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Technical note

The role of focal block (trough/plane) in panoramic radiography: Why do some structures appear blurred out on these images?

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ABSTRACT

Panoramic radiographs are commonly used in dental practice. The challenge with panoramic radiography is overlapping structures, ghost and air shadows. The area of interest can appear blurred especially in the anterior region. The focal block is a virtual space in which the dentition should be perfectly placed when acquiring the radiograph. Anatomical structures that are within this focal block appear focused and in perfect geometric accuracy on the final image. Structures outside this focal block appear blurred, and distorted. Accurate positioning of the patient will help in placing the region of interest within in the focal block and as a result minimising artefacts, ghost and air shadows. We utilise cone beam computed tomography (CBCT) software to explain this principle.

Introduction

Panoramic Radiography (PR) is a commonly used imaging modality in dental practice.[5] It is predominantly used to assess pathological conditions affecting the dento-alveolar region and its surrounding structures. Some of these conditions include generalised periodontal bone loss, multiple grossly carious teeth/retained roots and impacted teeth such as lower third molars. The principle behind capturing a diagnostic image in PR depends on the utilisation of the focal block (focal trough/focal plane).

The focal block is a virtual horse-shoe shaped volumetric zone which mimics the dental arch. Different shapes of these focal blocks have been created by the manufacturers to suit the different shapes of dental arches of patients (Fig. 1). It is designed with the anterior portion to be narrow and the posterior portion to be wider to accommodate the teeth (Fig. 2). This provides wider latitude in imaging posterior teeth. Challenging anatomical structures such as proclined or retroclined incisors could result in part of these teeth (predominantly the apices) to be displaced outside the focal block and therefore become blurred. This is less likely to occur with posterior teeth. The structures which fall within the focal block appear focused.

The literature

This concept of the focal block is not new to the literature. According to Patel (1989), the width of the focal trough depends on angular movement of the X-ray beam during exposure, focus-film distance, width of the X-ray beam, focal spot size and the film screen crystal size.[9] Yeo et al. (2002) described the lateral incisors and canines to be predisposed to horizontal magnification because of their position in the arch.[7] The limitation in diagnosing maxillary lesions is described by Lilienthal et al. (1991).[3] Fowler (1987) illustrated the limitations of the focal block when dealing with a young patient with excessive over-jet and supernumerary tooth.[2] Walker et al. (2009) explained one of the common artefacts caused by the pronounced depression of the mental region of the anterior mandible misinterpreted as radiolucency.[4] Liang et al. (2004) described one of the limitations of panoramic radiography to be its sensitivity to errors caused by positional discrepancy.[1] Kitai et al. (2013) described positional displacement of more than 12 mm to be responsible for measurement errors to be more evident.[6] Yeo et al. (2002)

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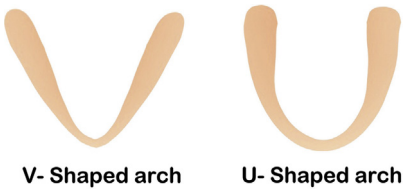

Figure 1. Different shapes of the focal block.

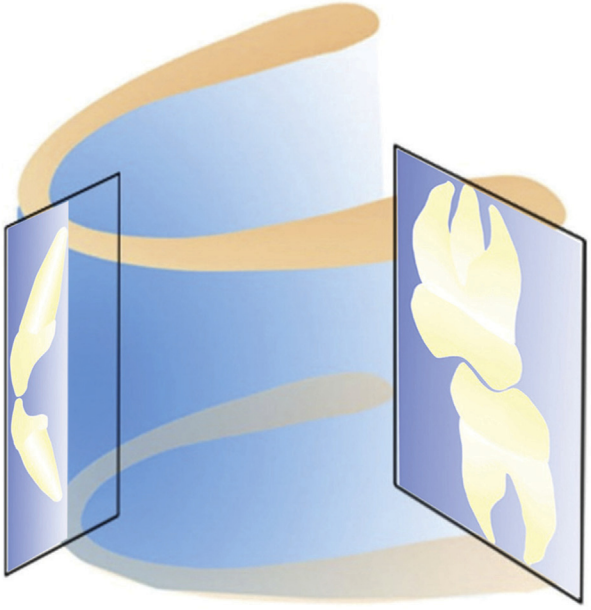

Figure 2. The size of the focal block in the incisal and molar area demonstrating the difference in their thickness.

emphasised the importance of the patient's position in the focal trough to minimise errors.[7] Artifacts are not limited to PR but also seen in other imaging modalities such as cone beam CT. Presence of metallic objects can cause beam hardening artifacts which distort the image and decrease the image quality.[8]

