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The Platformless Technique (PFLT): A Minimally Invasive Technique for Removing Separated Instruments: Case Report Study

Alexandru Gliga[1,2], Carlo Gaeta[2], Giovanni Salvati[2*], Federico Foschi[3], Adriano Azaripour[4], Simone Grandini[2], Cezar Tiberiu Diaconu[5], Ion Alexandru Popovici[6*], Marina Imre[7]

[1]Department of Operative Dentistry, Faculty of Dental Medicine, "Carol Davila" University of Medicine and Pharmacy, 050474 Bucharest, Romania

[2]Unit of Endodontics and Restorative Dentistry, Department of Medical Biotechnologies, University of Siena, Siena, Italy

[3]Department of Restorative Dentistry, Unit of Endodontology, UCL Eastman Dental Institute, University College London, London, UK

[4]Department of Oral and Maxillofacial Surgery, Plastic Surgery, University Medical Centre of the Johannes Gutenberg-University Mainz, Mainz, Germany

[5]Faculty of Dental Medicine, Department of Endodontics, University of Medicine and Pharmacy of Craiova, 200349 Craiova, Romania

[6]Department of Implant Prosthetic Therapy, Faculty of Dentistry, Carol Davila University of Medicine and Pharmacy, 17-23 Plevnei, 010221 Bucharest, Romania

[7]Department of Complete Denture, Faculty of Dental Medicine, "Carol Davila" University of Medicine and Pharmacy, 020021 Bucharest, Romania

***Corresponding authors**: Giovanni Salvati, Unit of Endodontics and Restorative Dentistry, Department of Medical Biotechnologies, University of Siena, Siena, Italy

Ion Alexandru Popovici, Department of Implant Prosthetic Therapy, Faculty of Dentistry, Carol Davila University of Medicine and Pharmacy, 17-23 Plevnei, 010221 Bucharest, Romania

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Abstract

This report validates a novel, minimally invasive, platformless technique (PFLT) for removing separated files from root canals. Managing separated files remains a challenge for dental practitioners due to the high risk of iatrogenic errors, such as perforation or root damage. Various techniques and devices have been developed, yet many lack precision and safety. Three clinical cases are presented, showcasing long-term follow-ups (2–5 years) with imaging that confirms complete periapical healing and symptom-free outcomes. The PFLT technique involves using a pre-bent ultrasonic file under a dental operating microscope to bypass and remove the fragment without creating a platform. Continuous irrigation with sodium hypochlorite (NaOCl) and ethylenediaminetetraacetic acid (EDTA) facilitates debris removal and lubrication. For fragments in the middle or apical third, pre-flaring with a shaping file may be required to expose the fragment. Guidance tools like cone-beam computed tomography (CBCT) and apex locators further enhance safety and precision, minimizing iatrogenic risks. This approach prioritizes tissue conservation and adapts to root canal anatomy, ensuring a high degree of precision. The successful outcomes from these cases highlight the technique's predictability when performed by a skilled endodontic specialist. The PFLT technique offers a transformative approach to fractured instrument management, promoting minimally invasive and conservative treatments with long-term success. Further research is needed to validate its effectiveness across diverse clinical scenarios and operator experience levels.

Keywords: Files; Fractured; Instruments; Removal; Retrieval; Ultrasonics.

Introduction

The removal of fractured instruments (FI) has always been one of the main endodontic complications [1,2]. Iatrogenic damage is around the corner in the attempt to remove FI (false paths, perforations, further fractures of instruments, excessive weakening of the root structure, etc.), hence the subject is often a matter of debate. Conditions such as limited experience of the operator, mischoice and misuse of endodontic instruments, narrow understanding of case complexity, deficient treatment planning and lack of focus are frequent circumstances leading to intracanal instrument separation. The presence of a FI oftentimes blocks the root canal system impeding the shaping and cleaning objective, threatening consequently the outcome [1,3,4]. Over the years different techniques have been developed offering clinicians predictable solutions more focused on the removal purpose rather than on intrusiveness [5,6]. Creating a straight access and a platform to expose the FI can be risky or impossible when considering the endodontic anatomy [7]. The need for an increasingly conservative approach generated a new technique described in this publication. The authors named this approach as "The Platformless Technique "and three cases were selected for this article, offering imaging follow-up (from 2 to 5 years), stability over time hence confirming the predictability of this management even in difficult clinical situations.

