Treatment outcome following a single-visit coronal indirect restoration by a CAD/CAM technique in endodontically treated teeth with coronal contamination: A pilot retrospective study

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Research article

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Abstract

Background

It is not uncommon that coronal contamination might take place in some clinical cases of ETT following improper treatment choices. This clinical investigation evaluated the outcome of endodontically treated teeth (ETT) with adequate root canal treatment and less than 12 months of coronal contamination by only a single-visit coronal indirect restoration.

Methods

Twenty-five patients with less than 12 months of coronal contamination following adequate root canal treatment were selected in the period from June 2016 to June 2018, and a single-visit coronal coverage restoration was performed by a chairside computer-aided design/computer-assisted manufactured (CAD/CAM) technique. The clinical outcome was evaluated by radiographical and clinical examination at 1 ~ 3 years recall.

Results

Twenty-three patients paid a return visit at 1 ~ 3 years recall. All teeth showed no clinical symptoms and no sensitivity to percussion through single-visit coronal coverage restoration, and the radiographic examination showed no change in comparison to the preoperative perirapical X-ray. Three typical clinical scenarios are presented in detail.

Conclusions

Coronal contamination may not be a unique indicator of endodontic retreatment, and clinicians should evaluate the quality of pre-existing endodontic treatment by radiographical and clinical conditions to determine whether retreatment is necessary.

Background

A successful outcome of endodontically treated teeth (ETT) not only depends on adequate root canal treatment but also rests with adequate coronal restoration [1, 2]. The type and period of coronal restoration play a role in the outcome of ETT. The types of coronal restorations are usually divided into direct and indirect restorations, and there are no exact guidelines regarding the choice of coronal restorations [3, 4]. Direct fillings are applied in ETT because it is a simple operation that takes place in a single clinical appointment and has a low cost, but direct fillings might not obtain long-term success in ETT with large defects due to inadequate protection [5, 6]. Furthermore, the time of the placement of coronal restoration has been questioned by the suggestion of different researchers. Whereas some

researchers recommend immediate coronal restoration to prevent coronal leakage after the completion of root canal treatment, other researchers propose that it is preferable to insert a provisional restoration while waiting for the resolution of apical periodontitis [7–9]. Provisional restoration does not form an effective coronal seal and is likely to drop if this waiting period is long.

The loss of a provisional restoration or of direct filling materials may, in turn, lead to coronal contamination of ETT if the patients delay seeking dental treatment. Varying results depending on whether root canal retreatment was carried out have been reported in experimental and clinical studies. A few studies considered that the loss of filling materials caused oral bacteria to penetrate the root canal and led to periapical infection [10–12]. An in vitro study suggested that the obturated root canals that had been exposed to the oral cavity beyond 3 months needed retreatment [13]. Other studies considered that periapical disease did not necessarily develop in all patients under the best root canal treatment despite coronal contamination, and no clear evidence supported retreatment in cases of well-obturated endodontic treatment with more than 3 months of coronal contamination due to suspected microleakage [14–16].

The placement of a cuspal covering restoration preserves the tooth structure and improves the survival of endodontically treated posterior teeth [17, 18]. Some clinical cases of ETT with coronal contamination might show no obvious apical radiolucency or clinical symptoms after the completion of adequate root canal treatment. Because root canal retreatment is troublesome and requires additional financial costs, can a good outcome be obtained by only a single-visit coronal restoration using a computer-aided design/computer-assisted manufactured (CAD/CAM) technique when clinicians are confronted with such asymptomatic ETT with coronal contamination? The emphasis of this study was to evaluate the practicability of a single-visit coronal indirect restoration without root canal retreatment for some asymptomatic ETT with 3 to 12 months of coronal contamination.

Material And Methods

Study design and patient selection

The patients of this study sought treatment owing to a loss of coronal filling material after root canal treatment in the period from June 2016 to June 2018. The patients were selected based on the following criteria:

1. Posterior teeth were affected.
2. Patients had undergone adequate root canal treatment for more than 12 months.
3. Radiographic examination: root filling ends 0–2 mm short of the radiographic apex; no signs of periapical radiolucency.
4. No spontaneous pain and no tenderness to percussion after the completion of root canal treatment were observed.

5. The provisional or permanent filling dropped, and coronal leakage had taken place for more than 3 months but less than 12 months.
6. The tooth defect did not reach the subgingival area.
7. Patients had no history of systemic diseases.

