GEORGIAN MEDICAL NEWS

ISSN 1512-0112

NO 12 (345) Декабрь 2023

ТБИЛИСИ - NEW YORK

ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

Monthly Georgia-US joint scientific journal published both in electronic and paper formats of the Agency of Medical Information of the Georgian Association of Business Press. Published since 1994. Distributed in NIS, EU and USA.

GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

GEORGIAN MEDICAL NEWS
No 12 (345) 2023

Содержание:

GEORGIAN MEDICAL NEWS
No 12 (345) 2023

EVALUATION OF INTERFACIAL ADAPTATION BETWEEN VARIOUS TYPES OF FIBER POSTS AND RESIN CEMENTS USING MICRO CT: AN IN VITRO COMPARATIVE STUDY

Nada J Alwan*, Raghad A Al-Askary.

Department of Conservative Dentistry, College of Dentistry, University of Mosul, Mosul, Iraq.

Abstract.

Aim: The aim of this study was to evaluate the interfacial adaptation between different types of prefabricated fiber posts and different types of resin cement using Micro Computed Tomography (Micro CT).

Methods: Twenty-seven (n=27) removed premolars with same single root lengths were divided into (three) groups each of (n=9) according to type of fiber posts. Teeth were decorated, and placed in poly vinyl silicone frame, showing 2 mm of the crown. Teeth were exposed to endodontic restoration, and preparation of post space. Then, in accordance with the type of resin cement, the three groups were further separated into three subgroups (n=3). After post cementation, the specimens were subjected to Micro-CT and 3D reconstruction to evaluate and estimate the gaps at the line between the post and cement. Statistical analyses were be done using IBM SPSS Statistics version 20, and Two-Way ANOVA and Duncan's Multiple Range test were used to compare the results at 5% significant level.

Results: The study outlined a statistically significant difference at ($P \leq 0.05$) among groups regarding to gap formation in μm at the interface between fiber post and resin cement and group (F1C3: glass fiber post + TOTAL C-RAM) represent the highest gap volume formation (575.00 ± 32.71), while group (F3C1: everStick post + RelyX U200) represent the lowest gap volume formation (85.50 ± 21.09).

Conclusion: The interfacial adaptation between fiber post and resin cement can be affected by various kinds of resin cements and fiber posts used.

Key words. Prefabricated post, resin cement, interfacial adaptation, micro-CT.

Introduction.

Numerous advancements in materials and methods have substantially improved the restoration of teeth that have undergone endodontic treatment. The dental post is frequently utilized during root canal therapy, to restore a tooth with significant coronal tooth structure loss, especially when (50%) or more of the coronal tooth configuration has been removed [1,2]. Due to their ease, aesthetic, and mechanical qualities that are equal to those of dentin, prefabricated fiber posts are popular for repairing teeth that have undergone endodontic treatment [3,4]. This is considered to be a clinical advantage [5,6]. Cement deformity may be associated with types, polymerization shrinkage and characteristics of the cement. Thick film of cement can cause a higher frequency of gap formation; in addition, it may result in high polymerization stress which in turn leads to an increase in the affinity for debonding [7]. This is the primary problem that causes fiber posts to fail. On the other hand, a consistent, thin layer could reduce gap creation [8]. The root canal with post retention may be compromised by the creation of voids and gaps due to the cement distortion [7]. However, the gap develops between the cement and the internal canal wall, whereas the void was created when air became trapped within the cement itself. Micro-computed tomography (micro-CT) consider as less destructive method that can be used for in vitro evaluation the gaps and voids formation at interfaces of fiber posts cemented inside the root canals, by using a three-dimensional (3D) view [9]. Therefore, the study's primary goal was to use Micro CT to assess the gap creation at the interface between several types of fiber posts and resin cements.

Materials and Methods.

Ethical Approval: Before starting the investigation, an ethical approval was received from the Research Ethics Committee at the Faculty of Dentistry, Mosul University, Iraq, at clearance number (REC reference no. UoM.Dent/H.DM.2/23 on December 1, 2019). This is because the research study used extracted human teeth.

