasts over different time periods (24, 48 and 72 h).

Methods: the bioceramic sealants used in this study were Fill Root ST, BioRoot™ RCS, Well-Root™ PT, CeraSeal; Pulp Canal Sealer™ EWT was used as control. Immortalized human gingival fibroblast-1 were incubated at 37°C for 24 h with 100 µL of extraction medium made eluting each root canal sealer sample in cell culture medium for 24, 48 or 72 h at 37°C. Cells incubated with fresh medium was used as control. The amount of viable cells in each well was calculated relative to control cells set to 100%.

Results: all the tested bioceramic sealers showed a mild cytotoxicity after 24 h, except for CeraSeal, with a moderate cytotoxicity after each time of incubation ($P > 0.05$). The cell viability significantly reduced after incubation of 48 h and 72 h with Fill Root ST but did not significantly reduce with BioRoot™ RCS and Well-Root™ PT ($P < 0.05$).

Conclusions: fill Root ST, BioRoot™ RCS and Well-Root™ PT bioceramic sealers appeared less cytotoxic after setting, compared with CeraSeal and Pulp Canal Sealer™ EWT.

RECIPROC BLUE AS INSTRUMENT FOR RETREATMENT OF GUTTAFUSION CARRIER-BASED SYSTEM

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Aim: to evaluate the effectiveness of reciprocating NiTi during a secondary root canal treatment (SRCT) of oval shaped canals filled with bioceramic sealer.

Methods: 16 single-rooted oval-shaped roots were shaped to size 25.06 using Rotate (VDW, Munich, Germany) NiTi and randomly divided into 2 groups: single cone group (SC; N = 8) was filled with Neosealer (NuSmile, TX, USA) and single cone, Guttafusion group (GF; N = 8) was filled with Neosealer and Guttafusion (VDW, Munich, Germany). Each tooth was retreated using Reciproc Blue (RB; VDW, Munich, Germany) #25, #40 and #50 with adequate irrigation. X-rays and CBCT were taken before first canal treatment, after instrumentation, after filling procedures, after SRCT with RB#40 and after RB#50. Periapical X-rays were used to quantify the area of the root and remnants in the coronal, middle and apical third of the canal. CBCT images were used to calculate the volume of the canal and the volume of residual filling material.

Results: X-rays allowed the quantification of remnants Area. GF group revealed great number of remnants at middle third. The remnants Volume was calculated by CBCT. SC group showed great number of remnants with a Volume higher then GF group. Middle third resulted the most affected root Area with the greatest remnants Area and Volume.

Conclusions: filling remnants were mainly located in the middle third of root. X-rays was reliable in detecting remnants. CBCT shows similar images but with some distortion that may affect the clinical interpretation.

ENDODONTIC POSTS AND FRACTURE RESISTANCE: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Aim: the present study aimed to answer the following PICO question: Is the fracture resistance of endodontically-treated maxillary premolar increased by different posts and composite reconstruction?

Methods: the PRISMA protocol was adopted to evaluate *in vitro* studies including endodontically-treated maxillary premolars, restored with different type of posts (fiber and metal) supporting direct composite reconstructions (layering technique, flowable composite or their combination). Meta-analyses were carried out only on homogeneous studies using fixed-effect model and Trial Sequential Analysis (TSA) was performed. The risk of bias was assessed and a further overall quality of evidence was evaluated using Grading of Recommendations Assessment Development and Evaluation (GRADE).

Results: 24 articles were included in the systematic review and 13 studies were also included in the meta-analysis. Fracture resistance of endodontically-treated premolars restored with fiber posts reported an enhanced fracture resistance when compared to equivalent teeth without post ($p = 0.003$), although the same outcome was significantly less than sound teeth ($p < 0.00001$). High power of the performed analyses was obtained by TSA. GRADE system showed moderate strength of evidence, since 23 studies revealed moderate risk of bias and 1 study showed high risk.

Conclusions: endodontically- treated maxillary premolars restored with a fiber post and direct composite restoration demonstrated an enhanced fracture resistance, tending to statistical significance, then equivalent teeth restored without post.

SINGLE *VS* MULTIPLE-VISIT ENDODONTIC TREATMENT IN NECROTIC TEETH: SYSTEMATIC REVIEW AND META-ANALYSIS

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Aim: a systematic review of the literature was conducted to determine if root canal treatment of necrotic teeth performed in a single visit or in two or more visits, with or without medication, makes any difference in terms of effectiveness or complications. This review updates the previous version published in 2016 on Cochrane Database of Systematic Reviews.

Methods: a thorough search for randomized and quasi-randomized controlled trials (RCTs) was performed. The outcomes of interest were tooth extraction for endodontic problems; radiological failure after at least one year; post-operative and post-obturation pain; swelling or flare-up; painkiller use and presence of sinus track after at least 1 month.

Results: we included 22 RCTs, with a total of 1836 participants and 1800 teeth analyzed. We judged 5, 11 and 6 studies to be at low risk, high and unclear risk of bias, respectively. No studies reported data on tooth extraction due to endodontic problems. We found no evidence of a difference in terms of radiological failure (RR 0.83, 95% CI 0.60 to 1.15; 924 participants; 10 studies; I^{22} = 15%; moderate evidence). The incidence of post-treatment pain within a week and the incidence and intensity of pain until 72 h post-obturation were not significantly different in the 2 groups. Swelling or flare-up, painkiller use and the presence of sinus track were not significantly different with the two approaches.

Conclusions: there was no evidence to suggest that one treatment regimen was better than the other, neither can prevent all short- and long-term complications.