All patients or their legal guardians were informed about the treatment options, including the first scheme (root canal retreatment and subsequent coronal coverage restoration) and the second scheme (single-visit coronal coverage restoration without root canal retreatment). All patients and their legal guardians were informed of the benefits and the risks of the two therapeutic methods. The patients who chose the second scheme were informed that root canal retreatment and subsequent coronal coverage restoration could still be carried out if the second scheme failed. Twenty-five eligible patients signed informed consent forms and chose the second scheme because they did not have enough time to complete multivisit treatment. The treatment scheme itself did not bring any increased risks or benefits to the patients. The study protocol was approved by the Institutional Review Board of Guanghua School of Stomatology, Sun Yat-sen University (Reference No.KQEC-2020-30).

Coronal restoration procedure

According to the patients' demand, 25 teeth (14 males and 11 females, 7 premolars and 18 molars) underwent single-visit coronal coverage restoration by a chairside CAD/CAM technique. All procedures were performed by an experienced specialist in the Department of Operative Dentistry and Endodontics, Guanghua School of Stomatology, Sun Yat-sen University, Guangzhou, China. The teeth were isolated with a rubber dam, and the caries and the residual filling materials were removed using a 4# round diamond bur. The fillings of the root canal orifice were removed using Gates-Glidden burs, and the pulp chambers were soaked with 3% sodium hypochlorite for 2 minutes. After being washed using saline, the pulp chambers were etched with 37% phosphoric acid. The pulp chambers were filled with a smart dentin replacement (SDR, Dentsply, USA) by single-bond universal adhesive (3M ESPE, St. Paul, MN, USA). The tooth preparation was designed as an overlay as follows: a minimum ceramic thickness in the cusp area and at the fissure line of at least 2.0 mm and 1.5 mm, respectively, and a 2 mm deep pulp chamber. The prepared teeth were examined using a dental microscope (Zumax Medical Co., Ltd., Suzhou, China). All prepared teeth were scanned with a standardized template using a chairside CAD/CAM unit (Cerec, Dentsply Sirona, USA). The restorations were designed using Cerec software and milled with lithium disilicate glass-ceramic restorations (IPS e.max CAD, Ivoclar-Vivadent). A layer of glaze coating and characteristic staining were applied with crystallization firing performed following the manufacturer's recommendations in a ceramic furnace. A dual-cure composite cement (Variolink N Kit, Ivoclar-Vivadent, Liechtenstein) was applied in the adhesion between the prepared teeth and the restoration according to the manufacturer's specification. All patients were followed up for 1 to 3 years, and their records were analyzed for clinical and radiographic recall data at intervals of 1 year. In the clinical follow-up examination, a percussion test and radiographic examinations were performed.

Results

The clinical investigation

In the clinical investigation, 6 teeth, 8 teeth and 9 teeth were followed after a recall period of 3 years, 2 years and 1 year, respectively, and 2 patients did not pay a return visit. All teeth that underwent single-visit coronal coverage restoration showed no spontaneous pain, no occlusal pain and no sensitivity to percussion. The radiographic examination showed no change in comparison to the preoperative periradicular X-ray. All 23 recall cases were categorized as treatment success on the basis of clinical and radiographic evaluation. We provide here three clinical scenarios to outline the treatment process.

Case Report 1

Pulp chamber contamination of tooth #46 of a 23-year-old male patient had occurred for 5 months due to the loss of a coronal temporary filling. Clinical and radiographic examinations were in accordance with the preceding criteria. After the pulp chamber was completely cleaned, it was filled with SDR. A preformed overlay for tooth #46 was prepared; scanned by a chairside CAD/CAM technique; and devised by software, milling, crystallization and restoration adhesion. At the 2-year recall, the radiographic examination showed no periradicular radiolucency (Fig. 1).

Case Report 2

A 26-year-old male patient was referred to our department for the restoration of the left mandibular posterior tooth. His dental history indicated that root canal treatment for tooth #36 had been completed 12 months prior, and the temporary filling imperceptibly dropped 10 months before. Clinical examinations showed a serious crown defect and significant coronal contamination. The preoperative radiograph presented adequate root canal obturation and no periradicular radiolucency. The tooth was treated through only a single-visit coronal coverage restoration using a chairside CAD/CAM technique, and root canal retreatment was not offered. At the 3-year recall, clinical and radiographic examination both revealed a successful outcome (Fig. 2).