Specimen Preparation: Twenty-seven human lower premolars extracted for orthodontic reasons in patients between 18 and 24 years old were used in this study. The teeth with fully formed apices, type I root canal system with nearly straight, single, and round root canal as confirmed with pre-operative radiographs, free from root defects and cracks as examined under stereomicroscope at 10X magnification. The teeth are stored in distilled water inside screw capped glass container during collection period at room temperature until the next step [10]. The collected teeth are cleaned with scaler to remove any calculus and immersed into 2% NaOCl ultrasonic bath for 5 min to dissolve the remaining soft tissues, then they were washed with distilled water and autoclaved at 121ºC, 15 lbs psi for 30 min. for effective teeth sterilization [11,12]. Then stored in distilled water until the next step.

Root Canal Preparation and Sample Grouping: The teeth are decoronated at 2mm above the cement - enamel junction using long straight flat end diamond bur in a high-speed hand piece with cooling system, leaving approximately 13 mm of root. The canals of roots were opened, and the pulp tissues were extirbated using a barbed broach. The working length was established by subtracting 1 mm from the length at which No. 15 K-file was visible at the apical foramen. The correct measurement of the working length was established with digital radiography [13]. Then the canals were instrumented, with ProTaper gold NiTi rotary files from S1 to size F3 following the manufacturer instructions. 1ml of 2% NaOCl, 2 ml of distilled water, 1ml of 15% EDTA gel and then 2 ml of distilled water were used as irrigations and lubricants that applied for one min for each alternately during root canal preparation and as a final rinse [10]. The root canals were obturated using F3 ProTaper gutta-percha with single cone obturation technique that fitted to the full predetermined working length and use AH plus sealer. Glass

ionomer cement (Vitremer, 3M ESPE, St. Paul, MN, USA) was used to temporarily seal the coronal section of the roots, which were then kept at 37°C and 100% humidity for a week14. Then the roots were divided into three groups as follows:

(Group) F1: Roots are filled with translucent smooth glass fiber post (Rely XTM).

(Group) F2: Roots are filled with translucent serrated quartiz fiber post.

(Group) F3: Roots are filled with everStick fiber post.

After that, each group will be separated into three smaller groups based on the type of luting cement that was utilized for luting each fiber post: n=3

(Group) C1: Samples in which fiber posts are cemented with (RelyX U200_ dual cure) resin cement.

(Group) C2: Samples in which fiber posts are cemented with U-Cem premium self-adhesive Universal Resin cement.

(Group) C3: Samples in which fiber posts are cemented with TOTAL C-RAM dual cure resin cement.

The materials used in this study were represented in (Table 1).

Post Space Preparation: After being stored, the coronal sealing material was removed using a high-speed handpiece and a #245 carbide bur from Brasseler, Savannah, Georgia, USA. F4 rotary instrument was utilized to remove the obturating material14. For all root samples, a standard size (Peeso Reamer #3; Dentsply Maillefer, Ballaigues, Switzerland) was used to generate a uniform post space (9 mm) [15].

A drill was changed after every five post space preparations. After that, the root canals were cleaned with 2 ml of 2% NaOCl for 1 min followed by 2.8 ml of 5% sodium thiosulfate solution for 1 min to neutralize the effect of NaOCl solution, then washing the canal with 5 ml of distilled water followed by 2 ml of 15% EDTA gel was introduced into the canal for 1 min to remove the smear layer. Finally, 5 ml of distilled water was used for cleaning, endodontic cannulae were used for aspiration, and absorbent paper points were used for drying [16-19].

