

# Reliability of different radiographic methods for the localization of displaced maxillary canines

Apostolos I. Tsolakis,<sup>a</sup> Michael Kalavritinos,<sup>a</sup> Elias Bitsanis,<sup>a</sup> Mattheos Sanoudos,<sup>a</sup> Vassiliki Benetou,<sup>b</sup> Konstantina Alexiou,<sup>c</sup> and Konstantinos Tsiklakis<sup>c</sup>

Athens, Greece

**Introduction:** The purpose of this study was to evaluate the reliability of the radiographic images of the main conventional x-ray techniques compared with the information from cone-beam computed tomography (CBCT). **Methods:** Twenty patients with unilateral or bilateral impaction of the maxillary canines had radiographic examinations by means of periapical x-rays, occlusal x-rays, panoramic x-rays, and CBCT scans. Three experienced orthodontists examined all x-rays from each patient and evaluated the radiographic images of the impacted canines. The examiners were asked to detect resorption in adjacent teeth and the buccal-palatal position of the impacted canines. Agreement between examiners was statistically tested. **Results:** Different diagnoses were produced by the 3 examiners regarding localization of the impacted canines and the presence or absence of root resorption of the adjacent teeth in conventional radiographic images. It appears that whereas panoramic x-ray is more sensitive in detecting resorption and tooth position, occlusal and periapical imaging have higher specificity and positive predictive value. The examiners were in good or excellent agreement when occlusal and periapicals were used for the definite diagnosis of resorption and tooth position. There was no disagreement of the examiners in CBCT images, which were used as the gold standard. **Conclusions:** Conventional radiographic methods demonstrated a more subjective diagnostic procedure compared with CBCT images. CBCT is a more accurate and precise examination method compared with conventional radiography for the localization of impacted teeth and root resorption of the adjacent teeth. (Am J Orthod Dentofacial Orthop 2018;153:308-14)

Several clinical and radiographic methods are used for the localization of maxillary impacted canines, with the radiographic techniques providing more accurate information for the position of impacted maxillary canines. The most commonly used radiographic method is the “tube shift method” or the “parallax technique” introduced by Clark<sup>1</sup> in 1910. Usually, 2 periapical radiographs are taken with a change in horizontal angulation of the x-ray beam to a reference tooth adjacent to the impacted maxillary canine area. The maxillary canine that is labially impacted moves in the

opposite direction to the tube, whereas the palatally impacted maxillary canine moves in the same direction as the tube.

The vertical tube shift was described by Keur<sup>2</sup> in 1986 involving a panoramic radiograph and an occlusal radiograph. The occlusal radiograph is taken at an angle of 60° to 65° to the occlusal plane. Because the panoramic tube is in front of the patient’s head at an angle of 7°, the palatally impacted canine moves in the same direction with the tube shift used for the occlusal radiograph.<sup>3</sup> Other methods involve the use of a lateral cephalogram and a posteroanterior cephalogram<sup>4</sup> or the combination of an orthopantomogram and a lateral cephalogram.<sup>5</sup>

Occlusal radiographs were suggested by Hitchin<sup>6</sup> in 1951. Whenever a person uses the true occlusal method, the central beam ray must be parallel to the long axes of the teeth that are to be used as reference points.<sup>2</sup> Chaushu et al<sup>7</sup> described a method using a single panoramic radiograph to determine the site of impaction of an unerupted maxillary canine. The magnification method may be applied to a panoramic film, and it is

From the National and Kapodistrian University of Athens, Athens, Greece.

<sup>a</sup>Department of Orthodontics, School of Dentistry.

<sup>b</sup>Department of Epidemiology, School of Medicine.

<sup>c</sup>Department of Oral and Maxillofacial Radiology, School of Dentistry.

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Address correspondence to: Apostolos I. Tsolakis, Leoforos Pentelis 66, 15235 Vrilissia, Athens, Greece; e-mail, [apostso@otenet.gr](mailto:apostso@otenet.gr).

