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The Role Of Periapical Radiography As A Clinical Guide In The Bypass Procedure Of A Fractured Endodontic File In The Root Canal Of Tooth 22: A Case Report

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Abstract

Instrument fracture is one of the most common procedural complications encountered in endodontic treatment, with an incidence ranging from 0.25% to 10%. A fractured file retained within the root canal may hinder adequate debridement and obturation, thereby significantly affecting the prognosis of treatment. Periapical radiography plays a crucial role as both a diagnostic modality and a clinical guide in the management of such cases. This case report describes the management of a fractured instrument in the root canal of tooth 22 (maxillary left lateral incisor) using a radiographically guided bypass technique. A 36-year-old male patient presented for continuation of root canal treatment on tooth 22; however, during intracanal medicament placement following canal preparation, the lentulo file fractured. Periapical radiographic examination confirmed the presence of a fractured instrument along the root canal accompanied by a periapical radiolucent lesion. A bypass technique was performed under periapical radiographic guidance at every stage of the procedure, including working length determination, instrument position confirmation, and post-obturation evaluation. Post-treatment radiographic assessment demonstrated hermetic obturation with improvement of the periapical radiolucency at the three-month follow-up. This case report emphasizes that periapical radiography serves as the primary clinical guide in bypass procedures for fractured endodontic instruments within the root canal.

Keywords: Periapical Radiograph; Bypass; Fractured File; Root Canal; Tooth 22

INTRODUCTION

Root canal treatment is a procedure in dentistry whose procedure relies heavily on accurate information or visualization of the anatomy of the root canal, the condition of the periapical tissue, and the position of the files within the canal. Periapical radiography has played an important role in the diagnosis process as well as guidance in endodontic care since it was first applied by Edmund Kells in 1899 to determine the length of work of the root canal (Patel et al., 2025). So far, periapical radiography has remained the primary imaging modality used in every stage of root canal treatment, from diagnosis, treatment planning, length of work measurement, to obturature quality evaluation and monitoring of periapical tissue healing, including being used as a guide in case of broken files in the root canal (Jain et al., 2023).

Endodontic instrument fractures are one of the most common procedural complications encountered in the clinical practice of root canal care. Some studies report that the incidence rate of instrument fractures ranges from 0.25% to 10% of all root canal treatment cases performed (Yousuf et al., 2015). Another retrospective study published in the Nigerian Journal of Clinical Practice (2024) of 3,150 endodontic cases found that the overall incidence rate of instrument fractures reached 3.4%, with the majority of cases occurring in the mandibular molars (53.7%) (Assiri et al., 2024). Fractures of endodontic instruments are generally caused by a combination of anatomical and operator factors. Sharp curvature of the root canal, narrow diameter of the canal, repeated use of the instrument, and excessive pressure during preparation are the main factors causing instrument fracture (Castellucci, 2018). In addition, inappropriate preparation techniques also increase the risk of file breakage.

The presence of a fracture in the root canal is a clinically challenging condition. Instrument fragments left in the apical third have a risk of failure of up to 21%, much higher than fragments left

in the middle third or coronal which is only 8.8% (Spili et al., 2005). In handling these cases, dentists are faced with several main management options, namely *retrieval* (removal of fragments), *bypass* (passing through fragments), or *entombment* (retaining fragments and continuing obturation). These clinical decisions are strongly influenced by accurate radiographic information regarding the location, length, and diameter of the fragments, root canal morphology, and the presence or absence of periapical lesions (Torabinejad et al., 2015).

Bypass techniques are one of the relevant *non-surgical* management options, especially when *retrieval efforts* are considered too risky for the strength of the tooth structure. This procedure aims to negotiate a small instrument through the gap between the fracture fragment and the root canal wall so that the actual working length can be achieved and adequate obturation can be performed. The success of bypass techniques is highly dependent on precise radiographic guidance, as each step of the procedure requires visual confirmation of the position of the instrument that can only be obtained through intraoral imaging (Lambrianidis, 2006).