Table 1. *Materials and their compositions that used in this study.*

Materials	Composition
RelyX U200 Automix, 3M ESPE, St. Paul, MN, USA	Base: Methacrylate monomers, methacrylate monomers containing phosphoric acid groups, stabilizers, initiators, rheological additives. Catalyst: Alkaline filler, Methacrylate monomers, initiator components, silanated filler, rheological additives, stabilizers, pigments. zirconia silica fillers.
U-Cem premium Vericom Co.,Ltd. Korea	Base: fluorinated barium, fumed silica, Bis-GMA, dimethacrylate, stabilizer, pigments. Catalyst: barium silicate, fumed silica, MDP, dimethacrylate catalyst, stabilizer.
TOTAL C-RAM ITENA, FRANCE	Resin matrix: TEGDMA, Bis-GMA, UDMA. Monomers adhesive acides: 4-META, esters di acid phosphoric methacrylates. Silane coupling agent, nanosilica.
Rely X™ fiber post 3M, ESPE, Germany	Translucent smooth glass fiber post Matrix: Epoxy-resin; Fibers: S-glass fibers (60–70% by weight); Fillers: Zirconia filler.
Quartiz fiber post (3A, China)	Translucent serrated quartiz Matrix: Epoxy-resin and bis-GMA; Fibers: quartz fibers 65% by weight which is pure silica in a crystallized form; Fillers: no filler.
everStick fiber post (GC, Europe N.V)	Fibers: Unidirectional silane coated, E-glass fibers (61.5% by weight); Fillers: no filler Matrix: Semi-interpenetrating polymer network of PMMA, and Bis-GMA.

Post Placement and Luting Application: To prevent premature polymerization, the soft, unpolymerized EverStick sheet will be cut to a predetermined length, inserted, and shaped by condensing to the prepared post space. The shaped post will then be initially light polymerized inside the root canal for 20 seconds. The contoured EverStick post was then taken out of the root canal and light polymerized for an additional 40 seconds. from all sides according to the manufacturer instruction.

Prior to insert, each prefabricated fiber posts (glass and quartiz) were cut to a predetermined length (11 mm: 9 mm inside the canal and 2 mm above the canal orifice), then each fiber posts (glass, quartz, and everStick) were washed with (70%) ethanol for (30)s, water cleaned and dried thoroughly. The resin cement was applied to the prepared post space in each group according to manufacturers' instructions. Each post was then put into the resin cement-filled post space, and after 30 seconds, the extra cement was taken out. According to the manufacturer's recommendations, the post was kept in place with finger pressure for around 7 minutes to allow the cement to initially set. Then, using a light-emitting-diode light-curing equipment (Valo, Ultradent Products Inc., South Jordan, Utah, USA) with an output intensity of 1000 mW/cm2 at 395-480 nm, the fiber posts are exposed to light for 40 seconds at the cervical end. The post can also be light cured for at least 40 seconds from each side after that [20]. Then the fiber posts are covered with glass ionomer cement (Vitremer, 3M ESPE, St. Paul, MN, USA). The specimens were kept at relative humidity and 37ºC, for one week [20,21]. After that, A high-resolution micro-CT scanner (SkyScan 1072, MicroCT Skyscan, Kontich, Belgium) scans the filled roots with a pixel size of 9.05 mm and an exposure length of 3.1s. NRecon program (SkyScan), which created 2-dimensional (2D) slices of the interior structure of the filled roots, is used to reconstruct the generated images. Volumetric analysis is accomplished using the CTAn and CTVol software (DataViewer, Skyscan, Kontich, Belgium) to model the roots in three dimensions (3D). Each sample is measured for the volume of bubbles/gaps at the interface and the percentage volume of bubbles [14].

Statistical Analysis: Statistical analysis was calculated using SPSS software (SPSS version 20, IBM, USA). The results will be analyzed by two-way analysis of variance (ANOVA) and Duncan's multiple range test at $p \leq 0.05$.

Results.

Micro CT evaluation of gaps formation in (µm) at the interface between fiber posts and resin cements for all groups is represented in (Figure 1).

The mean of gaps in (µm) and standard deviation at the fiber post - resin cement interface for each tested group were measured and recorded in (Table 2).

