



## Case Series

# Management of apical periodontitis using WaveOne gold reciprocating files, single-cone endodontic approach: A case series author

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## ABSTRACT

**Introduction:** The endodontic treatment of apical periodontitis (AP) without surgical intervention presents a unique clinical challenge. This case series aimed to test the changes in size of periapical lesion scale and healing in post-treatment of AP by cone beam computed tomography (CBCT) using WaveOne Gold reciprocating file with single cone treatment approach.

**Presentation of cases:** A total of 20 patients with 20 teeth (9 M, six premolars, one canine, and four incisors) with AP underwent CBCT scanning before and after non-surgical root canal treatment (NSRCT) or non-surgical retreatment (NSReTx). Standardized root canal chemo-debridement and instrumentation with WaveOne Gold (WOG) reciprocating files was used. The canals were obturated using epoxy-based sealer (AH Plus) with a single WaveOne Gold conform fit gutta-percha cone technique. After one year, assessment with CBCT images showed that the success and healing rate using (AH Plus) with single cone technique was very high.

**Discussion:** Apical periodontitis is an inflammatory disease at the root end of teeth. Following NSRCT or NSReTx, evaluation of lesion size by radiograph has been essential to the evaluation of lesions post-operatively. In addition to the absence of symptoms, complete restitution of the lamina dura and periodontal ligament (PDL) space on post-operative radiograph has been considered the optimal outcome success.

**Conclusions:** Within the limitations of this study, NSRCT or NSReTx using reciprocating WaveOne Gold and single cone with AH plus sealer resulted in healing of AP as assessed by CBCT.

## 1. Introduction

Endodontic treatment is directed at preventing or curing apical periodontitis (AP). Apical periodontitis is an inflammatory disorder mainly caused by dental caries, accidental trauma or iatrogenic causes of exposure of essential pulp to various oral microbiota [1]. Microorganism colonization contributes to dental pulp necrosis and infection growth in the periapical area of the infected tooth. Consequently, the host's immune response activation results in local acute and/or chronic inflammation, bone resorption and periapical tissue degradation, and periapical lesion development [2,3].

Post-treatment AP is associated with clinical procedures that may not follow appropriate requirements and thus do not adequately regulate the infection of the root canal due to anatomical variations such as isthmuses, lateral canals, recesses and dentinal tubules; these anatomical variations are typically inaccessible to the instrumentation of the root canal and antimicrobial agents used during root canal treatment [4, 5].

Conventional and digital two dimensional periapical radiographs are

still considered as the gold standard tools to assess root canal anatomy, treatment outcome and diagnosis of AP [6]. However, cone-beam computed tomography (CBCT) is a non-invasive process useful in the detection of additional roots and root canals in a three-dimensional view and more accurate in detection of AP [7].

One of the recent major advances in endodontic therapy is root canal preparation with a WaveOne Gold (WOG) reciprocating single-file system, mainly because of its flexibility that extends the life span of the M-Wire alloys, and reduces preparation time; moreover, it allows a matching-taper single cone to fill the canal, which is simpler than other strategies for filling the root canal and has become a common endodontic therapy procedure [8,9]. On the other hand, shorter procedure length with WOG reciprocating files (primarily during instrumentation) allows more time for the irrigation solution to disinfect the root canal efficiently, leading to a reduction in the microbial content of the root canal system and hence better healing for AP [10,11].

Over time, root canal sealers of different formulations have been created. Thanks to its biocompatibility with apical and periapical tissues, greater bond strength with dentin, and stronger protection of the

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chemistry of epoxy amines, the resin-based epoxy sealer AH Plus (Dentsply/DeTrey, Konstanz, Germany) has recently been commonly used, so that the material no longer releases toxins [12,13].

Following the completion of non-surgical root canal treatment (NSRCT) or non-surgical retreatment (NSReTx), due to technical and ethical concerns it is not possible to obtain histological data to assess the healing of AP. Therefore, the treatment outcomes of NSRCT and NSReTx have been evaluated based on the clinical and radiographic signs and symptoms such as the absence of swelling, sinus tracts, evaluation of the size of AP lesions post-operatively, and full restitution of the space of the lamina dura and periodontal ligament (PDL) [14].