The lateral incisive teeth of the left upper jaw anatomically have a relatively straight root canal although they often show slight to moderate curvature variations in the apical section. This condition makes the tooth an ideal case for *bypass* surgery when a fracture of the root canal occurs, but it still requires accurate radiological guidance. Periapical radiography provides a representative two-dimensional picture of root canal morphology, fracture fragment position, and periapical tissue condition that is the main clinical reference throughout the procedure (Antony et al., 2020). This case report aims to describe the strategic role of periapical radiography as a clinical guide in each stage of the *fracture file bypass* procedure in the lateral incisive root canal of the left upper jaw.

RESEARCH METHODS

This study employed a descriptive case report design to describe the clinical management of a fractured endodontic file in the root canal of tooth 22 using a bypass technique guided by periapical radiography. The treatment was carried out at Soelastri Dental and Oral Hospital, Universitas Muhammadiyah Surakarta. The report focuses on the diagnostic, procedural, and follow-up roles of periapical radiography throughout endodontic treatment.

The subject of this case was a 36-year-old male who presented for continuation of root canal treatment of the maxillary left lateral incisor (tooth 22). Clinical examination revealed a temporary restoration, positive percussion test, negative palpation test, absence of tooth mobility, and normal periodontal pocket depth. During intracanal medication placement with a lentulo spiral, instrument separation occurred within the root canal. Periapical radiographic examination using the bisecting-angle technique confirmed the presence of a fractured instrument extending along the root canal and a periapical radiolucent lesion measuring approximately 2 mm in diameter. These radiographic findings were used to establish the diagnosis and formulate the treatment plan.

Following informed consent, the bypass procedure was performed under local anesthesia with rubber dam isolation. Periapical radiography was used throughout the procedure to determine and confirm the working length, evaluate the location of the fractured instrument, and monitor instrument progression during bypass. Stainless steel K-files (#8 and #10) lubricated with EDTA gel were carefully negotiated past the fractured fragment using a watch-winding motion with repeated irrigation using 2.5% sodium hypochlorite. Canal preparation was subsequently completed using the crown-down technique with stainless steel K-files (#15–30), alternating irrigation with 2.5% sodium hypochlorite, 17% EDTA, and normal saline. Intracanal calcium hydroxide dressing was placed at the end of instrumentation.

At the subsequent visit two weeks later, the patient was asymptomatic and root canal obturation was performed using the lateral condensation technique with gutta-percha and a resin-based sealer. Immediate postoperative periapical radiography was obtained to assess the quality of obturation,

including apical extension, density, homogeneity, and the absence of material extrusion. Permanent restoration was completed with a fiber-reinforced composite post and a jacket crown.

Clinical and radiographic follow-up was performed three months after treatment. Periapical radiographs were acquired using the same bisecting-angle technique, film positioning, and exposure geometry as the preoperative radiographs to ensure standardized comparison. Treatment outcomes were evaluated based on patient-reported symptoms, radiographic quality of the obturation, and changes in the size of the periapical radiolucency. Radiographic evaluation demonstrated a reduction in the diameter of the periapical lesion, indicating favorable healing following radiographically guided bypass treatment.

RESULTS AND DISCUSSION

CASE REPORT

A 36-year-old man came to RSGM Soelastri UMS to continue root canal treatment in the left front teeth. Based on the patient's medical record records, the tooth one week ago had been started for root canal treatment with *open access* and *pulp debridement*. The patient comes back to resume the scheduled treatment with root canal preparation measures. Clinical examination showed the presence of temporary restoration in tooth 22 with a negative probe (-), a positive percussion test (+), a negative palpation test (-), negative mobility (-) and a depth of the periodontal pocket within normal limits in all aspects.

The preparation of the root canal begins with the provision of *informed consent* first, then continues with the operator carrying out *universal precaution* and disinfection of the work area. Infiltration anesthesia on the labial and palatal teeth 22, isolation of the work area using *rubber dams* and temporary opening of the lump until the root canal is visible 22 teeth that will be prepared. The *step back preparation technique* is carried out by the operator in accordance with the working length that has been measured in the previous meeting, which is 22 mm. The root canal preparation process is going well which begins with the preparation of the apical third, the preparation of the root canal body, and finishing. Each file change was recapitulated according to the length of work and irrigation was carried out using 2.5% NaOCl and 2% chlorhexidine rinsed with saline.