Two-way ANOVA for fiber post types, resin cement types, and their interactions, is shown in Table (3). Although the results showed that all the tested groups represented gaps at the

Table 2. *The gaps volume at fiber post-resin cement interface for all tested.*

Groups	N	Mean ± Std	Minimum	maximum
F1C1	3	349.83 ± 33.35	322.50	387.00
F2C1	3	200.00 ± 10.53	190.00	211.00
F3C1	3	68.66 ± 21.09	45.00	85.50
F1C2	3	459.67 ± 21.50	438.00	481.00
F2C2	3	178.17 ± 9.16	171.00	188.50
F3C2	3	98.16 ± 8.25	89.00	105.00
F1C3	3	540.33 ± 32.71	510.00	575.00
F2C3	3	325.83 ± 14.28	311.00	339.50
F3C3	3	209.33 ± 8.80	200.00	217.50

F1= Glass fiber post.
F2= Quartz fiber post,
F3= everStick fiber post.
C1= RelyX U200 dual cure resin cement.
C2= U-Cem premium dual resin cement.
C3= TOTAL C-RAM dual cure resin cement.

Table 3. *The levels of fiber posts, resin- cements, and their interactions.*

Source of Variance	(DF)	Sum of Square	Mean Square	(F)	(Sig.)
Fiber posts (F)	2	490867.389	245433.694	607.648	0.000
Resin cements (C)	2	112638.500	56319.250	139.436	0.000
Fiber posts × Resin cements (F × C)	4	13353.778	3338.444	8.265	0.001
Error	18	7270.333	403.907		
Total	27	2592430.000			
Corrected Total	26	624130.000			

Table 4. *The effect of fiber post types upon fiber post-resin cement interfacial adaptation.*

Fiber post types	**N**	**Mean ± Std**	**Duncan Grouping**
F1 (smooth glass)	9	449.94 ± 86.71	c
F2 (serrated quartz)	9	234.66 ± 69.74	b
F3 (everStick)	9	125.38 ± 65.38	a

Table 5. *The effect of resin cement types on fiber post-resin cement interfacial adaptation.*

Resin cement types	N	Mean ± Std	Duncan Grouping
C1 (RelyX U200)	9	206.16 ± 123.53	a
C2 (U-Cem premium)	9	245.33 ± 164.90	bc
C3 (TOTAL C-RAM)	9	358.50 ± 146.56	c

interface between fiber posts and resin cements. However, two-way ANOVA, represented statistically significant difference among groups (P≤0.05).

Duncan's multiple range test for the fiber post types regardless to cements types, and their interaction Table (4), showed that the glass fiber posts group represented statistically the highest gap volume formation (449.94 ± 86.71) in comparison to other types of fiber posts, while the everStick represented statistically the lowest gap volume formation (125.38 ± 65.38).

Duncan's multiple range test for the types of cements regardless to fiber post types and their interaction Table (5), showed that the RelyX U200 resin cement groups represented statistically the lowest gap volume formation (206.16 ± 123.53) in comparison to other types of cement, while the TOTAL C-RAM cement represented statistically the highest gap volume formation (358.50 ± 146.56). Although the latter do not demonstrate statistically significant difference (p>0.05) with U-Cem premium resin cement (245.33 ± 164.90) in gap volume at fiber post-cement interface.

Table 6. *The Interaction between fiber post and resin cement on the fiber post-resin cement interfacial.*

Groups	N	Mean ± Std	Duncan Grouping
F3C1	3	68.66 ± 21.09	a
F3C2	3	98.16 ± 8.25	a
F2C2	3	178.17 ± 9.16	b
F2C1	3	200.00 ± 10.53	b
F3C3	3	209.33 ± 8.80	b
F2C3	3	325.83 ± 14.28	c
F1C1	3	349.83 ± 33.35	c
F1C2	3	459.67 ± 21.50	d
F1C3	3	540.33 ± 32.71	e

F1= Glass fiber post,
F2 = Quartz fiber post,
F3= everStick fiber post,
C1= RelyX U200 dual cure resin cement.
C2= U-Cem premium dual resin cement.
C3= TOTAL C-RAM dual cure resin cement.