Materials & Methods

The concept behind this procedure is to reduce the removal of healthy dentin by eliminating the platform stage. The "Platformless Technique" protocol for removing separated instruments from within the root canal space is described as follows. The use of a microscope is mandatory to perform this minimally invasive management correctly, while avoiding the risk of iatrogenic circumstances [8,9]. The technique consists in creating a bypass using a stainless-steel ultrasonic file after using a final shaping mechanical file to reveal the separated fragment, thus avoiding creating a platform using Cutting Burs, Gates Glidden or modified Gates Glidden drills as it is described in other techniques that have been widely used [10]. The approach varies depending on the position of the instrument in relation to the canal anatomy.

If the file is located coronally and there is no need to expose the fragment, an ultrasonic K-file 15 ISO (U-file) (Mani, Japan) is used directly to bypass the instrument using an ultrasonic device on endodontic module with the lowest intensity first. The stainless steel U-file should be pre-bended and inserted in the correct position and angle inside the root canal, following the inner curvature or the free available canal space, so that, by activating the ultrasonic movement, it slowly engages in between the separated instrument and the canal wall without creating iatrogenic errors (it is important to underline that a ledge/perforation can be created if the bypass is performed on the outer wall of the canal). If the angulation and curvature of the root canal cannot be predicted by imaging means (periapical X-ray/CBCT), and microscopic clinical details of anatomic landmarks are not visible, the use of an apex locator (VDW Gold; VDW GmbH, München, Germany) connected to the bypassing U-file is encouraged to be used to avoid perforations and unnecessary stripping. The ultrasonic advancement of the U-file between the root canal wall and the separated instrument will be performed progressively. Respecting the tactile feedback is very important so that the U-file does not advance more than 2 mm at once. The clinician should constantly adjust the pre-bended form of the U-file to respect the canal morphology, removing a minimal amount of dentine during the by-passing process. To avoid secondary file separation, the ultrasonic intensity should be increased with caution, moreover a constant irrigation with

sodium hypochlorite (NaClO 3-5%) (Cerkamed Company, Stalowa Wola, Poland) is mandatory for evacuating the debris and cooling down the instruments together with ensuring the endodontic disinfection. Ethylenediaminetetraacetic acid (EDTA 17%) (Cerkamed Company, Stalowa Wola, Poland) solution is recommended to be used as an irrigant during the removal process of the broken instruments. EDTA is specific for smear layer removal and lubrication. After the complete bypass of the instrument EDTA solution is placed inside the root canal (a stopper can be used to measure the position of the U-file inside the root canal). Secondly, in and out movements will be carried out with the U-file, brushing the separated instrument in its entire length, gradually increasing the power of the ultrasonic device until the releasing of the fragment.

If the instrument is in the middle or apical third, it needs to be revealed to increase visibility, control and prediction over the procedure. No platform is necessary to expose the fractured instrument. A simple pre-flaring technique is used for the enlargement of the endodontic space to the FI. For this procedure it is sufficient to use a final shaper such as an 0.6 taper ISO 25 mechanical file (Reciproc; VDW, Munich, Germany) to preflare the canal and detect the separated instrument. When reaching the separated instrument with the pre-flaring file, the instrument might stop advancing or might start bypassing, case in which clinicians should immediately remove the pre-flaring instrument from inside the root canal. If the mechanical file used for initial enlargement engages in between the fractured file and the canal wall, the clinician feels resistance in the file movement and hears a metallic sound. Consequently, the pre-flaring step is over, abundant irrigation is recommended to remove the debris and expose the fragment. The following stage is the ultrasonic bypassing that should be performed as previously described.

If the instrument cannot be exposed to a magnified view after initial pre-flaring (06 taper, ISO 25) (Reciproc; VDW, Munich, Germany), increasing the taper and the ISO size of the enlargement instrument can be considered. Tactile feedback and experience enable a skilled clinician to remove separated instruments even without visual identification. A direct bypass procedure using U-files can be performed with a pre-operative CBCT scan for anatomical guidance and an apex locator attached to the U-file to reduce the risk of improper scouting [11].

During the operational phases, a Zumax microscope with beam splitter and a camera adapter for Sony Full frame A7 body were used. The videos, made for archive purposes and with the consent of the individual patients, were captured through the camera, taking advantage of the microscope's magnification of 0.3 steps to access the cavity, step 0.8 and 1.2 for exposing, bypassing and removing files.