The problem then arises when the root canal medification process uses the $Ca(OH)^2$ medicative material applied with the lentulo. The operator applies lentulo into the root canal using *a low speed handpiece* according to the working length of 22 mm. Initially the file can enter and rotate as it should, but in the middle of the process the lentulo begins to stall and get stuck in the apical of the 22nd gear. The depth of application of lentulo in the inappropriate root canal causes the file to get stuck in the apical section. Periapical radiography examination was performed using a bisectarian technique with adjustment of film position, tubular angulation either vertically or horizontally, and focus-object distance to minimize geometric distortion (Nilasary R, *et all.*, 2024). The radiographic image shows the presence of radiopak instrument fragments located along the root canal of tooth 22, accompanied by a periapical radiolucent image surrounding the apexes with a diameter of approximately 2 mm. This condition indicates pulp necrosis with chronic apical periodontitis in 22 teeth that have an intracanal fracture.

Based on the radiographic information, the treatment plan was prepared taking into account the location of the fragment so that it was still possible to carry out *a bypass* procedure. The width of the root canal visualized on the radiograph shows that there is still enough space around the fragment to insert a small instrument. The diagnosis and treatment plan are comprehensively communicated to the patient, including the risks and possible success of the procedure as part of the information that must be conveyed.

GOVERNANCE

The *bypass procedure* begins with the taking of periapical radiography of the bisectic technique to determine the position of the lentulous file left inside the root canal. The results of the preoperative

radiography showed that the file was stuck along the root canal and that there was still a gap between the fragment and the root canal so that a small instrument for *the bypass procedure* could enter. The radiographic results also confirmed that the instrument was located 1 mm from the apek with a working length of 22 mm previously determined with the apex locator (Figure A). Stainless steel instruments numbers 8 and 10 that had previously been given *EDTA gel* as a lubricant were inserted into the root canal slowly in a *watch-winding* motion while performing repeated irrigation using NaOCl 2.5% to dissolve *the smear layer* and organic debris.

The root canal instrumentation was then performed using the *crown-down* technique in stages with stainless steel K-file manual instruments of numbers 15, 20, 25, and 30 respectively at a confirmed working length. Irrigation was carried out alternately between 2.5% NaOCl for antimicrobial effects and 17% EDTA to remove the remaining *layer smear*, interspersed with saline normal irrigation to prevent chemical interactions between the two. Recapitulation with K-file number 10 is performed after each instrument change to maintain the working length and prevent the formation of *ledges* around the fragments. At the end of the instrumentation session, intracanal measurement of calcium hydroxide ($Ca(OH)_2$) is applied into the root canal using K-files.

Figure A. Preoperative periapical radiography – Tooth 22 with fracture file accompanied by periapical lesion

The patient returned at the next visit, two weeks later with reports of significantly improved symptoms. Obturation is carried out using lateral condensation techniques with gutta-percha and resin-based sealers. Post-obturation radiography is immediately taken to evaluate the quality of the filling. The radiographic image showed a dense and homogeneous obturation with an apical boundary of 1 mm from the radiographic apks and no image of extrusion of the filling material into the periapical tissue. Radiolusensis in the periapical of tooth 22 was also found to be widening after obturation with a size of approximately 2-3 mm, especially on the mesial and apical sides, which indicates the presence of chronic apical periodontitis in tooth 22 (Figure B). The treatment after the obturature is the installation *of fiber reinforced composite* pegs and the crown of the jacket as a permanent restoration of the 22 teeth. Patients are scheduled for follow-up control at 3 months post-treatment. At the control visit, periapical radiography of the bisectarian technique was taken using positions and angulations identical to preoperative radiography to allow for valid comparisons. Standardization of photographic positions is important so that changes in the size and density of periapical lesions can be accurately assessed without geometric bias. At the 3-month follow-up, periapical radiolux images showed a significant reduction in diameter to approximately 1 mm compared to preoperative and post-obturation radiographic images, indicating the beginning of a good healing process and the patient did not report any pain or clinical symptoms (Figure C).