Duncan's multiple range test for the interaction of fiber posts with resin cement Table (6), showed that the group of F1C3 (glass fiber post + TOTAL C-RAM cement), represented statistically the highest gap volume formation (540.33 ± 32.71) in comparison to other group, while the group F3C1 (everStick post + RelyX U200 cement) and group F3C2 (everStick post + U-Cem premium) represented statistically the lowest mean gap volume formation (68.66 ± 21.09), (98.16 ± 8.25) respectively. However, group (everStick post + RelyX U200 cement) illustrated the lowest mean gap volume formation. Duncan's multiple range test for all tested groups were represented in a bar chart in Figure 2.

Discussion.

Many methods can be used for examination the reliability of the interface between root filling components. Conventionally, serial sectioning and then observation and imaging use stereomicroscopy, scanning electron or confocal laser microscope to see the interfaces between tooth tissues and filling usually used [22]. All of these techniques are damaging because their demand for physically cutting the samples could unintentionally result in cracks [23]. In addition, the smear layer or sample preparation may lead to an underestimation of the size of interfacial gaps. From other side, the using of dyes to evaluate microleakage at interfacial gaps is controversial [24], since silver nitrate or organic colorants as tracer dyes denote that ‘through-and-through’ gaps must exist for dye permeation through the interfaces [25,26]. From other side, tracer penetration generally is never consistent and often contains 'false-positive' results because the dye either go into natural openings (such as dentinal tubules, or lateral canals), or reacts with the filling material, cause overestimating the existence of

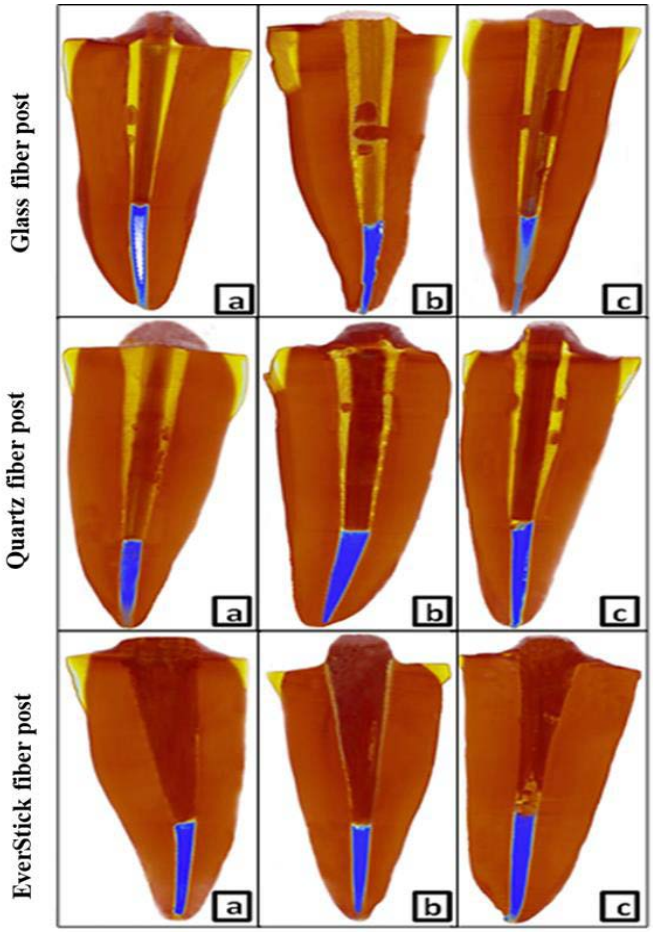

Figure 1. *The Micro CT representative images for evaluation of gaps formation at interface between fiber posts and resin cements for all groups. (a): RelyX U200;(b): U-Cem premium; (c): TOTAL C-RAM.*

