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Comparison of Clinical and Radiographic Healing of Periapical Lesions Using MTA or Conventional Filling Materials: Randomized Controlled Clinical Trial

Meltem Sümbüllü[1-a*], Ezgi Doğanay Yıldız[2-b], Mehmet Ali Ünlü[3-c], Hakan Arslan[4-d]

[1] *Department of Endodontics, Faculty of Dentistry, Ataturk University, Erzurum, Turkiye.*
[2] *Department of Endodontics, Faculty of Dentistry, Bursa Uludağ University, Bursa, Turkiye.*
[3] *Dental Specialist, Rize Oral and Dental Health Hospital, Rize, Turkiye.*
[4] *Department of Endodontics, Faculty of Dentistry, İstanbul Medeniyet University, İstanbul, Turkiye.*

**Corresponding author*

Research Article

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ABSTRACT

Objectives: To compare the effect of Mineral Trioxide Aggregate (MTA) versus conventional filling materials on the healing of teeth with periapical lesions.

Materials and methods: Sixty-four teeth with periapical lesions of greater than 5 mm were divided into two groups; G1) MTA (ProRoot MTA; Dentsply Maillefer, Ballaigues, Switzerland) filling, G2) conventional filling materials (n = 32/group). In MTA group, the apical portion of the root canal was filled with ProRoot MTA and the middle and coronal thirds of the root canal were filled with injectable thermoplasticized gutta-percha system. Patients were followed for 15 months. The data were statistically analyzed with Mann-Whitney U and chi-square test.

Results: With a follow-up rate of 89.06% of all patients for 15 months, favorable outcomes were obtained in 100% in ProRoot MTA and 83.3% in conventional technique.

Conclusions: ProRoot MTA showed better results compared to conventional filling materials in teeth with periapical radiolucency.

Keywords: Apical Periodontitis, Necrotic Tooth, MTA, Filling, Large Periapical Lesion.

Periapikal Lezyonların Klinik ve Radyografik İyileşmesinde MTA veya Konvansiyonel Dolgu Materyallerinin Karşılaştırılması: Randomize Kontrollü Klinik Çalışma

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ÖZ

Amaç: Bu çalışmanın amacı, periapikal lezyonlu dişlerin iyileşmesinde Mineral Trioksit Agregat (MTA) ve geleneksel dolgu materyallerinin etkisini karşılaştırmaktır.

Gereç ve Yöntemler: Periapikal lezyonu 5 mm'den büyük olan 64 diş iki gruba ayrıldı; G1) MTA (ProRoot MTA; Dentsply Maillefer, Ballaigues, İsviçre) G2) geleneksel dolgu materyalleri (n = 32/grup). MTA grubunda kök kanalının apikal kısmı ProRoot MTA ile dolduruldu ve kök kanalının orta ve koronal üçte birlik kısmı sıcak gutta perka tekniği ile dolduruldu. Hastalar 15 ay boyunca takip edildi. Veriler Mann-Whitney U ve ki-kare testi ile istatistiksel olarak analiz edildi.

Bulgular: 15 ay sonunda hastaların %89.06'lık takip oranı ile ProRoot MTA'da %100 ve geleneksel dolgu materyallerinde %83,3 başarı elde edildi.

Sonuçlar: ProRoot MTA, periapikal radyolüsensli dişlerde geleneksel dolgu materyallerine kıyasla daha iyi sonuç göstermiştir.

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Anahtar Kelimeler: Apikal Periodontitis, Nekrotik Diş, MTA, Dolgu, Büyük Periapikal Lezyon.

[a] meltem_endo@hotmail.com https://orcid.org/0000-0002-2647-7988
[b] dtezgidoganay@gmail.com https://orcid.org/0000-0003-4113-7794
[c] mehmetali.unlu.90@gmail.com https://orcid.org/0000-0002-8155-4616
[d] dt_hakan82@hotmail.com https://orcid.org/0000-0003-4890-1062

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Introduction

Root canal infection is of great effect in the pathogenesis of periapical lesions (PL).[1,2] Root canal infection pursues a natural path in the apical direction, reaches periapical tissues cause inflammation or even destruction of periapical structures.[3] In the management of periapical pathology of endodontic origin, it is important to eliminate bacteria from the root canal system and to prevent re-infection.[4] Therefore, chemo mechanical preparation and obturation of the root canal are important steps for periapical healing by eliminating bacteria and bacterial toxins and preventing their spread.[5]