There are scant reports to determine the healing of AP using conventional radiography. Thus, the goal of this case series reports was to assess the usefulness of reciprocating WaveOne Gold files and single cone endodontic treatment approach in healing of AP. **This study has been reported in line with PROCESS criteria [15].**

## 2. Presentation of cases

The Ethics Committee of the University of Sulaimani College of Dentistry has accepted the current observational report (No. 178). A patient data sheet has been given and consent has been obtained.

A total of 20 patients (12 female and 8 male, within an age range of 21–57 years) with 20 teeth (9 M, 6 premolars, 1 canine and 4 incisors) were recruited to the study based on their referral for NSRCT or NSReTx between October 2018 and March 2020 in **B&R private Dental Center in Sulaimani City Kurdistan region/Iraq.**

Pulp necrosis, symptomatic and asymptomatic AP, acute and chronic apical abscess with one or more teeth with post-treatment AP, radiographically determined and further validated by CBCT imaging, is diagnosed in all patients.

The inclusion criteria were: restorable teeth with AP and mature apex, no pathological mobility, ankylosis, root fracture, or probing pocket depths >3 mm, not allergic to medicaments and antibiotics necessary to complete procedure. Patients taking medications that could change the metabolism of the bone, such as immunosuppressants, corticosteroids or antiresorptives, were excluded. **This case series was reported in accordance with declaration of Helsinki and registered at [www.researchregistry.com](http://www.researchregistry.com) with Research Registry UIN: research registry 6785. Hyperlink to your specific registration (must be publicly accessible and will be checked): <https://www.researchregistry.com/browse-the-registry#home/>.**

### 2.1. CBCT examination

All the CBCT images were acquired with a GALILEOS Sirona comfort PLUS unit (Sirona Dental Systems GmbH, Bensheim, Germany). Technical specifications are: 15.4 cm spherical imaging volume, 0.25/0.125 mm isotropic voxel size, and field of view of 15 cm diameter. The CBCT radiographs were taken according to the following parameters: 98 kVp, 3–5 mA and exposure time of 14s by Sidex XG/Galileos implant software.

Each scan was evaluated by operator on-site using the same step-by-step screening procedure that included initial tooth/root selection with AP, followed by a required root alignment in the sagittal plane.

### 2.2. Root canal treatment protocols

Under local anesthesia and rubber dam isolation, non-surgical root canal therapy (NSRCT) or non-surgical retreatment (NSReTx) was carried out using normal clinical practice. Root canals were found using a straight probe after establishing the access cavity and patency was achieved using a stainless steel Flexofile #10 K (Dentsply Maillefer, Ballaigues, Switzerland). Using an electronic apex locator (Root ZX; J Morita Co, Tustin, CA, USA), the root canal working length was calculated and further checked with a periapical radiograph (Vistascan 2+;

Durr dental SE, Bietigheim-Bissingen, Germany). The working period was always 1 mm shorter than the reading of the “0” apex locator.

Using ProGlider (#16/progressive taper; Dentsply Sirona, Ballaigues, Switzerland), the glide path principle was obtained. Canals were then prepared to at least WOG Primary file size with WOG (Dentsply Sirona, Ballaigues, Switzerland) reciprocating approach operated by an X-Smart IQ motor (Dentsply Sirona, Ballaigues, Switzerland).

Throughout the instrumentation process, when the files were replaced by 27 gauge side-cut open-ended needles, 3 mL of 2.5% or 5.25% sodium hypochlorite (Neo Cleaner, Neo Dental, Tokyo, Japan) was used as an irrigating solution (Monoject Luer lock syringe; Sherwood Medical, St. Louis, MO, USA). The root canals were then irrigated (Ultradent, South Jordan) with 17% ethylenediaminetetraacetic acid (EDTA), followed by final irrigation with 1% sodium hypochlorite. The irrigants were subjected to Endoactivator (Dentsply Maillefer size 25) ultrasonic agitation for 1 min.

Calcium hydroxide (Apexal) (Ivoclar Vivadent, Liechtenstein) was used as a standard inter-appointment medicament. Cavit (3 M Espe, Madrid, Spain) was used as a temporary restoration material. The root canals were then dried with paper points and the operators, following an alternate sequence, obturated using epoxy-based sealer AH Plus (Dentsply Maillefer, Switzerland) with a single WOG conform fit gutta-percha cone technique (Dentsply Sirona, Ballaigues, Switzerland). The teeth were then restored with permanent composite resin (Dentsply Sirona, Ballaigues, Switzerland) and, within 1 month of completion of root canal treatment, those needing permanent complete cuspal cover were restored.