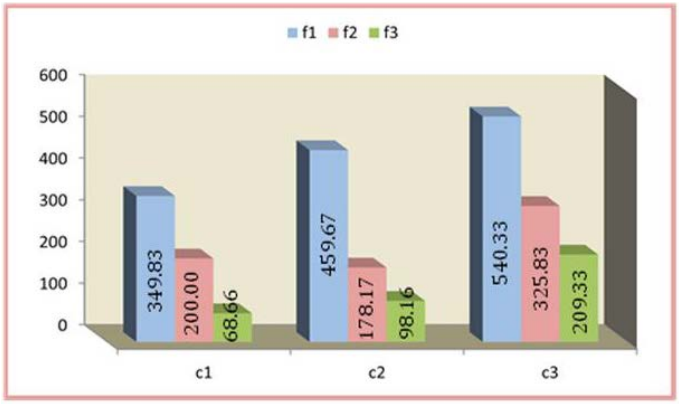

Figure 2. *The bar chart illustrated the mean gap volume formation and Duncan's multiple range test for all tested groups.*

gaps [27,28]. Such investigations are generally qualitative and typically concentrate on a single slice with little to no depth (3D) data [24,29]. To examine restoration interfaces, non-destructive, the spatial integrity of 3D approaches must be preserved and revealed. Studies on the interfacial gap and adaptation have used tomography-based volume imaging techniques [29-31].

The presences of gaps consider as potential weak zones which may initiate the degradation of interface and hence decrease the durability of the fiber post [20,32]. The results of the current research presented that the group of (everStick post + RelyX U200 cement) represented the lowest gap volume formation, while the group of (glass fiber post + TOTAL C-RAM cement) represented the highest gap volume formation in comparison to another group.

In addition, the results illustrated that the lowest mean value of gap volume is occur in groups of everstick posts regardless to the cement types and their interactions, while the highest mean value of gaps is present in the glass fiber post.

The everStick post is highly adapted to the contour of root canal; this will result in a thin cement layer around the post and hence less gap formation. According to certain clinical investigations, a thicker resin cement layer may produce greater post debonding because of volumetric shrinkage, and polymerization stress that are brought on by the thickness of the resin cement, which results in interface gaps, and post displacement. By other word, thin cement layer lead to less polymerization shrinkage so less gap formed between fiber post and resin cement [7,21,33]. While the glass fiber post is a prefabricated and smooth and this may be lead to less fully adaptation to canal wall thus thicker cement layer would be present around the post. This agrees with Juloski et al., confirmed that polymerization shrinkage causes deformation, and if the cement used has a thicker layer, it could result in polymerization stress [7].

Another reason is the prefabricated glass post consists of semi IPN polymer matrix. While the everStick post consist of both linear and cross-linked polymer phases. The linear phase in everStick post which is the Polymethylmethacrylate (PMMA) can be dissolved and react with HEMA, Bis-GMA, and TEGDMA based monomers and this in turn additionally, can result in more adaptation and less gap formation. However, tests have revealed that monomers like HEMA, Bis-GMA, and TEGDMA were unable to pierce the surface of cross-linked epoxy-based fiber posts that were already manufactured [20,34].

In the present study, the mean value for gap volume of quartz fiber post groups is lower than that for glass fiber post groups and this may be due to that the quartz fiber post have different surface tomography which is serrated rather than smooth, and this serration would result in thin cement layer with less gap formation at the interface between fiber post and cement [8,25].

According to the type of resin cements used in this study regardless the fiber post types and their interactions; the RelyX U200 cement had the lowest mean value of gap volume while the TOTAL C-RAM showed the highest. The RelyX U200 was delivered into the root canal with the help of elongated endodontic tip in comparison to an application tips of other used resin cements, this may lead to a decreased risk of bubble formation and air entrapment, which would increase the resin cement's sporadic adaptability to dental substrate and fiber post. This finding would agree with other studies who addressed higher sealing ability of RelyX U200 cement dispensed with elongation tip in comparison with other application techniques of cement [35].

