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This article counts towards one of the five core subjects introduced in 2007 by the GDC.

A Transymphyseal X-ray Projection to Assess the Anterior Edentulous Mandible Prior to Implant Placement

Abstract: The provision of an implant-retained overdenture with two implants in the canine regions is a well established treatment modality. Assessment of the form of the anterior mandible is essential in order to avoid surgical complications. Cross-sectional imaging gives ideal images but has radiation and economic costs. A panoramic radiograph supplemented by a lateral cephalometric radiograph is commonly used in these cases, but the latter is not widely available in dental practices. A transymphyseal radiographic technique is presented, using equipment and materials readily available in general dental practice, which may be used as an alternative to the lateral cephalometric radiograph.

Clinical Relevance: In appropriate cases, a cross-sectional image of the edentulous anterior mandible may be obtained using materials and equipment which are easily available in general dental practice.

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Implant-supported overdentures in the edentulous anterior mandible are considered the treatment of choice in many cases of severe or moderate alveolar resorption.[1] For example, the provision of two implants in the lower canine regions with stud attachments can be a relatively simple way of addressing otherwise insoluble denture problems. The form of the anterior mandible varies greatly, according to the degree and pattern of resorption. This can result in narrow, shallow or knife edge ridges which can complicate implant placement. In addition, there is often a lingual concavity, or the mandible can appear lingually inclined in relation to ideal implant orientation. Perforation of the lingual cortical plate during preparation for placement of dental implants is a risk in the anterior mandible and can endanger the network of vessels in the floor of the mouth. This has the potential to cause severe bleeding and a life-threatening upper airway obstruction. Several such cases are reported.[2-8] Kalpidis and Setayesh[2] and Hofschneider and co-workers[9] have published assessments of the anatomy of this region and discuss the contributions of the sublingual and submental arteries to this network of vessels. Kalpidis and Setayesh[2] also review several clinical cases and suggest crisis management guidelines.

Selection criteria and guidelines exist for prescription of radiographs, where the placement of osseointegrated implants is planned.[10-12] As has been previously pointed out,[11] however, there is only a small evidence base on which to formulate such guidelines and decisions are therefore based heavily on clinical judgement.

There is agreement that a three-dimensional appreciation of the form of the mandible is required in order to plan, adequately, dental implant placement and avoid complications resulting from unfavourable bone morphology, such as perforation of the lingual cortical plate.[13] The following techniques may be used:

- Panoramic radiograph supplemented by a lateral cephalometric view;
- Tomography;
- Palpation of the area;
- A new transymphyseal x-ray view.

Panoramic radiograph supplemented by a lateral cephalometric view

The panoramic radiograph gives a two-dimensional view of the anterior mandible. To provide information about

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Figure 1. Lateral cephalometric view of edentulous mandible.

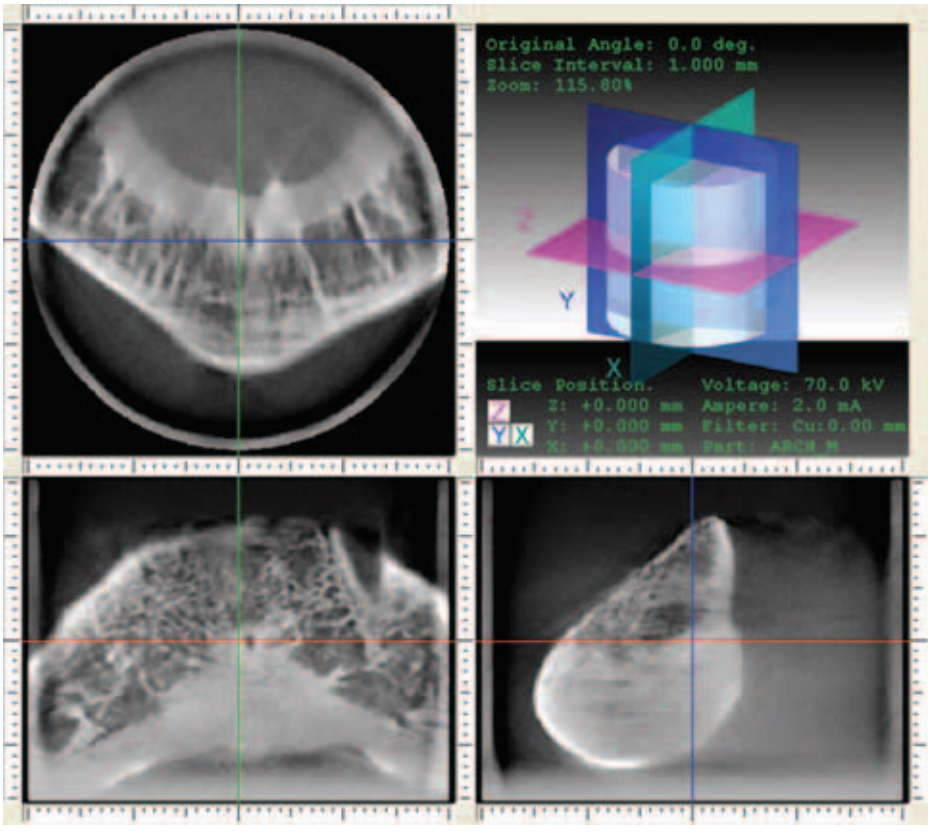


Figure 2. Cone-beam CT examination of the anterior mandible, showing the coronal, axial and sagittal images produced by this technique. Image courtesy of Reinhilde Jacobs, Paulo Couto and Livia Corpas, Oral Imaging Center, KU Leuven.