Case Report 3

A 37-year-old male patient was referred to our department for the restoration of the left maxillary posterior tooth. His dental history showed that root canal treatment of tooth #25 had been performed 12 months prior, and a coronal fracture had occurred due to biting hard food 8 months prior. Clinical examination found a buccal lesion of the crown of tooth #25 and gutta-percha in the root canal orifice exposure. The tooth underwent a single-visit coronal coverage restoration without root canal retreatment. At the 3-year follow-up visit, the clinical and radiographic examination revealed a favorable outcome (Fig. 3).

Discussion

The quality of coronal restoration will directly influence the survival and success of ETT [2, 17, 19]. Though inadequate coronal restoration is a major risk to survival, a small proportion of teeth do not receive any restoration after the completion of root canal treatment [20–22]. It is not surprising to find a few clinical cases of ETT with coronal contamination, which might require root canal retreatment. After all, root canal retreatment is a comparatively difficult operation due to unforeseen factors [22, 23]. The ability to obtain good outcomes in ETT with coronal contamination with no root canal retreatment is desirable. In this clinical investigation, the 23 recalled patients with less than 12 months of coronal contamination achieved success by only a single-visit coronal restoration.

It is acknowledged that coronal leakage may adversely influence the long-term success of ETT because bacteria possibly reach the periapical tissue through the root canal system [24, 25]. Coronal contamination can potentially result in periapical infection, but not certainly. A sufficient number of pathogens in periapical tissue is a prerequisite for the occurrence of apical periodontitis [26, 27]. An in vitro study (1991) considered that root canal retreatment should be performed if obturated root canals are exposed for more than three months [13]. A few researchers even speculated that the contamination of root canals occurred within a month in an in vitro model [12, 28, 29]. The studies did not yet present clear clinical evidence because the in vitro root-filling infection models were based on tracers such as dye, India ink, and methylene blue, which could not mimic the clinical conditions, and the size, type and penetrative ability were also significantly different from those of live oral bacteria.

Some bacteria or saliva were also employed in the in vitro experimental model, but the tracer alone was not able to provide evidence [11, 30]. Many studies have deemed that the quality of root canal filling is the most critical factor for the treatment outcome of ETT [1, 31, 32]. Compact obturation and adequate depth of root filling block the penetration of oral bacteria into the root canal. Furthermore, in the clinic and in experiments, acceptable antibacterial activity and sealing ability of root canal sealers create an inadequate environment for the viability of bacterial organisms [33–36]. In the in vitro model of other studies, if even small amounts of bacteria in saliva entered the apical root through coronal sealing, turbid culture medium in which the apical root was immerged was noted [37, 38]. Even so, this did not imply the occurrence of apical periodontitis. The small amounts of bacteria could not multiply or propagate in a compactly obturated root canal after effective coronal sealing. If the small amounts of bacteria reach the periapical tissue, they may still be removed by a healthy immune system. Therefore, defective teeth with coronal contamination should undergo coronal restoration as early as possible, provided that the primary root canal treatment is effective to prevent more bacteria from entering the root canal. Our pilot retrospective study indicated that 23 patients with ETT recalled with less than 12 months of coronal contamination treated with only a single-visit coronal coverage restoration were categorized as having treatment success; therefore, 3 months of coronal contamination may not be considered decisive evidence to support root canal retreatment.

The timing of the coronal restoration of ETT depends upon multiple factors: the pre-existing endodontic status, the quality of root canal filling, the position of the tooth, the type of restoration, the preoperative lesion size, and indecisive diagnosis [17, 39]. The consideration of retreatment should not be conjectural

by the time of bacterial penetration; rather, it should be based on evidence of healing. A case report noted that endodontically treated teeth showed evidence of periradicular healing after more than 2.5 years by temporary restorations [40]. In our clinical investigation, to ensure a successful outcome, the period of coronal contamination was limited to less than a year, a comparatively safe time. None of the treatments failed with only a single-visit coronal restoration, though our study lacks sufficient sample size. This study suggested that retreatment was not necessary for well-obturated root canals with coronal leakage.