In addition, the RelyX U200 cement is acidic and hydrophilic upon application and have low viscosity, high flowability with less polymerization shrinkage (contain salianated fillers) so less chance of gaps formation would occur. While the TOTAL C-RAM the short working and setting durations, relatively high

viscosity, and significant polymerization shrinkage may be detrimental to adaptation along the root-canal dentin and even be the cause of the gaps seen at the interface between fiber posts and cements despite its user-friendly handling [36].

Conclusion.

Within the limitations of this study, it can be concluded that the interfacial adaptation can be affected by various types of fiber posts and resin cements used. The everStick post and the RelyX U200 cement represented statistically the lowest gap volume formation, while the glass fiber post and the TOTAL C-RAM cement represented statistically the highest gap volume formation.

Conflicts of Interests.

There was not detected any potential conflict of interest pertaining to this article.

Acknowledgments.

This work was reinforced by the College of Dentistry, University of Mosul .

REFERENCES

1. Al-Shaibani M, Al-Saffar M, Mahmood A. The impact of Aloe vera gel on remineralization of the tooth and its effect against enterococcus faecalis: an in vitro study. Georgian Medical News. 2023;338:63-8.
2. Torbjörner A, Fransson B. Biomechanical aspects of prosthetic treatment of structurally compromised teeth. International Journal of Prosthodontics. 2004;17.
3. Soares CJ, Rodrigues MD, Faria-e-Silva AL, et al. How biomechanics can affect the endodontic treated teeth and their restorative procedures?. Brazilian oral research. 2018;32.
4. Abduljawa M, Samran A, Kadour J, et al. Effect of fiber posts on the fracture resistance of endodontically treated anterior teeth with cervical cavities: An in vitro study. J Prosthet Dent. 2016;116:80-4.
5. Schmitter M, Hu C, Ohlmann B, et al. Fracture resistance of upper and lower incisors restored with glass fiber reinforced posts. J Endod. 2006;32:328-30.
6. Faria-e-Silva AL, Pedrosa-Filho Cde F, Menezes Mde S, et al. Effect of relining on fiber post retention to root canal. J Appl Oral Sci. 2009;17:600-4.
7. Juloski J, Fadda GM, Monticelli F, et al. Four-year survival of endodontically treated premolars restored with fiber posts. Journal of dental research. 2014;93:52S-8S.
8. Bru E, Forner L, Llena C, et al. Fibre post behaviour prediction factors. A review of the literature. Journal of clinical and experimental dentistry. 2013;5:e150.
9. Berman LH, Hargreaves KM. Cohen's pathways of the pulp expert consult-e-book. Elsevier Health Sciences. 2015.
10. Ricardo S, Marissa C, Usman M, et al. Comparison of three bioceramic sealers in terms of dentinal sealing ability in the root canal. Int J Appl Pharma. 2020;12:4-7.
11. Kumar M, Sequeira PS, Bhat GK. Sterilization of extracted human teeth for educational use. Indian J Med Microbio. 2005;23:256-258.
12. Garg N, Garg A, Kang RS, et al. A comparison of apical seal produced by zinc oxide eugenol, Metapex, Ketac Endo and AH Plus root canal sealers. Endodont. 2014;26:252-258.
13. Pedreira APR, D'alpino PHP, Pereira PNR, et al. Effects of the application techniques of self-adhesive resin cements on the interfacial integrity and bond strength of fiber post to dentin. J Appl Oral Sci. 2016;24:437-446.
14. ArRejaie A, Al-suliman SA, Aljohani MO, et al. Micro-computed tomography analysis of gap and void formation in different prefabricated fiber post cementation materials and techniques. Saudi Dent J. 2019;31:236-241.
