Evaluation of sensitivity, specificity and accuracy of conventional radiography, digital radiography and CBCT in detection of fractured endodontic instruments: an in vitro study

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بسم الله الرحمن الرحيم

قَالُواْ سُبْحَانَكَ لاَ عِلْمَ لَنَا إِلاَّ مَا عَلَّمْتَنَا إِنَّكَ أَنتَ الْعَلِيمُ الْحَكِيمُ

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Dedication

I would like to dedicate my thesis to my family who helped me a lot and without them I couldn't have
Achieved anything.

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Intracanal fracture of endodontic instruments is considered to be an unfortunate incidence which may complicate and compromise the outcome of endodontic treatment. These complications may occur especially if adequate cleaning and shaping and/or proper sealing cannot be achieved.[1] This unfortunate accident may take place during all stages of treatment and affect the prognosis of the tooth, especially if the separated part is located in the apical third of root canal.[2] In addition, decreased strength of the root and an increased risk of perforation during attempts of fragment removal or a bypass may be encountered.

The effect of a retained fractured endodontic instrument on the outcome of endodontic treatment is controversial. Early studies reported that the retained fragment reduces healing, particularly in the presence of a preexisting periapical radiolucency and others stated that it had no influence on healing. further studies suggested that in most cases the retained fractured instrument can be incorporated into the final root canal filling if they are not hindering a proper disinfection of the canal.[3]

The conflict of opinion regarding the clinical significance of retained fractured instruments makes the preoperative detection of these retained separated instruments crucial for a rational decision-making process regarding the treatment. So, Careful assessment of the root canal system based on high quality radiography is of utmost importance.

Conventional periapical (PA) radiographs have always been the most common used modality in endodontic practice for several past years. In addition, digital PA radiography added several advantages;

lower radiation dose, less time-consuming nature, the ability to process, modify, save and transfer the images and elimination of developing procedures.[4]

Nowadays, Cone-beam computed tomographic (CBCT) imaging has been proven to be better than periapical radiographs in detecting external root resorption, root perforation, overcoming the anatomical overlapping of structures, allowing an accurate assessment of dental morphology and the diagnosis of endodontic complications.[5] Cone-beam computed tomographic (CBCT) is also assumed to be better than periapical radiographs in detecting the location of fractured instruments accurately by providing a 3-dimensional evaluation of the location and morphology of the fractured instrument inside the root canal .Nevertheless, (CBCT) imaging could produce artifacts arising from metallic objects or root filling material, which may lead to misinterpretation and misdiagnosis.[5,6]

Studies showed different results upon comparing CBCT imaging, conventional and periapical radiography in the diagnosis of fractured instruments. So, further investigation regarding the best imaging modalities for such cases is required, especially in multiradicular teeth.[1]Therefore, conducting a study to compare the sensitivity, specificity and accuracy of conventional radiography, digital radiography and CBCT in detection of fractured endodontic instruments was thought to be of value.

1. Problem of Separated instruments in endodontics

Endodontic instruments whether made from stainless steel or Ni Ti; might separate during root canal treatment. This may occur during all stages of the endodontic treatment because of a lack of experience of the clinician, improper use of the instruments, inherent microcracks in new instruments, and curved or calcified canals.[7–10] The retained fragment may affect endodontic treatment prognosis if it compromises the achievement of the treatment goals by preventing adequate canal preparation, disinfection, or obturation.[1]

Iqbal et al [11] investigated the incidence of hand and rotary instrument separation in the endodontics graduate program at the University of Pennsylvania between 2000 and 2004. In 4,865 endodontic resident cases the incidence of hand and rotary instrument separation was 0.25% and 1.68%, respectively. Rotary instrument separation were seven times more than for hand instrument separation. The probability of separating a file in apical third was higher compared to coronal and middle thirds of the canals. The highest percentage of instrument separation occurred in mandibular (55.5%) and maxillary (33.3%) molars. Instrument separation incidence in molars was 2.9 times greater than premolars.

Tzanetakis et al [12] conducted a retrospective study to investigate the prevalence of instrument fracture during root canal preparation by postgraduate students. The dental notes of 1367 patients treated by postgraduate students in a given period of time were gathered. Regarding

Tooth type, canal type, length, presence and level of fractured segments inside the canal, and management that followed. They concluded that the overall prevalence of instrument fracture during root canal preparation by postgraduate students was relatively low (1.83%). The prevalence of stainless-steel hand instrument fracture by postgraduate students were less frequent compared to rotary nickel-titanium. The prevalence of instruments fractured in the apical third was significantly higher than coronal and middle thirds of the canals.

Parashos and Messer [8] clarified factors affecting intracanal instrument separation as factors related to the instrument including its alloy type , design and manufacturing process, factors related to the clinician including his experience, technique, adherence to instrumentation dynamics (torque speed), and additional factors such as canal configuration which was considered as a major contributing factor to instrument separation.

Wu et al [13] identified the influential factors responsible for clinical instrument separation of reused NiTi rotary instruments. NiTi files were used to prepare 2654 teeth in endodontic clinics. Data about size of fractured instrument, the length and location of a broken segment within the root canal, and the curvature of canal were all gathered. They concluded that incidence of separation in molars were significantly higher ($P < .05$) than those in premolars or anterior teeth. Tooth type, rotary file size, canal location, and anatomy are all factors influencing the instrument separation of reused NiTi files.

McGuigan [14] analyzed the literature assessing the impact of endodontic instrument fracture on the treatment outcome. Within the confines of the literature it appeared that intracanal fractured instruments did not affect