Conclusions

Despite its limitation of sample size, 23 high-quality root canal treatments of patients with coronal contamination less than 12 months obtained successful outcomes with only a single-visit coronal restoration at 1 ~ 3 years recall. The time of coronal leakage may not be a unique indicator of endodontic retreatment, and the clinician should evaluate the quality of the existing endodontic treatment by radiographical and clinical examination to determine whether retreatment is necessary.

Declarations

Competing interests

The authors declared that they have no competing interests.

Ethical approval and consent to participate

Ethical approval for this study was obtained from the Institutional Review Board of Guanghua School of Stomatology, Sun Yat-sen University (Reference No.KQEC-2020-30).

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Authors’ contributions

ZT conceived the study together with XL and DC, participated in data retrieval and manuscript processing. XL conceived the study, interpreted the statistical analysis and helped to draft the manuscript. DC was responsible for data analysis. ZT evaluated X-ray success and performed coronal restorations, and finalized the manuscript. All authors read and approved the final version.

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Figures

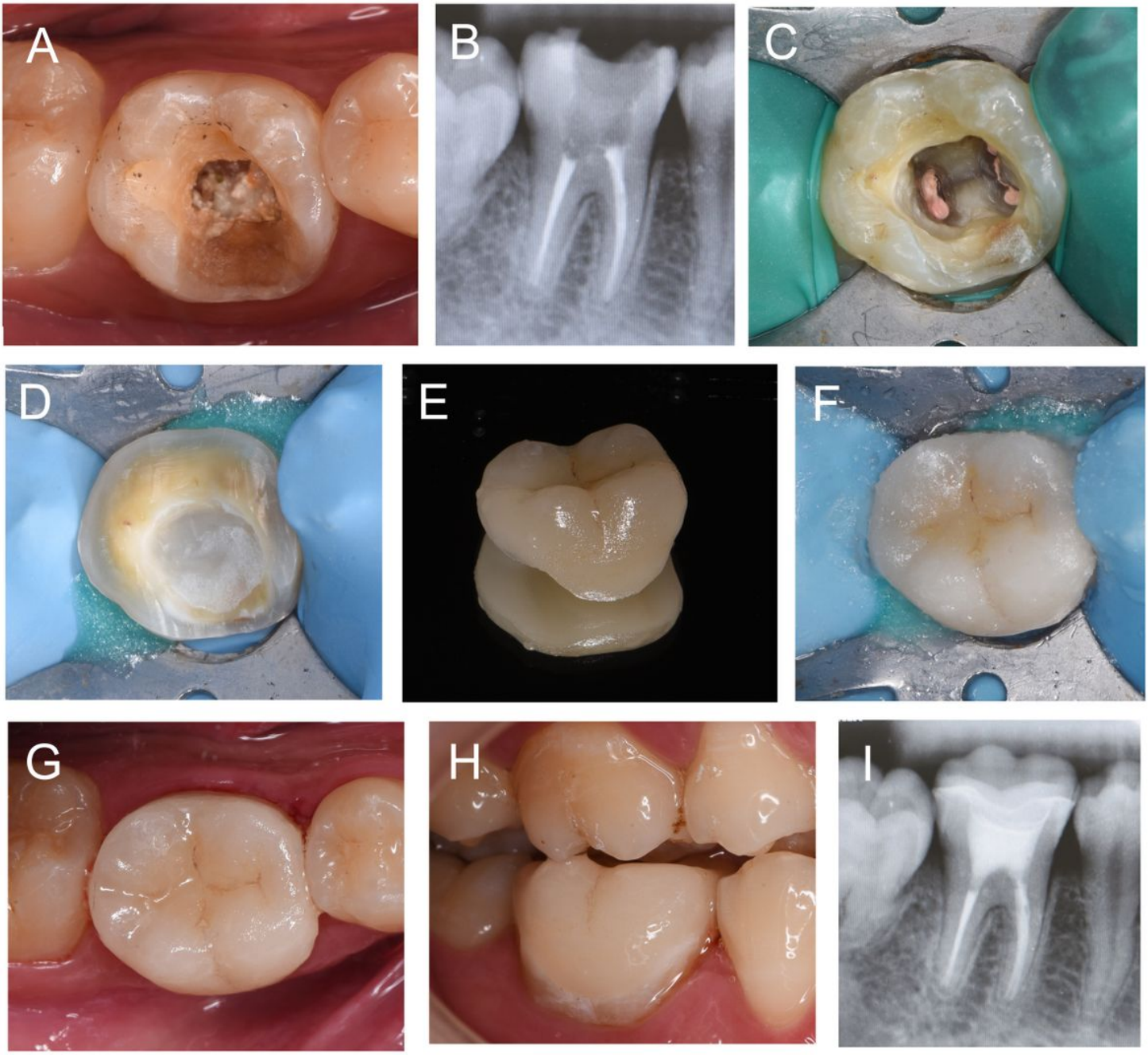

Figure 1

Single-visit coronal indirect restoration of tooth #46 with coronal contamination. A: Pulp chamber exposed to oral cavity for 5 months; B: Radiograph indicated adequate root canal obturation and no periradicular radiolucency before restoration; C: Cleaning the pulp chamber; D: SDR filling and tooth preparation; E: Aspect of the EMAX overlay; F: Adhesion of the restoration; G-H: Completion of coronal restoration; I: Radiograph at the 2-year recall showing normal periapical tissue.

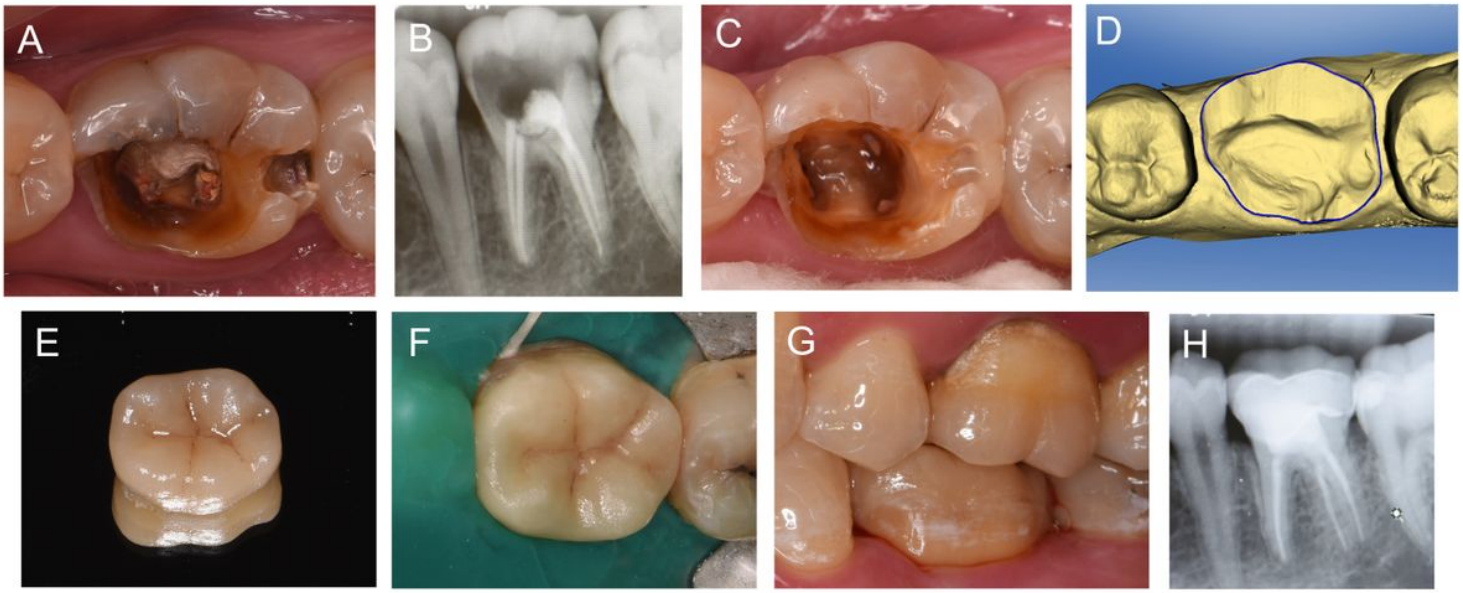

Figure 2

Single-visit coronal indirect restoration of tooth #36 with coronal contamination. A: Pulp chamber and gutta-percha in root canal orifices exposed to the oral cavity and major coronal destruction; B: Preoperative radiograph showing adequate root canal obturation and no periradicular radiolucency; C: Pulp chamber cleaning; D: Scanning and devising by a chairside CAD/CAM technique; E: Aspect of the EMAX overlay; F: Restoration adhesion; G: Recovery of occlusive function; H: Radiograph at the 3-year recall showing a successful outcome.