15. Al-Askary RA. Effect of NaOCl and EDTA as post space cleansing solutions on the bond strength of resin cements to root canal dentin (An in vitro study). Al–Rafidain Dent J. 2013;13:266-274.
16. Webber MB, Bernardon P, França FM, et al. Oval versus circular-shaped root canals: bond strength reached with varying post techniques. Braz Dent J. 2018;29:335-341.
17. Moogi P, Sayyad A, Rathore V, et al. Comparative evaluation of marginal adaptation of two resin-based sealers: A scanning electron microscopic study. Endodont. 2020;32:137-141.
18. Almulayounis M, Al-Ali A. Effect of heat treatment duration and cooling conditions on tensile properties and hardness of selective-laser-melted cobalt-chromium alloy. Georgian Medical News. 2023;337:38-42.
19. Alamdari Mahd M, Moeiny P, Heshmat H, et al. In Vitro Comparison of Fracture Resistance of Severely Damaged Primary Anterior Teeth Restored with Different Post and Core Systems. International Journal of Dentistry. 2023;2023.
20. Abreu RT, Monteiro JB, Abu-Hasna A, et al. Bond strength of cemented fiber posts to teeth with simulated internal root resorption. J Clin Exp Dent. 2020;12:277-284.
21. Heintze SD. Clinical relevance of tests on bond strength, microleakage and marginal adaptation. Dent Mater. 2013;29:59-84.
22. Zaslansky P, Fratzl P, Rack A, et al. Identification of root filling interfaces by microscopy and tomography methods. Int Endod J. 2011;44:395-401.
23. Neves AA, Jaecques S, Van Ende A, et al. 3D-microleakage assessment of adhesive interfaces: exploratory findings by µCT. Dent Mater. 2014;30:799-807.
24. De Munck J, Van Landuyt K, Peumans M, et al. A critical review of the durability of adhesion to tooth tissue: methods and results. J Dent Res. 2005;84:118-32.
25. Hilton TJ. Can modern restorative procedures and materials reliably seal cavities? In vitro investigations. Part 2. Am. J. Dent. 2002;15:279-89.
26. Shemesh H, Souza EM, Wu MK, et al. Glucose reactivity with filling materials as a limitation for using the glucose leakage model. Int Endod J. 2008;41:869-872.
27. Križnar I, Zanini F, Fidler A. Presentation of gaps around endodontic access cavity restoration by phase contrast-enhanced micro-CT. Clin Oral Investig. 2019;23:2371-2381.
28. Carrera CA, Lan C, Escobar-Sanabria D, et al. The use of micro-CT with image segmentation to quantify leakage in dental restorations. Dent Mater. 2015;31:382-90.
29. Bakhsh TA, Sadr A, Shimada Y, et al. Non-invasive quantification of resin-dentin interfacial gaps using optical coherence tomography: validation against confocal microscopy. Dent Mater. 2011;27:915-25.
30. Kwon OH, Park SH. Evaluation of internal adaptation of dental adhesive restorations using Micro-CT. Restor Dent Endod. 2012;37:41-49.

31. Gomes GM, Rezende EC, Gomes OM, et al. Influence of the resin cement thickness on bond strength and gap formation of fiber posts bonded to root dentin. J Adhes Dent. 2014;16:71-78.
32. Caceres EA, Sampaio CS, Atria PJ, et al. Void and gap evaluation using microcomputed tomography of different fiber post cementation techniques. J Prosthet Dent. 2018;119:103-107.
33. Alnaqbi IOM, Elbishari H, Elsubeihi ES. Effect of Fiber Post-Resin Matrix Composition on Bond Strength of Post-Cement Interface. Int J Dent. 2018;4751627.
34. Das AK, Muddugangadhar BC, Amarnath GS, et al. Comparative Evaluation of Push Out Bond Strength of a Fiber Post System using Four Different Resin Cements: An In-Vitro Study. J Int Oral Health. 2015;7:62-7.
35. Amiri EM, Balouch F, Atri F. Effect of Self-Adhesive and Separate Etch Adhesive Dual Cure Resin Cements on the Bond Strength of Fiber Post to Dentin at Different Parts of the Root. J Dent. 2017;14:153-158.