Cases presentation

Case 1

A-52-year-old female patient was referred to the endodontic office for evaluation of a mandibular left second molar. The patient was in good general health with no significant past or present illness. No comorbidities or genetic information were reported. The family and psychosocial history had no relevance in the development of treatment plan and in the application of the technique. The tooth tenderness to percussion and the periapical imaging investigation led to a diagnosis of symptomatic apical periodontitis (SAP). The two-dimensional radiograph showed the presence of a dental crown coverage, a screwed metal post inside the distal canal. A fractured instrument was visible in the middle/apical third portion of the mesial root canal surpassing the curvature level. A large apical lesion involved both root apices and the intra-radicular tract. After the removal of the prosthetic crown, the first step was to remove the metal post from the distal root. Once the cavity was cleaned, a 25/0.6 instrument (Reciproc; VDW, Munich, Germany) was used to reveal the fragment (mesiobuccal canal). The bypass procedure was guided towards the internal curvature of the root canal. Abundant irrigation assisted the insertion of the UF (15 ISO) among the root canal wall and the FI, dislocating the separated instrument and removing it (see images below). There were no complications during the file removal. The shaping was completed, the root canal system sealed and the restoration reinforced with a fiber post placed in the distal canal. The crown coverage was carried out by the referral dentist. After 3 years, a new two-dimensional radiograph showed that the lesion had undergone complete healing (Figure 1).

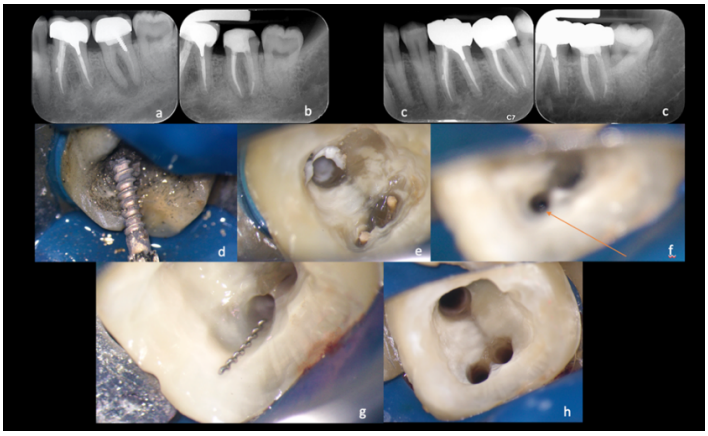

Figure 1: a) Pre-operative x-ray; b) Post-operative x-ray; c) 3-year follow-up (mesial/distal view); d) Metal post removal; e) Post space view; f) Mesial fractured instrument; g) Broken instrument removal; h) Cavity before obturation (the two mesial orifices are observable, there are no significant differences in tissue involvement between the two canal entrances).

Case 2

A 20-year-old male patient presented to the endodontic specialist's office for evaluation of his left mandibular first molar. The patient accused pain of biting associated to tooth 36 and had no relevant systemic conditions. No comorbidities or genetic information were reported. The family and psychosocial history had no relevance in the development of treatment plan and in the application of the technique. The tooth had no coronal seal and the x-ray forecasted three different FIs inside the mesial root and at least one in the distal. Apical radiolucency can be observed on both roots. The various sizes and types of instruments were located in three different sections of the root canal system, fostering different challenges in their approach. Cavity cleaning also allowed the clinician to visualize the fragments, allowing minimally invasive management. The fragments were removed following the PFLT protocol and despite the number it was possible to carry out the procedure safely and without unexpected events. Shaping, cleaning and sealing were conducted highlighting secondary anatomies in some areas. After 5 years, the lesion had completely gone into remission (Figures 2&3).