### 2.3. Follow-up assessment

One year after treatment, all the patients were contacted. Patients reported symptoms, tenderness to percussion examination; agility and periodontal probing depths were included in clinical evaluation. The soft tissues have also been evaluated for palpation tenderness, and the involvement of sinus tracts and the integrity and marginal fit of the final reconstruction have also been evaluated.

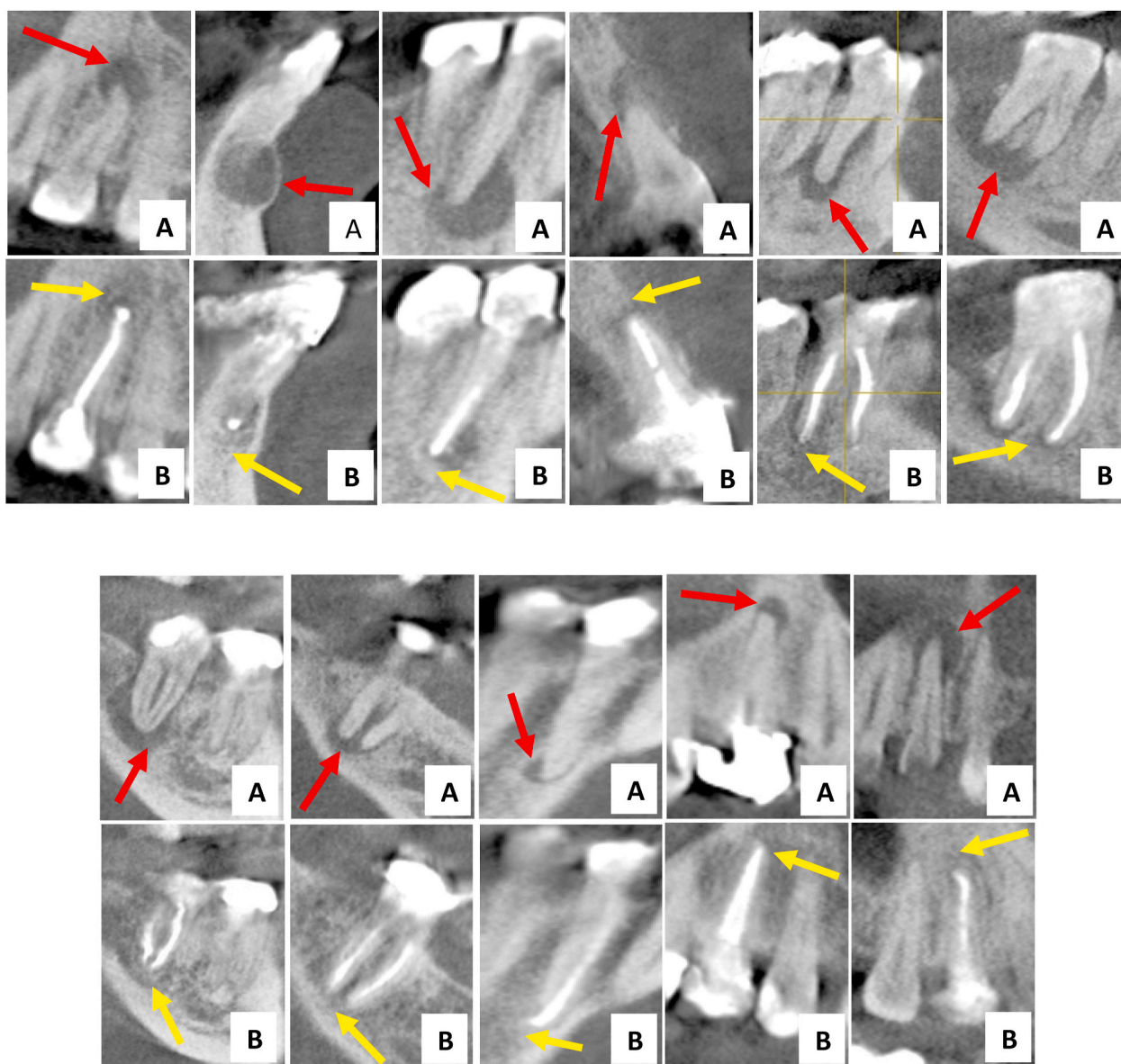
In the sagittal plane of CBCT, each root was examined for the presence, absence, and shift (increase/decrease) in size of any AP after NSRCT or NSReTx, and the images were compared before and after treatment. AP has been described as expanding beyond the PDL space. Widening of the space of the PDL was described as less than double that of the adjacent healthy teeth’s corresponding healthy PDL space. The radiolucence associated with the radiographic apex of the root and twice the width of the healthy PDL space was described as a PA lesion. If the teeth were functional and asymptomatic with absence or decreased PA radiolucence size, the result of treatment was deemed successful.