Since the filling material is in contact with the periodontal tissue, its biocompatibility is substantial.[6] It has been shown that Mineral Trioxide Aggregate (MTA) cement has better biocompatibility and sealing ability compared to conventional filling materials.[7,8] It is an important advantage of MTA that contact of the set MTA with water results in the release of calcium hydroxide as a reaction product without any dissolution of MTA.[9] In one study, apical plug with MTA was applied to 22 immature teeth with PL and it was reported that the clinical success rate accounnts for 95.5%.[10] In another study, MTA and conventional filling materials were compared in mature teeth with chronic apical abscess. Although there were no statistical differences between them, it was shown that MTA is better at the single-visit endodontic treatment.[4]

The aim of this study was to compare ProRoot MTA with conventional filling materials on the healing of PL. The null hypothesis was that there were no significant differences between groups in terms of periapical healing.

Materials and Methods

Current study was planned as a randomized controlled two-armed parallel clinical trial. In this clinical trial, the Preferred Reporting Items for Randomized Trials in Endodontics 2020 guidelines were followed[11,12]. The patients were distributed into two groups using a web site (www.randomizer.org). Randomization, treatment procedures, and data analysis were all done by different blind researchers. Also, the patient was blinded to the treatment group. The Research Ethics Board of University A (no.20/17) and Thai Clinical Trials Registry (no. TCTR20170328001) approved the study protocol.

The G*Power 3.1 software (Heinrich-Heine, Dusseldorf, Germany) was performed to conduct a minimum sample size calculation, considering a type I error (alpha) of 0.05, power (1-beta) of 0.95, and an effect size of 1.0997. The calculated minimum sample size required was a minimum of 27 patients per group. In order to strengthen the statistical power of the study and account for potential patient attrition, each group enrolled 32 patients.

Patients Selection

The inclusion criteria

- healthy patients aged ≥18,
- patient having non-vital single rooted teeth and one root canal with mature apice
- teeth with a periapical lesion score of ≥ 3 according to Ørstavik *et al.*'s[13] classification.

The exclusion criteria

- patients with presence of any systematic disease/allergic reaction,
- patients with smoking habit,
- pregnant females,
- teeth with sinus tract, swelling, palpation,
- teeth with previous root canal treatment,
- teeth with canal curvature of more than 25°,
- teeth with PL of less than 5 mm in diameter,
- teeth with periodontal pocket deeper than 3 mm,
- teeth with developmental anomalies (e.g. dens invaginatus, palate-gingival groove).

The vitality of the teeth was checked by using an electrical pulp test (Digitest 2; Parkell, Inc, Edgewood, Newyork, USA) and cold test (Roeko Endo-Frost spray; Coltene Whaladent, Langenau, Germany) and resulted as negative. Moreover, the absence of bleeding from the root canals during access cavity preparation was also considered as a confirmatory clinical diagnosis. Oral and written consent was obtained from the patients.in which the possible risks and benefits were completely described.

Treatment Protocol

Local infiltration anesthesia was administered to the patients using 4% articaine with 1:100000 mg/mL epinephrine (UltracaineDS ® forte; Aventis, Istanbul, Turkey). All treatments were performed under the rubber dam isolation. Coronal flaring was performed using ProTaper Universal files (SX; Dentsply Maillefer, Ballaigues, Switzerland). Working length (WL) was determined with an apex locator (Raypex 6; VDW GmbH, Munich, Germany) and confirmed by radiographic evaluation. The root canal preparation was performed using K files (Jensen JP-1 K files; Bahadir Dis Malzemeleri, Istanbul, Turkey) up to six sizes larger than the first binding file size. Between each instrument, a size of 10 K-file was used to avoid an apical blockage and 2 mL of 2.5% NaOCl was used for irrigation. Final irrigation was applied as 5 mL 2.5% NaOCl, 5 mL 10% citric acid and 5 mL saline solution for one minute each, respectively. All irrigation stages were performed using a 30-gauge needle (Navitip; Ultradent, South Jordan, UT, USA) which was placed 2 mm shorter than the WL.