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based on the principle that when the teeth move farther away from the film, they appear larger compared with the contralateral teeth aligned in the dental arch. Conventional computed tomography (CT) scans have been used since 1990 as an alternative for accurate localization of impacted canines and identification of root resorption areas of the adjacent teeth. More recently, cone-beam CT (CBCT) has been introduced; it seems to be the most promising advanced method for the precise location of ectopic canines, the direct measurement of the transverse (buccolingual) inclinations of the canines and molars, the accurate identification of root resorption areas of the adjacent frontal teeth, and the selection of the less-invasive surgical exposure technique.<sup>8-11</sup>

The magnification method has been negatively criticized for its reliability, and it is stated as inaccurate for clinical usage. On the other hand, the vertex occlusal method results in reliable x-ray views, but the amount of radiation needed is questionable, and it is criticized negatively because various organs in the head and neck area are exposed to radiation before the x-ray beam influences the ectopic tooth and the film.

The parallax method is thought to be more reliable for the location of ectopic canines compared with the magnification and vertex occlusal methods. Also, with the parallax method, one may be exposed to a smaller radiation dose especially when the initial radiograph from which the impaction was diagnosed may be one of the radiographs used for the parallax method. Nevertheless, with conventional radiographs and methods, it is impossible to justify the depth of the impaction—in other words, the distance of the impacted tooth from the dental arch. Intraoral and panoramic radiography provide 2-dimensional representations of 3-dimensional (3D) tissues. If any element of the geometric configuration of an object is compromised, the radiographic image can be false. For impacted teeth, radiographic projections with different beam angulations may help in more accurate imaging and localization of the object, although interpretation of planar “shadows” may be difficult due to the complex anatomy of surrounding structures.<sup>12</sup> Therefore, the radiographic information obtained may not always ensure the most appropriate planning of surgical and orthodontic intervention. Also, it seems that there is no accurate information concerning the pathology caused by the ectopic tooth to the adjacent teeth, such as root resorption. With CBCT, 3D information is obtained at high resolution, and the total radiation needed is considerably less than conventional CT scanning. Radiation dosage of CBCT is generally much less compared with conventional medical CT<sup>13</sup>; with recent improvements in technology, it is similar to

a panoramic x-ray.<sup>11,14</sup> Due to the ability of CBCT to collimate the beam, the radiation exposure to the region of interest may be limited.<sup>15</sup> CBCT scans can be requested with a small (maxilla or mandible), medium (maxilla and mandible), or large (face and cranium) field of view. As the field of view increases, so does the radiation dose. Consequently, the examination should include only the areas of diagnostic interest to minimize the radiation dose and follow the ALARA (as low as reasonably achievable) principle.<sup>14</sup> Furthermore, the milliamperage setting must be the lowest, and the exposure time must be the shortest. A full scan of the face and cranium (with field of view >15 cm) can be as low as 52  $\mu$ Sv, and the effective dose for a panoramic radiograph ranges from 6 to 50  $\mu$ Sv,<sup>16</sup> and the complete series of 2 dimensional radiographs is 34.9  $\mu$ Sv.<sup>17</sup> However, there are still big differences in radiation dosages between manufacturers of cone beam devices.<sup>16</sup>

The aim of this study was to investigate the reliability of conventional radiographic techniques (panoramic, occlusal, and periapical) in detecting the location of impacted maxillary canines and resorption in adjacent teeth. CBCT was used as the gold standard.

## MATERIAL AND METHODS

The study population included patients with impacted canines seeking overall routine orthodontic treatment between 2008 and 2010 at the School of Dentistry of the National and Kapodistrian University of Athens in Greece. The sample comprised 20 patients who (1) after routine clinical and radiographic examination, a CBCT was considered to provide more information about the impaction and possible root resorption of the anterior teeth; and (2) agreed for a CBCT to be taken and signed the informed consent form. The main criteria for the use of CBCT, after the routine radiographic examination, was the degree of overlapping of adjacent teeth that prevented accurate diagnosis of resorption. For some patients, the oral surgeon preferred to have tomography images to better evaluate access and timing of exposure for the impacted tooth.<sup>18</sup> The range of ages was 10 to 17 years. The study was approved by the ethics committee of the School of Dentistry of the National and Kapodistrian University of Athens. The most common radiographic methods were initially applied to locate the impacted maxillary canines. Panoramic, occlusal, and periapical radiographs were taken using the “tube shift method.” Later, CBCT scans were obtained for each patient. The 3 diagnostic methods were evaluated and compared with the CBCT images, which were used as the gold standard for the detection of resorption and the location of the impacted teeth.<sup>19,20</sup> That means that we considered that CBCT images provide accurate diagnoses in every

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