All cases showed full lesion resolution, and lamina dura reconstitution demonstrated healing and decreasing size of periapical lesion in sagittal plane after one year of follow-up/recall via CBCT inspection. (Figs. 1 and 2).

## 3. Discussion

The key causes of primary and post-treatment AP are bacteria persisting in the most apical section of the root canal system [16]. The purpose of this study was to assess the healing outcome of NSRCT or NSReTx in pre-therapeutic AP patients after one year of follow-up using CBCT analysis. Therapy was simplified by endodontic care using WOG reciprocating single-file instrumentation and the single-cone obturation technique. However, clinical trials showing the efficacy of this simplified technique would support this method. The simple protocol incorporating reciprocating single-file instrumentation and a matching-taper single conform fit gutta-percha cone with AH Plus sealer was shown to be correlated with healing of AP in the current non-randomized clinical trial.

Studies by Eriksen et al. (1998) [17] and Murphy et al. (1991) [18]



**Fig. 1.** NSRCT of AP: (A) CBCT sagittal plane preoperative image sections; (B) CBCT sagittal plane post-operative image sections. Red arrow (AP) and yellow arrow (healed AP). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

have stated that healing is representative of a decrease in the size or complete removal of the periapical lesion after treatment. On periapical radiographs, dimensional changes in periapical lesions cannot be identified after 6–12 months of completion of endodontic therapy. A range of the drawbacks of periapical radiographs are overcome by CBCT. Compared to periapical radiographs, it is postulated that CBCT could be capable of detecting dimensional changes in lesions faster [19,20]. The explanations for the superior performance of CBCT, especially with minor radiolucencies, are the additional representation of the orofacial region, imaging without geometric distortion, and lack of superposition by cancellous bone or other neighboring anatomical structures, such as the cheekbone, the maxillary sinus or the roots of other teeth [21].

It should be noted that Orstavik (1996) [22] has confirmed that, after one year of endodontic therapy, the highest occurrence of AP healing occurs. Factors influencing periapical lesion healing have been identified as the type of tooth, root canal anatomy, number of root canals and previous endodontic treatment with continuous AP [23,24]. Thus, four groups of teeth (incisors, canine, premolars, and molars) in both maxilla and mandible with AP but no previous endodontic treatment or

persistent AP with inadequate root canal filling were included.

Higher bacterial density and larger post-treatment lesions will be correlated with teeth with insufficient apical filling in this sample. This is due to the potentially greater space for residual bacteria colonization and accumulation of bacterial products and antigens. Unfilled areas can also cause periradicular tissues to seep inflammatory exudate to supply nutrients to intracanal bacteria [25,26]. This is in line with studies which have shown that the quality of the root canal filling is one of the most important risk factors for post-treatment disease, especially in cases with fillings too short of the apex and showing long unfilled areas [27,28]. Teeth with NSReTx were stated to have a high incidence of AP healing in this study (Fig. 2).

The advent of NiTi rotary instruments allowed predictable preparation of taper and apical gauge that can be matched with industrially developed gutta-percha cones that fit with an accurate dimensional tolerance to the prepared canal. In fact, the efficacy of reciprocating systems (Reciproc and Waveone) in reducing cultivable bacteria (>99%) and endotoxin (95–96%) in infected root canals was shown in a previous clinical study by Machado et al. (2013) [29], and the results of the