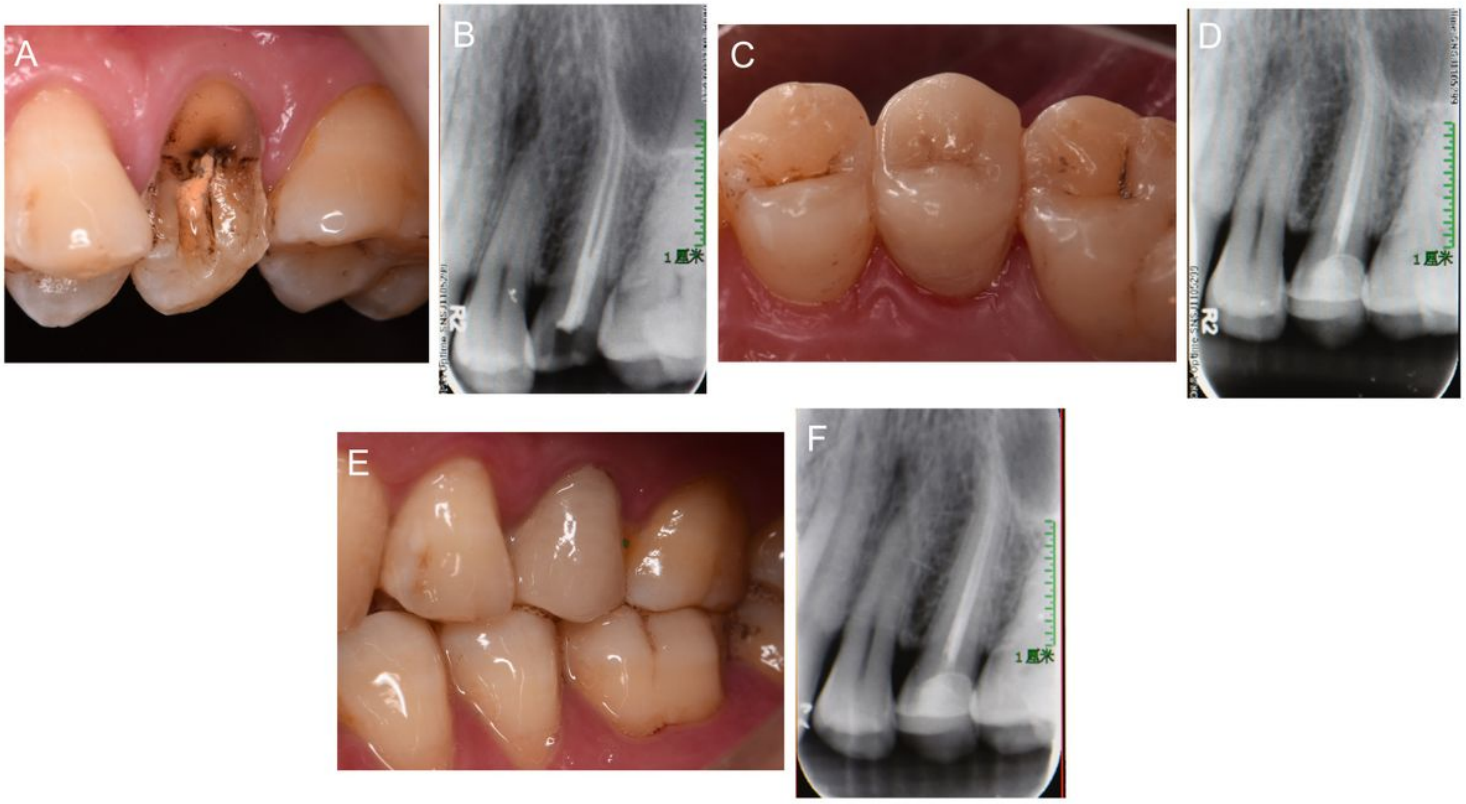

Figure 3

Single-visit coronal coverage restoration of tooth #25 by a chairside CAD/CAM technique. A: Buccal lesion of crown and gutta-percha in root canal orifice exposure; B: Initial radiograph showing adequate root canal treatment; C: Overlay restoration; D: Radiograph after restoration; E and F: Intraoral photograph and X-ray showing a successful outcome of ETT at 3 years after restoration.