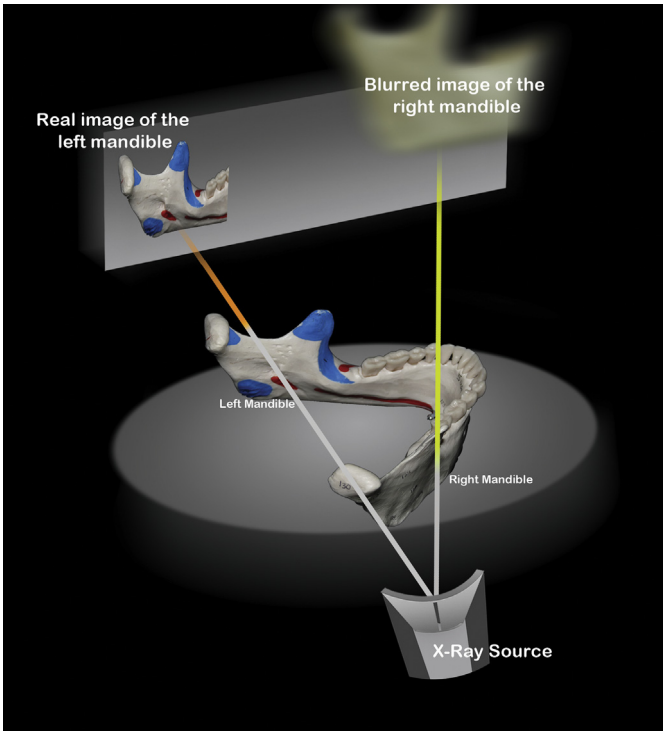

Figure 3. Demonstrates the X-ray beam capturing the real image and the ghost shadow.

The technique

In PR, simultaneous rotational movement in the opposite directions of the X-ray beam and the film/digital receptor is responsible for creating the image. While the beam is capturing images of structures within the focal block on one side, it is also capturing images of other structures outside the focal block on the contra lateral side. This will result in the formation of "real" structures and "ghost" shadows. Considerable superimposition of these structures and shadows occurs. The final image is a collective combination of "real" structures and "ghost" shadows (Fig. 3).

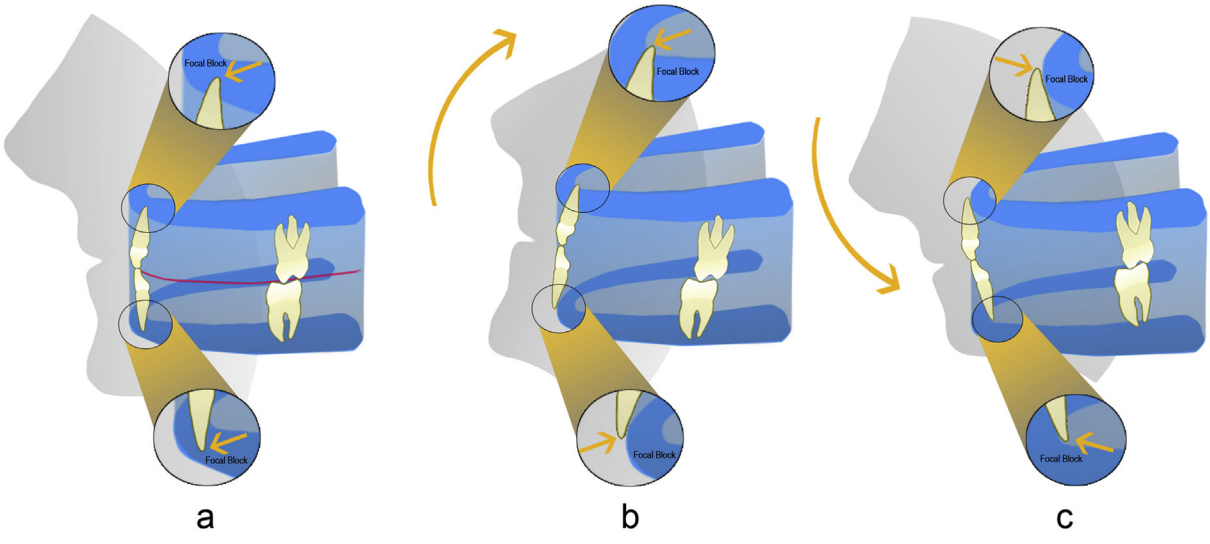

Figure 4. Demonstration of correct (a) and incorrect (b) – Chin up and (c) – Chin down.