MTA Group: White mineral trioxide aggregate (MTA) (ProRoot MTA; Dentsply Maillefer, Ballaigues, Switzerland) was introduced into the canal using a fine-tipped amalgam carrier and was then condensed into the apical third by using gutta-percha. An ultrasonic tip (15,.02) was placed 2 mm shorter than the WL and activated for 2 s. The ultrasonic device (NSK-Varios 750; Nakanishi Inc., Tochigi, Japan) was used at power setting of 3 (28–32 kHz). The following day, the rest of the canal was filled with a backfilling device (BeeFill; VDW) after the canal walls had been sealed with 2Seal sealer (VDW). Since it is necessary to allow the ProRoot MTA to set, root canal treatment was completed in two-visit in this group.

Conventional technique group: Root canal treatments were completed with gutta-percha cones and epoxy resin-based sealer (2Seal; VDW, Munich, Germany) in one-visit using cold lateral compaction technique.

In both groups, a resin-based composite (3M ESPE, St. Paul, USA) was used for restoration. All of the clinical procedures were performed by the same operator. The operator was calibrated in terms of the protocol for each experimental procedure. The subjects were followed up for 15 months and examined clinically and radiographically. Periapical radiographs were taken using the Belmont Phot-X II (Takara-Belmont) with phosphor plates (VistaScan II, Dürr Dental).

Postoperative Examination

A) Clinical Examination

Age, gender, tooth number, pain levels, pain on percussion, palpation sensitivity, swelling, sinus tract were noted. Pre- and post-operative pain levels and percussion pain were measured on a visual analog scale (VAS).

B) Radiographic examination

Periapical intraoral radiographs were taken with paralleling technique. A blinded operator evaluated preoperative and follow-up periapical radiographs. The change of lesion size was calculated using Image J (Version 1.41; National Institutes of Health, Bethesda, MD) previously used by Arslan *et al.*[14] The change in the size of the PL was expressed as a percentage using the pixel calculation.

When the size of PL was smaller in follow-up radiographs than in preoperative radiographs and the tooth was clinically asymptomatic (without sinus tract, swelling, with no spontaneous, palpation or percussion pain), the case was considered as successful. When the size of PL was bigger in follow-up radiographs than in preoperative radiographs and/or the tooth was clinically symptomatic, the case was considered as unsuccessful.

Statistical Analyses

The statistical analyses were performed using SPSS version 20 software (IBM SPSS, Chicago, IL, USA). The data of pain level, pain on percussion and age were statistically analyzed using the Mann-Whitney U test. The data of presence of success, radiographic outcome, pain on palpation, presence of swelling or sinus tract, gender and tooth number were analyzed using chi-square tests. The significance level of all statistical analyses set at $p<0.05$.

Results

Fifty-seven patients were included in this study. There were no significant differences in terms of demographic data (age, gender and tooth number) between the groups ($p>0.05$) (Table 1). Out of the total of 57, 39 patients (27 teeth for MTA and 30 teeth for the conventional technique) attended the follow-up clinical and radiographic assessment as shown in Figure 1. The follow-up rate was 89.06 %.

Based on clinical and radiographic examinations (Table 2), 100% of the teeth in the MTA group and 83.3% of the teeth in the conventional technique group were classified as being successfully treated ($p<0.05$) (Figure 2-3). The results showed no statistically significant differences between the groups in terms of pre- and post-operative clinical findings, i.e., palpation, swelling, sinus tract, pain and pain on percussion ($p>0.05$). Four teeth in the conventional technique group were considered unsuccessful due to sinus tract. In the MTA group, sinus tract, swelling, pain on palpation was not observed in any of the teeth (Table 1).

There was no significant differences among the groups in terms of the change in lesion size ($p>0.05$) (Table 2). One tooth in the conventional technique group was considered unsuccessful due to enlargement of PL size in follow-up radiographs.

Discussion

Filling material should be biocompatible as it could be in contact with periodontal tissue. MTA has better biocompatibility and sealing ability than conventional filling materials.[7,8] Consequently, this preliminary study compared the results of filling using MTA and a conventional technique (gutta-percha + root canal sealer) on the clinical and radiographic healing of mature teeth with PL. There were significant differences between the groups in terms of success, and therefore the null hypothesis was rejected.

