THE RELATIONSHIP OF APICAL OBTURATION LEVEL TO THE ANATOMIC Apex

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The position of the root canal filling materials at the root apex was studied using intact mandibular teeth of a cadaver. Teeth were divided into two groups. Each group received routine root canal therapy. The root canal filling materials were placed at the radiographic apex in one group, and at 0.5 to 2 mm short of radiographic apex in the other group. The position of the gutta percha at the root apex was checked radiographically and microscopically. Results showed an extrusion of the filling material out of the canal when placed at the radiographic apex. Placing the filling materials 1.0 to 1.5 mm short of radiographic apex showed an acceptable position microscopically.

Introduction

The structure of the root apex and the apical foramen have been studied by several investigators.1-4 The displacement or deviation of the apical foramina from the anatomic root apex has been reported. This deviation was found to be a common finding. It ranged from 0.3 mm to 2 mm.1,4 In addition, the position of the apical constriction can be changed by the deposition of secondary cementum and external root resorption. Knowing this will allow the operator to avoid overinstrumentation or overfilling which will cause trauma to the periodontium and the surrounding tissues. Furthermore, the prognosis of the root canal therapy will be affected.7-10

The placement of the endodontic instruments or filling materials has always been recommended to be limited to the dentino-cemental junction.
Radiograph is always used to detect the position of the root canal instrument and filling material but it can not detect the position of the apical constriction.

The purpose of the present investigation is to study the position of the root filling materials at the apical third of the root using the clearing technique. Results will be correlated to clinical practice.

Materials and Methods

Two mandibles selected from the human cadaver obtained from the Anatomy Department of King Saud University College of Medicine were used for this study. The anatomy of the root canal was examined using periapical radiograph. Teeth with pulp calcification or root resorption were eliminated.

A total of ten intact teeth with twenty canals were selected and divided into two groups. An access opening was established and the working length was determined. The file tip was placed at the radiographic apex in one group (five canals) and in the other group. The file tip was placed at 0.5 - 2 mm short of the radiographic apex in the other group (fifteen canals). Serial instrumentation of the root canal was done up to the fourth file size (the master apical file). Irrigation, using 1% sodium hypochlorite, was used during instrumentation. The canals were dried with paper points and filled with gutta percha and AH26 sealer cement. Radiograph was taken after completion of the root canal filling. The teeth were extracted by grinding the buccal and lingual plate of the alveolar bone.

The extracted teeth were radiographed then stored in sodium hypochlorite solution to remove the periodontal tissue. All teeth were washed in running tap water for two hours. The teeth were decalcified for three days in 5% nitric acid at room temperature. The nitric acid solution was changed daily and agitated by hand. After decalcification, the teeth were rinsed in running tap water for four hours, dehydrated in series of ethyl alcohol, rinsed then placed in methyl salicylate for two hours. The root apices of the transparent teeth were examined with a dissecting microscope (Wild photo micro-scope). Colored slide photographs of the root apex were taken using the camera attached on the microscope.

Results

The microscopic examination showed an extrusion of the gutta percha filling when placed at the radiographic apex [Figs 1a and b]. The level of the extruded gutta percha was more than what was seen radiographically. When the filling material was placed short of the radiographic apex, the level of the gutta percha was shown to be slightly more when viewed microscopically than what was seen radiographically [Figs. 1a and c]. Placing the filling materials 1.0 to 1.5 mm short of radiographic apex showed an acceptable position microscopically.

Figure 1a. Periapical radiograph of two treated teeth. The second premolar shows flush filling at radiographic apex. The mesial root of the first molar shows a root canal filling 1.0 mm short of the radiographic apex. Note the location of the filling material at the mesial side of the root apex.
The clinical significance of the apical foramen in endodontics is its function as a terminal boundary for the root canal filling. The prognosis of the root canal therapy is mainly concerned with the root apex and the surrounding tissue. Thus, the anatomical knowledge of the root canal apex is required for the practicing endodontist. Kuttler reported that up to 80% of the roots examined showed deviation of foramina from the apex. Burch and Hulen reported 92% deviation of foramina from the root apex. The deviation ranged up to 2 mm. The apical foramina may make a U-turn before opening on the root surface. The radiographic film can not normally demonstrate this. The thickness of the apical cementum is more than 0.5 mm in patients 18 to 25 years old. The thickness is usually increased in older patients. In addition, Kuttler reported that there is a 0.5 mm thin layer of cementum often overlapped the dentin covering the internal ends of the dentin at the apical constriction area before the apical foramen.

Mandible of human cadaver was used to simu-
late the clinical picture. According to Voorde and Bjorndahl, measurements based on radiographs are usually longer than the actual tooth. This was clearly observed in this study when the filling materials was placed to the whole radiographic length of the tooth. Radiographic appearance of the filling materials placed at the radiographic apex (flush) was out in fact. This class of root canal filling failed most frequently. Efrausquin et al microscopically examined the apical area of the rat teeth with root canal overfilling using different filling materials. Tissue changes including necrosis of the periodontal ligament, chronic inflammation and hard tissue resorption were reported. Similar observation was reported by Seltzer et al. According to Kuttler when overfilling is avoided, cementum is more likely to be deposited over the filling materials at the apex that will lead to obliteration of the terminal 0.3 mm of the root canal. Healing of the lesion occurred when the root canal was prepared and filled at 1.0 mm short of the radiographic apex. A variable thickness of deposited cementum was observed when the root apex was examined by a fluorescent dye.

Langeland demonstrated histologically the anatomical changes that occur at the root canal and the root apex under physiologic and pathologic conditions. This was avoided in this study by using an intact tooth. The thickness of the cementum and the position of the cemento-dentinal junction were not determined because a histological sectioning was not done. However, the radiographic and microscopic observation of the filling materials together with the observation of Kuttler, Voorde and Bjorndahl and Fouad leads to the conclusion that cleaning and filling the root canal at 1.0 to 1.5 mm short of the radiographic apex is the ideal treatment that leads to good prognosis.

Conclusion

The root apex should be viewed as a vital dynamic tissue capable of growth, development and repair. This study was undertaken to increase our knowledge about the termination of the root canal filling at the root apex. Our findings demonstrated that cleaning the root canal system and placing the filling materials 1.0 to 1.5 mm short of radiographic apex and not at the level of the radiographic apex is the ideal treatment. This means that care should be taken during working length measurement, instrumentation and filling of the root canal system. Bearing this in mind will allow the clinician to avoid traumatizing the periodontal ligament and surrounding tissues, thus, a better prognosis of the root canal therapy could be obtained. Finally, the information we gained from this study gives better view of what the radiographic image means.

References