the third dimension, a lateral cephalometric radiograph can be taken to supplement this panoramic view (Figure 1). In the lateral cephalometric view, the beam is at 90° to the sagittal plane and records an image of the symphyseal region, albeit a superimposition of the lower left to lower right canine region. This is considered to be an adequate representation of the form of the bone in the anterior mandible for planning implants in the region.[13] However, this view does have a number of disadvantages. First, lateral cephalometric x-ray equipment is not widely available and is often installed only in hospitals and a few specialist orthodontic practices. Also, although the beam can be collimated to some degree, there is normally a wide exposure of the face when examination of only a small area of the mandible is required. Mandall *et al*[14] described a technique for collimation of cephalometric radiographs to show the anterior mandible and maxilla, but this method requires special customization of equipment that is difficult to achieve practically. There is also a loss of detail, compared with intra-oral image receptors, on both panoramic and lateral cephalometric radiographs, because the images are produced using intensifying screen/film combinations or digital alternatives.

Tomography

Tomography, or cross-sectional imaging, is currently the gold standard for imaging the jaws in implant planning (Figure 2). Such images are usually acquired using computed tomography (CT). Data acquisition can be followed by the use of specialized dental implant planning software to obtain true cross-sectional images perpendicular to the curve of the jaw, free from superimposition. While this type of image is ideal, it has some disadvantages. Radiation dose can be high[11] and, even if the area of interest is limited to a localized site, the entire section of the head must be exposed. Furthermore, conventional CT scanners are rarely available in dental practices. Recently, cone-beam computed tomography (CBCT) has become more readily available and can be found in a few dental practices. This gives a relatively lower radiation dose and some types of CBCT equipment can image small volumes rather than the entire head section. Nonetheless, the radiation dose is still greater than that associated with panoramic or cephalometric radiographs and both availability and cost are important considerations.

Palpation of the area

Some operators rely on a panoramic view and pre- and peri-operative palpation. Palpation of the area pre-operatively is unreliable, as it is difficult to palpate adequately the lingual surface of the anterior mandible. It is, nevertheless, possible to reflect a lingual mucoperiosteal flap at the time of surgery to examine the lingual anatomy more closely. However, this still gives limited information and, in itself, risks damage to the lingual vessels and surgical morbidity. Furthermore, it is clearly good practice to be aware of potential problems in advance.

A new transymphyseal x-ray view

A need was identified for a simple, inexpensive and easily available x-ray technique for general dental practice, which can assist in the assessment of

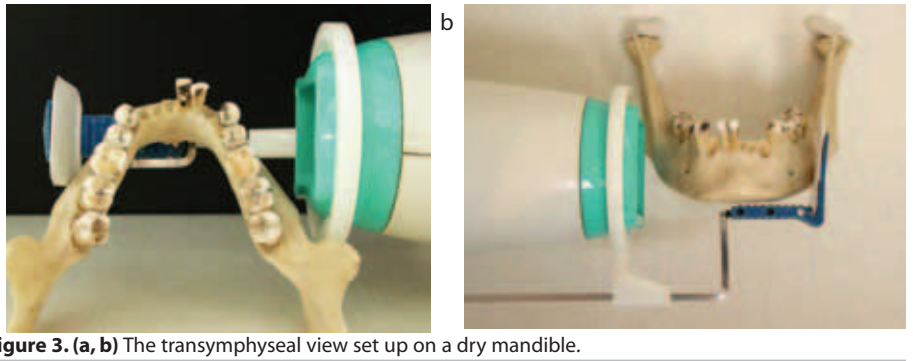


Figure 3. (a, b) The transymphyseal view set up on a dry mandible.

Figure 4. A transymphyseal radiograph taken on a dry mandible.

bone volume in the anterior mandible. When planning a complete lower overdenture, supported by two implants in the canine regions, it is felt that more complex radiographic techniques may be unnecessary or unjustified in many cases. A new transymphyseal x-ray view is described which can be taken in general dental practice using conventional intra-oral film and holders.

Materials and methods

Using an intra-oral film holder and conventional intra-oral film, radiographs were taken of a dry mandible. The intention was to produce a similar view of the symphysis to that shown by a lateral cephalometric radiograph. The film and holder were therefore used extra-orally. Rectangular collimation was used. A Rinn intra-oral film holder, which is intended for use on anterior teeth, was selected. The film holder was positioned so that the beam was directed at 90° to the sagittal plane and the symphyseal region was centred on a size 2 film (Figure 3). It was found that the point of the chin should be about 4–5 mm anterior to the blue plastic part of this film holder. The resulting radiograph gave a clear view of the superimposition of the symphyseal region in sagittal section. Experimentation with the x-ray exposure on the dry mandible also gave an indication of that required to reproduce the same view *in vivo* (Figure 4).