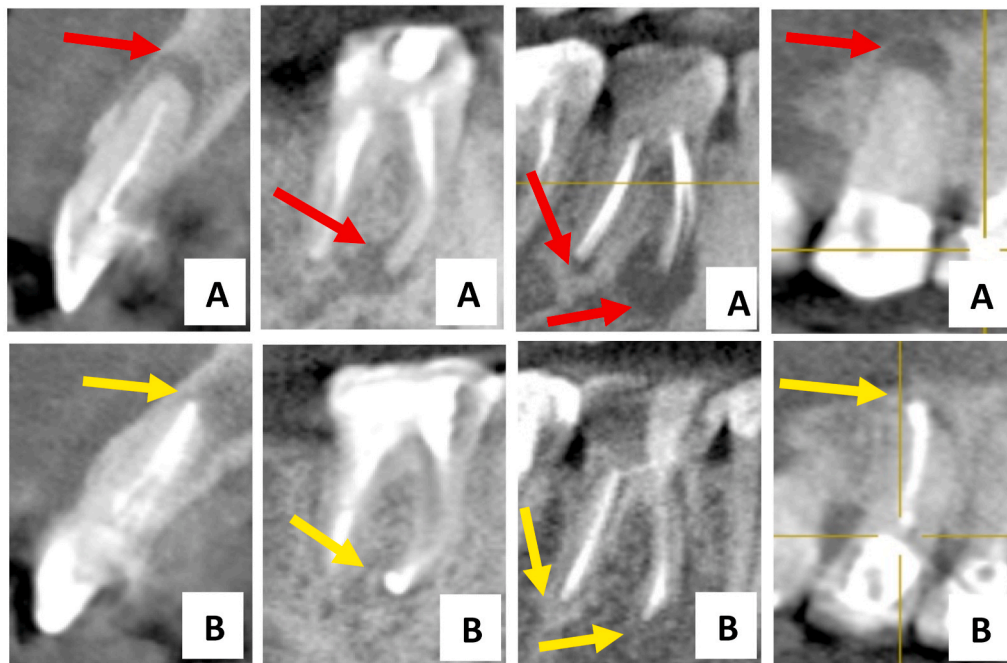
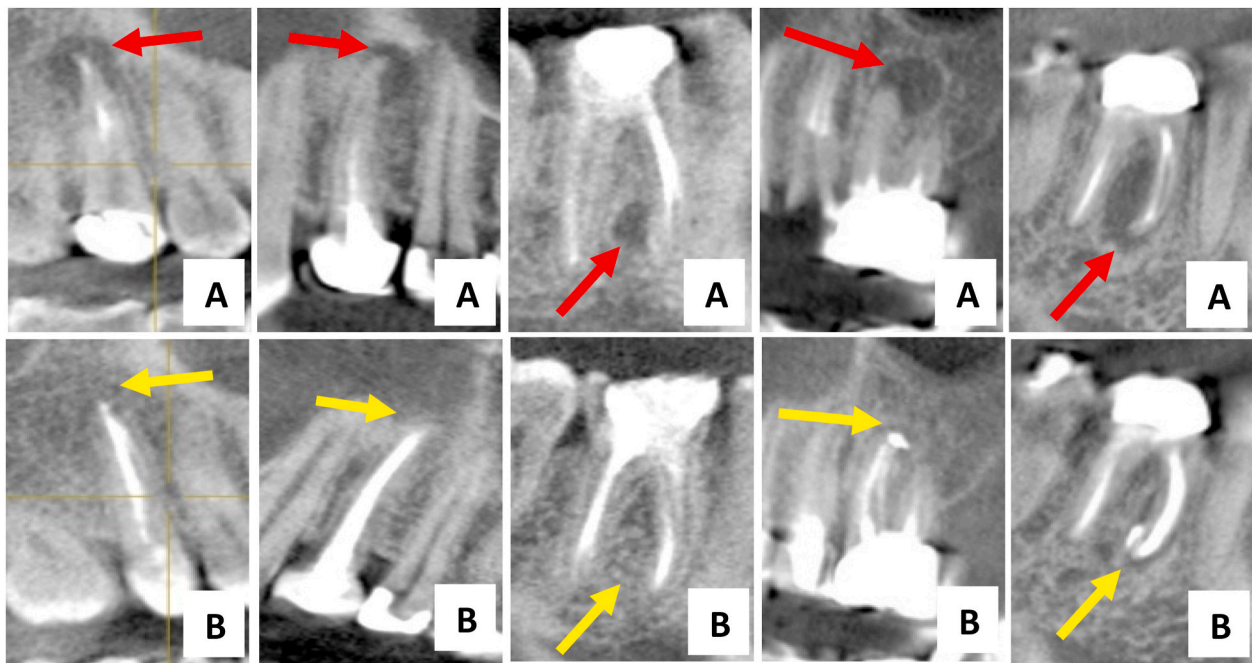


Fig. 2. NSReTx of AP: (A) CBCT sagittal plane preoperative image sections; (B) CBCT sagittal plane post-operative image sections. Red arrow (AP) and yellow arrow (healed AP). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

present study provide more evidence supporting the use of these simplified endodontic protocols in clinical practice.