Ricucci *et al.*[15] showed that conventional filling was successful at the rate of 78.2% in teeth with a PL greater than or equal to 5 mm. Also, Dorasani *et al.*[16] and Saoud *et al.*[17] observed that single or double visit treatments have similar percentages. In the current study, a higher success rate (83.3%) was found with regard to the conventional technique in teeth with PL from the aforementioned studies.[15-17] This could be elucidate by the different preparation sizes used in the studies. In this study, the canals were prepared to six sizes bigger than the first binding file size. Saini *et al.*[18] demonstrated that the rate of healed cases was 48%, 71.43%, 80%, 84.61%, and 92% when the canals were enlarged two, three, four, five and six sizes larger than the first binding file size, respectively. Therefore, in this study the canals were prepared to the maximal limit to obtain a high success rate.

When MTA cement comes into contact with water, calcium hydroxide is released as a reaction product and dissolution does not occur in the MTA surface.[9] A clinical study showed that the application of MTA as an apical plug to teeth with PL resulted in a clinical success of 95.5%.[10] Alsulaimani[4] performed a clinical study comparing the results of MTA and conventional filling materials on root canal treatment success in mature teeth with chronic apical abscess. Although Alsulaimani[4] could not find a statistically significant difference between the two techniques, he showed that single visit filling with MTA was better.

Although favorable clinical results were reported for immature and mature teeth used MTA, one study compared the MTA with the conventional technique[4]. It was concluded that the clinical success of teeth treated with MTA was 100%,

while the clinical success of teeth treated with conventional technique was 83.3%. Similarly, in the present study, 100% of samples in the MTA group and 83.3% samples in the conventional technique group were successful. MTA is a radiopaque Portland cement. MTA can induce and accelerate bone repair in giant cell tumors in bone.[19] MTA influences the differentiation of odontoblasts and bone marrow stromal cells with high expression of some genes such as Alp (alkaline phosphatase), Osx (Sp7, osterix), Bglap (osteocalcin), and Col1a1 (Type I collagen).[20,21] MTA is sterile, and the calcium hydroxide released from the MTA can react with phosphate in the tissues, resulting in the formation of hydroxyapatite.[20,21] This molecular mechanism can explain the 100% success rate found in the MTA group. Also, the sealing ability of MTA is good, and this could be improved by ultrasonic activation.[22] In our study, the 100% success in the MTA group can also be explained by the sealing ability of the MTA.

Some difficulties may arise for the clinician if root canals treated with MTA need to be retreatment. Boutsioukis *et al.*[23] reported that rotary instruments cannot penetrate canals, but ultrasonic tips can. Also, it was reported that MTA could not be completely eliminated from the root canal by the ultrasonic method.[23] It can be a limitation of MTA filling. On the other hand, MTA is more biocompatible and has a better sealing ability than conventional filling materials. Therefore, this is the strength of MTA filling.[7]

Liu *et al.*[24] analysed the healing rate of root canal treatment for teeth with apical periodontitis. They showed that a statistically significant preoperative prognostic factor in the successful was the patient's age. Younger patients had a more favourable outcome. In our study, the mean ages of the groups were 28.55±8.78 and 23.50±4.65, respectively, and there was no statistical difference between the group. This may have favourably affected the periapical healing.

Radiographic assessment of periapical status using Orstavik's periapical index (PAI) is the most frequently cited method in research studies.[25] Cone-beam computed tomography may prove to be an excellent alternative for assessing healing in 3 dimensions since it has been shown to be more sensitive and specific than periapical radiographs in evaluating radiolucent periaical zones.[26] The radiation dose is much higher when using CBCT compared to intraoral radiographs, therefore it is not appropriate to recommend CBCT as a standard method to identify periapical inflammation. Clinical signs and symptoms and intraoral radiographs are the best/recommended way for assessing root canal treatment.[25]

An important limitation of this study is the fact that the follow-ups were conducted at 15 months to obtain detailed information on the healing course of the teeth. The European Society of Endodontology recommends 4 years of follow-up.[27] Huumonen *et al.*[28] showed that teeth with PAI 3, 4, and 5 significant healing was seen at the 3-month control. Also healing of apical periodontitis occured fastest during the first postoperative year in all apical periodontitis groups. This study results may be useful in clinical practice, especially for teeth with extensive lesions requiring prosthetic rehabilitation.[29] To confirm our outcomes, further trials should be performed followed up for a longer period of time.

Table.1 Demographic data, presence of palpation tenderness, swelling, sinus tract, pain level, pain level on percussion according to the groups.