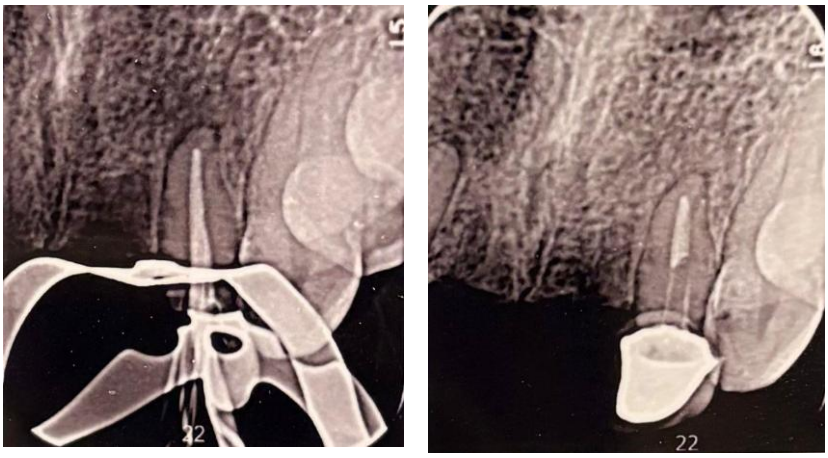

Figure B and Figure C. Post-dental obturation radiography 22 and 3-month follow-up with MJ peg restoration

Discussion

This case illustrates vividly how periapical radiography serves as an irreplaceable clinical guide in every stage of the *fracture file bypass* procedure. The standard imaging technique in endodontic diagnosis and treatment planning is with periapical radiography either with parallel or bisectarian techniques to display the optimal geometry of the examined tooth and at least 3 mm of periapical bone so that apical status can be adequately assessed (Patel et al., 2025). In these cases, periapical radiography provides important information that forms the basis for clinical decisions to guide fracture file retrieval with *bypass techniques*.

The diagnostic function of periapical radiography in this case includes several interrelated aspects. First, preoperative radiography functions to identify and localize instrument fragments precisely, namely determining the location of the fragments, the length of the fragments, and the orientation and angulation of fragments within the root canal. This information is crucial as it determines the most appropriate management approach. Second, radiography plays a role in assessing the overall morphology of the root canal, including estimating the diameter of the canal around the fragment which determines whether there is still enough space for a small bypass instrument to pass through . Third, the radiographic picture allows an assessment of the condition of the periapical tissue, namely the presence or absence of radiolucent lesions, the area involved, and the integrity of the lamina dura (Gudac et al., 2021). In this case, a picture of a periapical radiolusce about 2 mm in diameter identified on preoperative radiographs confirms the presence of chronic apical periodontitis that requires definitive treatment through debridement and complete root canal disinfection.

The decision to choose bypass technique in this case was based on several radiographic parameters identified on the preoperative picture. The location of the fragments in the middle third is a better prognosis indicator than the apical third. Fragments of the instrument located in the apical third make it difficult to eliminate the infection

comprehensively, so that the choice of management strategy must consider the location of fragments in a measured manner (Chai et al., 2024). As for the case of tooth 22, the fragment is located along the apical with a relatively straight channel morphology, so the chances of bypass success are greater.

In addition to the preoperative diagnostic function, periapical radiography also plays an important role in determining the working length of the root canal in cases that have complications of fracture files. Although *electronic apex locators* have now become standard in determining working lengths, the presence of metal fragments within the root channel could potentially cause interference to electrometric readings so that the accuracy of this tool may be compromised. In such conditions, confirmation using periapical radiography is an absolute thing to do to ensure the accuracy of the length of work. A study in the International Journal of Dentistry states that the accuracy of periapical

radiography in endodontic evaluation reaches a high level when the imaging technique is performed correctly using the correct film position and the correct angle of exposure (Radeva et al. 2018). In this case, the combination of *apex locator* and radiography for confirmation of the length of work provides complementary data. The 22 mm long working length obtained from the *apex locator* is confirmed radiographically by indicating the position of the instrument 1 mm from the radiographic apex, so that the risk *of underfilling* and *overfilling* can be minimized.