A research by (Khabbaz and Papadopoulos 1999) [30] concluded that the effective control of infection by chemical and mechanical properties as well as sealing of the root canal can be due to the healing procedure. Depending on the completion of multiple stages during root canal treatment, a good endodontic result is multifactorial [31]. After WOG instrumentation, the use of EndoActivator sonic irrigation was shown to be a more powerful method of cleaning canals and isthmuses, with better debridement and disruption of the smear layer and biofilm. It has been demonstrated that the use of an efficient irrigation protocol with

adjunct activation regimes is effective in achieving three-dimensional endodontic space cleaning and in preventing bacterial invasion and recolonization of the filled endodontic space [32,33]. In addition, studies by Katebzadeh et al. (2000) and Augsberger and Peters (1990) [34,35] suggest that obturation plays a key role in AP healing and may occur in well-obturated canals with periapical healing.

The high periapical healing success rate in the current study also suggests that the AH Plus sealer is a key factor in periapical healing. In order to stimulate the reorganization of damaged apical tissue that remains in direct contact with the material and also accelerate the deposition of mineralized tissue in the apical foramen, the biocompatibility

and antibacterial properties of the AH Plus sealer are significant, thus helping to heal. These characteristics can allow a single cone technique to be used clinically [36,37]. The findings obtained in the current study agree with previous studies [38,39] that the periapical reaction of the tissue to AH Plus is excellent.

It has also been stated that the likelihood of success of teeth with favorable coronal restoration is 1.82 times greater than that of unfavorable restoration [40], as well as a higher probability of periapical healing of lesions [41]. In the present study, teeth with favorable coronal restoration were associated with high periapical lesion healing during follow-up visits.

This study clearly demonstrates that the first-line treatment option for AP or after failure of initial root canal treatment is NSRCT or NSReTx and these are superior to traditional surgical endodontic treatments due to their high survival rates. The findings regarding this type of approach in treatment of periapical lesion or endodontic failure are in accordance with other studies [42,43].

**To the authors' knowledge this report describes the first clinical trial assessing the outcome of NSRCT or NSReTx using single cone technique with AH Plus sealer after WOG reciprocating instrumentation on healing of AP by CBCT in different tooth types with two different clinical conditions: primary AP without endodontic treatment and post AP with inadequate apical filling.** Although two previous retrospective observational studies evaluated the impact of a reciprocating single file and single cone system with AH Plus sealer on healing of AP using periapical radiograph in anterior teeth, the previously treated root canal was excluded from their studies [43,44].

This report has limitations, further studies with larger sample size, longer follow-up and using different cleaning and shaping and obturation techniques are necessary.

#### 4. Conclusions

Within the limitations of this case series, it was clearly demonstrated the effectiveness of using reciprocating WaveOne Gold files and single cone endodontic treatment approach in healing of AP without the need for periradicular surgery.

#### Ethical Approval

The Ethics Committee of the University of Sulaimani College of Dentistry has accepted the current observational report (No. 178).

#### Source of funding

The author declares that this study had no funding source.

#### Author contribution

Ranjdar Talabani: Conception and design of study, acquisition of data, Analysis and/or interpretation of data, Drafting the manuscript, revising the manuscript critically for important intellectual content.

#### Consent

Written informed consent was obtained from the patient for publication of this case series and accompanying images.

#### Registration of research studies

1. Name of the registry: Research Registry
2. Unique Identifying number or registration ID: researchregistry6785
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): <https://www.researchregistry.com/browse-the-registry#home/>

#### Guarantor

Dr. Ranjdar Talabani

#### Provenance and peer review

Not commissioned, externally peer-reviewed.

#### Declaration of competing interest

No potential conflict of interest relevant to this case series was reported.

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#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amsu.2021.102385>.

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