Group		MTA	Conventional	P value
N		27	30	
Age		28.55±8.78	23.50±4.65	>0.05
Gender	Female	17 (62.9%)	19 (63.3%)	>0.05
	Male	10 (37.1%)	11 (36.7%)	
Tooth Number	#4	*1* (3.7%)	3 (10%)	>0.05
	#6	1 (3.7%)	0 (0%)	
	#7	*4* (14.8%)	4 (13.3%)	
	#8	*8* (29.6%)	5 (16.7%)	
	#9	5 (18.5%)	3 (10%)	
	#10	5 (18.5%)	5 (16.7%)	
	#11	0 (0%)	1 (3.3%)	
	#13	1 (3.7%)	1 (3.3%)	
	#22	0 (0%)	3 (10%)	
	#23	1 (3.7%)	0 (0%)	
	#24	1 (3.7%)	0 (0%)	
	#25	0 (0%)	1 (3.3%)	
	#26	0 (0%)	2 (6.7%)	
	#27	0 (0%)	2 (6.7%)	
Presence of Palpation Tenderness	Preoperative	0 (0%)	0 (0%)	>0.05
	Control	0 (0%)	2 (7.1%)	>0.05
Presence of Swelling	Preoperative	0 (0%)	0 (0%)	>0.05
	Control	0 (0%)	0 (0%)	>0.05
Presence of Sinus Tract	Preoperative	0 (0%)	0 (0%)	>0.05
	Control	0 (0%)	4 (13.3%)	<0.05
Pain level	Preoperative	1.66±8.66	3.20±9.12	>0.05
	Control	0.00±0.00	0.00±0.00	>0.05
Pain level on percussion	Preoperative	2.14±11.16	4.06±12.41	>0.05
	Control	0.00±0.00	0.00±0.00	>0.05