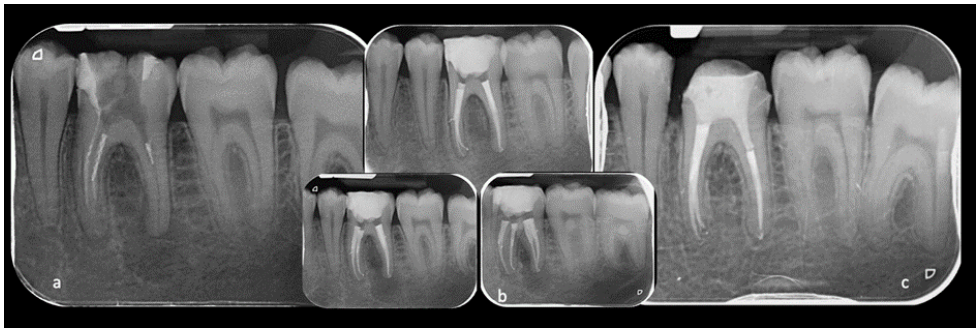

Figure 2: a) Pre-operative x-ray; b) Post-operative x-ray (mesial and distal shifts highlighting conserved root anatomy); c) 5-year follow-up.

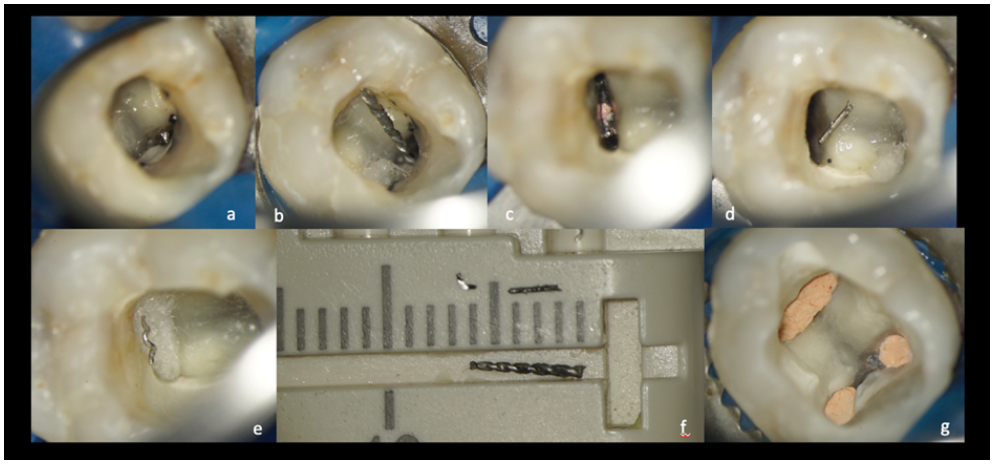

Figure 3: a) and c) Fractured instruments inside the root canal space captured with the operating microscope; b), d) and e) Removal of fragments (protection of accessible root canals with cotton pellets); f) Checking broken instruments removed with ruler; g) Cavity after obturation (the conservative orifices are also observable in this case).

Case 3

A 43-year-old female patient, with no relevant systemic conditions, was referred to the endodontic office after a failed classic procedure intent of file removal. The patient reported pain while biting, and a large periapical lesion involving both root apices was observed, leading to a diagnosis of SAP. No comorbidities or genetic information were reported. The family and psychosocial history had no relevance in the development of treatment plan and in the application of the technique. On the two-dimensional x-ray the tooth appeared mesioverted, with a fractured instrument inside the mesial root, surpassing the curvature area. After cleaning the pulp chamber, no pre-flaring was performed since the referral dentist's failed intent was carried out using a platform stage with excessive healthy dentine sacrificed already. The instrument was directly removed using U-Files. Although a favourable outcome, unnecessary pericervical tissue was removed prior to the "Platformless" approach and no complications or adverse conditions had to be reported. Fiber post was placed in the distal canal and post-endodontic restauration was performed. After 2 years, a complete healing of the periapical lesion can be noted (Figure 4).

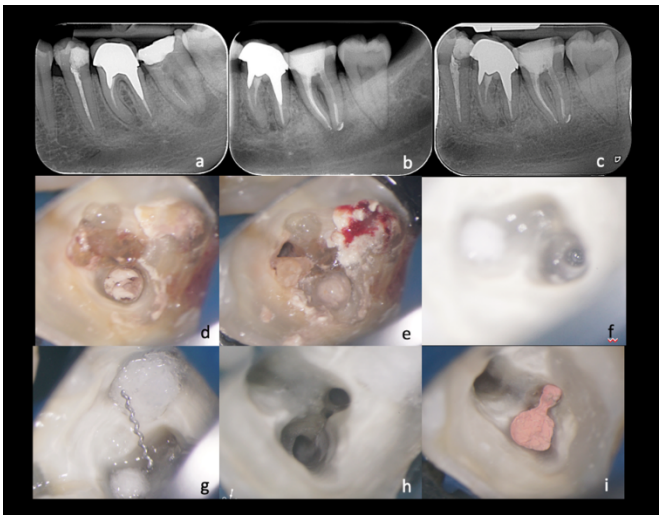

Figure 4: a) Pre-operative x-ray; b) Post-operative x-ray); c) 2-year follow-up; d) and e) Pulp chamber before retreatment; f) Fractured instrument inside the mesio-bucccal canal (visible under magnification); g) Removal of the fractured instrument; h) Cavity before obturation (the compromise of the orifice is not minimal due to an invasive initial management); i) Obturation of the mesial canals.