There are two non-surgical approaches to the management of fracture instruments in the root canal, namely *fragment retrieval* and *bypass*. In these cases, *the bypass* was chosen because the *retrieval* attempt on the narrow root canal risks causing excessive loss of dentin substance so as to increase the risk of vertical root fractures. Periapical radiography is a preoperative guide to see the position of the fracture file in the root canal and predict the position of the insertion of *the bypass* instrument through the gap drawn on the radiograph. Ideally, any movement of the instrument during the *bypass* procedure is also confirmed with periapical radiography to ensure that the instrumentation is running on the correct path without causing perforations or *ledges* (Aminshobani et al., 2024). Clinical decision-making in fracture instrument management should always be supported by a comprehensive radiographic assessment at every stage of the procedure. However, radiographic confirmation also does not have to be done at every stage of *the bypass procedure* to minimize radiation exposure according to the ALADAIP principle, improve treatment efficiency, and because the progress of the instrument can be monitored through tactile response and measurement of working length (AAE, 2020).

The function of periapical radiography in the evaluation of obturation quality is an aspect that is no less important than the function of intraoperative diagnostics and guidance. Post-obturation radiography functions as an objective verification tool for three root canal filling quality parameters: (1) obturation length, which ensures that the filling reaches 0.5 - 1 mm from the radiography apecs as an ideal limit that minimizes the risk of periapical failure; (2) obturation density, which assesses the homogeneity of the filling material without the presence of voids or empty spaces that can be a place for colonization of residual bacteria; and (3) the lateral contour of obturation, which ensures that there is no extrusion of material into the periapical tissue that can trigger an inflammatory response (Parolia et al., 2025). In this case, the post-obturation radiographic image showed that the three parameters were adequately met, namely the result of a solid and homogeneous obturation with an apical limit of 1 mm from the radiographic apecs without an extrusion image. Good obturation quality, which can only be definitively assessed through radiography, is one of the strongest predictors of the success of endodontic treatment (Siqueira & Rôças, 2022).

The results of radiographic evaluation at the three-month control showed an improvement in the periapical radiolucent image previously detected in preoperative and post-obturation photographs. These findings indicate a positive healing process of periapical tissue. This condition is consistent with literature reports stating that successful *bypass* accompanied by adequate obturation can result in periapical healing comparable to cases without complications of fracture files, especially when debridement and root canal disinfection can be performed thoroughly through the existing fragment (Yadav et al., 2022).

The function of periapical radiography in healing monitoring has a very strategic role and cannot be replaced by clinical examination alone. Methodologically, standardization of photographic techniques at follow-up should use the same techniques of controlling the same film position, identical X-ray tube angulation, uniform patient head position, and identical focus-object distances to minimize geometric distortion thus allowing for valid comparisons between preoperative, post-obtural, and follow-up images. Changes in periapical lesion dimensions assessed by periapical radiography are clinically recognized objective indicators of healing. The success rate of fracture instrument management including *bypass* and *retrieval* can be assessed prognostically using radiographic parameters in the form of periapical lesion resolution.

In this case, the reduction in periapical radiolus lesion diameter observed at the 3-month control was an encouraging early signal of healing and was consistent with the postoperative prognosis. Thus, periapical radiography serves not only as a diagnostic tool and procedural guide, but also as an instrument for evaluating treatment outcomes that are objective, accurate and evidence-based (Plotino et al., 2024).

CONCLUSION

This case report shows that periapical radiography serves as a fundamental clinical guide in the procedure of *bypass* fracture files in the root canal of teeth 22. Preoperative periapical radiography assessment provides critical information regarding fragment location, root canal morphology, and periapical status on which to make informed clinical decisions. Post-obturation radiographic confirmation is carried out to ensure the success of *the bypass* technique with hermetic filling quality. Radiographic evaluation at 3-month follow-up showed progressive healing of periapical lesions. Bypass technique guided by periapical radiography has proven to be an effective and safe management option for cases of fractures in the root canal with periapical lesions.

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