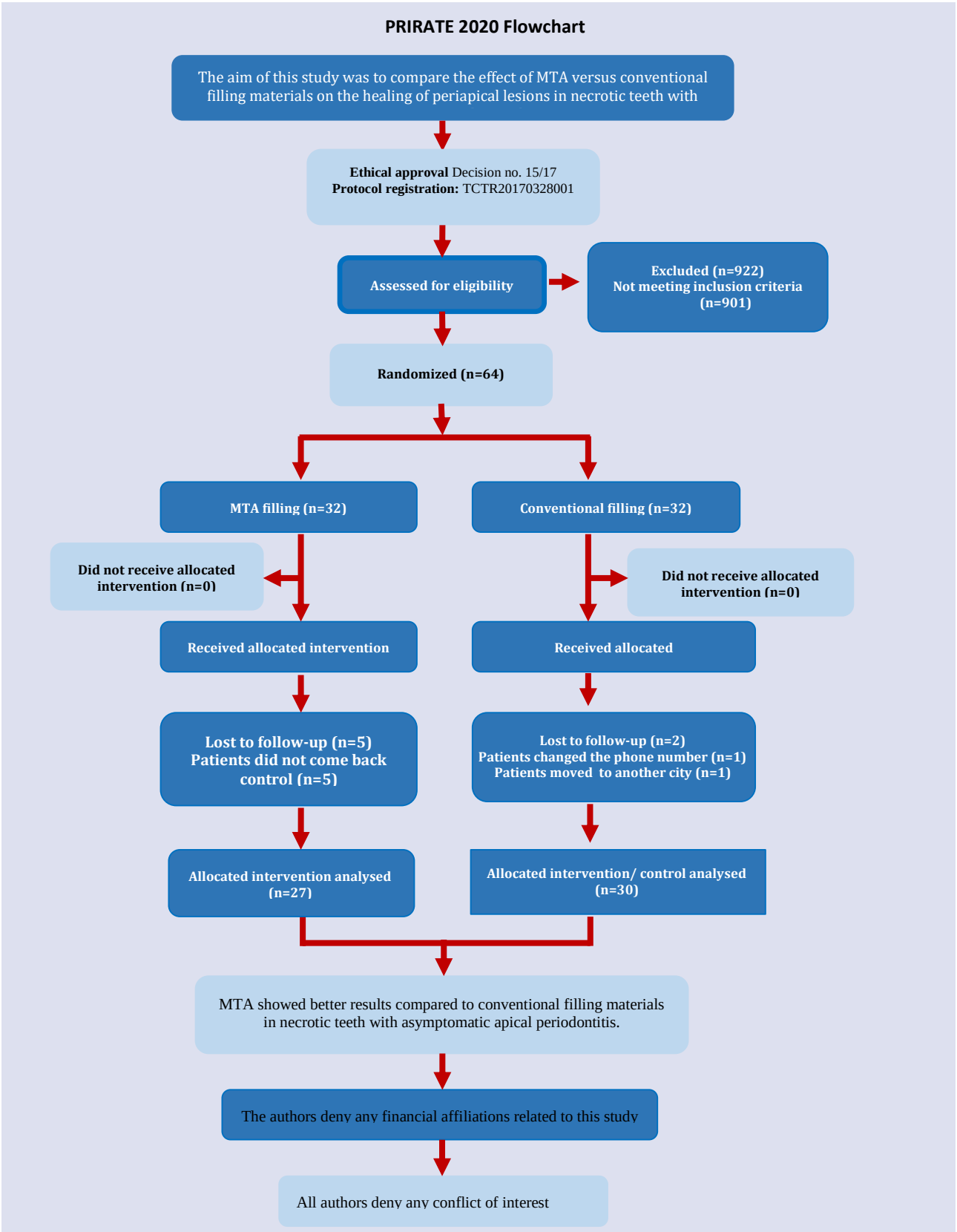

Figure Legends:

Figure 1: Preferred Reporting Items for Randomized Trials in Endodontics 2020 flowchart.

*From: Nagendrababu V, Duncan HF, Bjørndal L, Kvist T, Priya E, Jayaraman J, Pulikkotil SJ, Pigg M, Rechenberg DK, Vaeth M, Dummer P. (2020) PRIRATE 2020 guidelines for reporting randomized trials in Endodontics: a consensus-based development. International Endodontic Journal Mar 20. doi: 10.1111/iej.13294. For further details, visit: http://pride-endodonticguidelines.org/prirate/

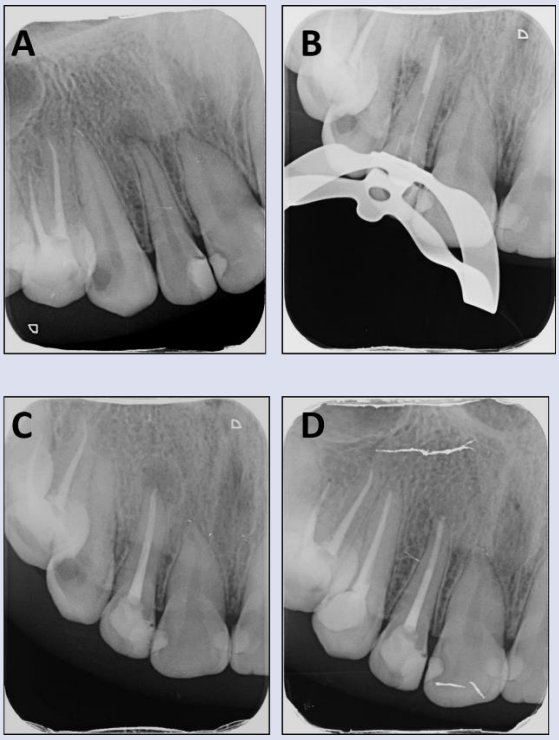

Figure 2: (A) Right lateral incisor tooth with periapical lesion in a 22 year-old female patient. (B) The apical portion of the tooth was obturated with MTA, (C) The middle and coronal thirds of the tooth were obturated with gutta-percha. (D) The 15-month follow-up shows the healing of periapical lesion without clinical symptoms and periapical lesion.

Table.2 Clinical and radiographic assessment of the protocols

Group		MTA	Conventional	P value
	N	27	30	
Success	Successful cases	27 (100%)	25 (83.3%)	<0.05
	Unsuccessful cases	0 (0%)	5 (16.7%)	
Change in lesion size (%)		-78.94±22.47	-73.39±36.58	>0.05

Figure 3: (A) Left lateral incisor tooth with periapical lesion in a 25 year-old female patient. (B) Root canal treatments were completed with gutta-percha cones and epoxy resin-based sealer in one-visit using cold lateral compaction technique. (C) The 15-month follow-up shows the healing of periapical lesion without clinical symptoms and periapical lesion.

Conclusion

Within the limitations of this study, MTA filling has statistically more success rate than conventional obturatin materials in teeth with PL. Further studies with larger sample sizes are needed to verify the outcomes obtained from the current study.

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