Results

In all three cases shown, the symptoms disappeared immediately after treatment, allowing the patients to regain chewing function. The immediate resolution and long-term stability of the works produced positive feedback from patients and satisfaction in having been treated with the use of a conservative and minimally invasive technique.

Discussion

Within the evaluation of an endodontic retreatment, the presence of a fractured instrument plays a fundamental role in the prognostic outcome [1,3,4]. The presence of a fractured instrument significantly reduces the treatment success rate [11,12,13]. This in fact represents a variable of considerable importance, with an outcome that varies depending on the anatomical characteristics of the tooth involved [14,15], the position and size of the fractured instrument, the equipment available and the operator's skills [5,9]. In the therapeutic approach, the fundamental aspect is to save as much healthy dentine as possible, without leading to excessive weakening of the tooth, which could lead to intraoperative damage or an increase in the long-term fracture index [1,6,16]. Over time, different removal techniques have been used, with different success rates [6,17]. Disregarding surgical management, the technique described in this study aims to be compared to other orthograde mechanical removal techniques. The underlying idea is to try to preserve the original endodontic anatomy, maintaining a tailored and conservative root canal shaping as performed in primary endodontic treatments. For this reason, the technique described does not make use of any removal of healthy tissue all around the coronal portion of the FI, therefore there no platform is created. The creation of a platform around the coronal segment of FI facilitates removal. However, when comparing to an 0.4 or 0.6 tapered shaping (enough for efficient irrigation) [6,8], the unnecessary trespassing becomes conspicuous. The 360° platform is generally performed with trephine burs with a cutting head tube from 0.7-2.4 mm to expose coronal portion of the structure (REF), with a big amount of sacrificed dental structure to allow the positioning of an extractor for grabbing the FI. In many clinical situations this technique is excessively invasive, increasing the risks for iatrogenic events, menacing the outcome [17]. Moreover, comparing the "Platformless technique" with other ultrasonic techniques described in literature [18-20] for example Endo Plus System (Endo Technic), ET25 (Setelec Corp) or TFRK-S (DELabs) etc., the use of a pre-bendable stainless-steel ultrasonic K-file 15 ISO proves more conservative. It should be emphasized that in cases where the instrument is in the middle or apical third of the root, a light removal of tissue might be needed. However, when this occurs through a conservative pre-flaring procedure with final shaping files such as 25/0.4 or 25/0.6 (ISO) and not with Gates Glidden or Modified Gates Glidden burs, the retained fragment is reached and exposed with no unwanted healthy tissue removal. The main advantage of this technique is indeed the reduced amount of healthy dentine loss, lowering the tooth weakening effect. As shown in the proposed radiographs, the alteration of the canal anatomy is minimal and if only the post-operative radiographs were

to be considered, it would be difficult to highlight the presence of a retained file inside the canal lumen prior the retreatment [21-23]. It is fair to say that the main limitation of this technique is not in the operational sequence, but in the requirement for training and patience, therefore, given its learning curve, it is mainly aimed at endodontists who have experience with microscope workflows and time management, therefore not making it the mastery of beginners and general practitioners. Advancing apically along the fragment using the inner curvature or the free canal space when available, constantly adjusting the ultrasound power and gradually pre-bending the tip of the U-File, remains exclusive to the clinician expertise, that always makes the difference.

Conclusion

In conclusion, the developing of this new technique may give clinicians a new perspective on how to improve clinical skills and provide a patient centered approach that ensures predictability and minimal invasiveness.

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Ethical Guidelines: A statement of informed consent was submitted to each individual patient and only after approval was it decided to intervene by applying this new technique.

Conflict of Interest: The authors have stated explicitly that there are no conflicts of interest in connection with this article.

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