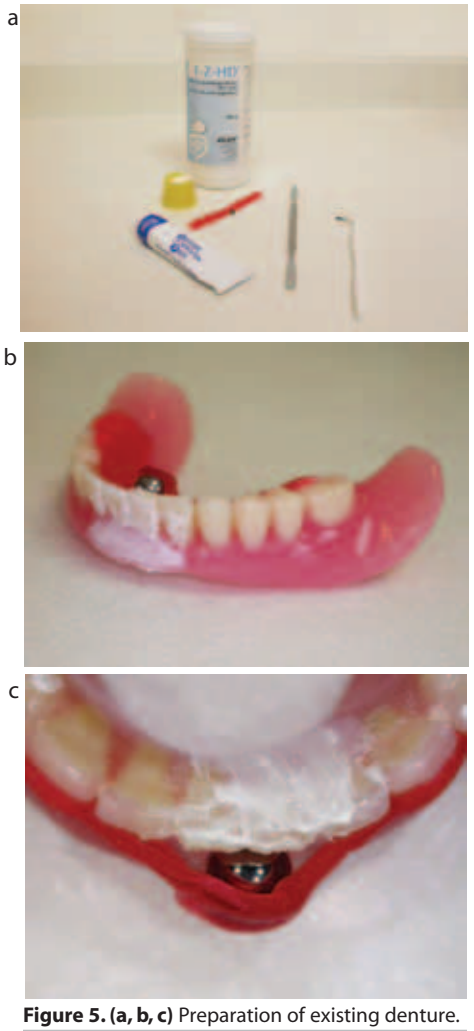


Figure 5. (a, b, c) Preparation of existing denture.

Following discussion, it was felt that the value of the radiograph could be improved by including the outline of the intended denture *in situ*. In this way, the ideal orientation of dental implants could be assessed in relation to both the available bone and the intended position of attachments. This was accomplished by painting the patient's existing denture at the midline with a radio-opaque paste. The paste was made by mixing denture pressure indicator paste (Minerva Dental Ltd, Cardiff, UK) and barium sulphate powder (Dentocare Ltd, London, UK). In addition, a 5 mm steel ball was placed at the midline to give an indication of the magnification of the view. This was fixed to the denture temporarily using a strip of ribbon wax (Figure 5). The radio-opaque paste, steel ball and wax were easily removed after use.

A series of transymphyseal radiographs was taken on patients for whom implant-supported overdentures were considered. Ethical approval was not sought for this trial since all equipment and materials were those normally used in general dental practice. The surgeon performing the treatment had, in each case, justified cross-sectional imaging and the available conventional technique (CT) would have led to higher radiation doses.

The patients' dentures were prepared with radio-opaque paste and a

Figure 6. The transymphyseal view set up on a patient.

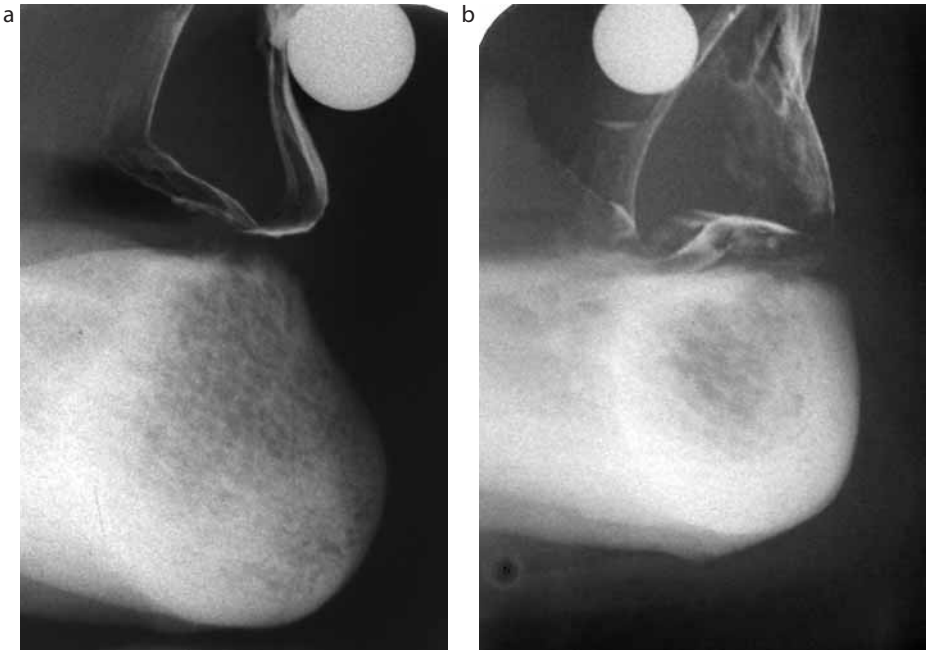


Figure 7. (a, b) These transymphyseal views suggest that implants can be placed in ideal orientation with regard to the available bone volume and position of the denture.

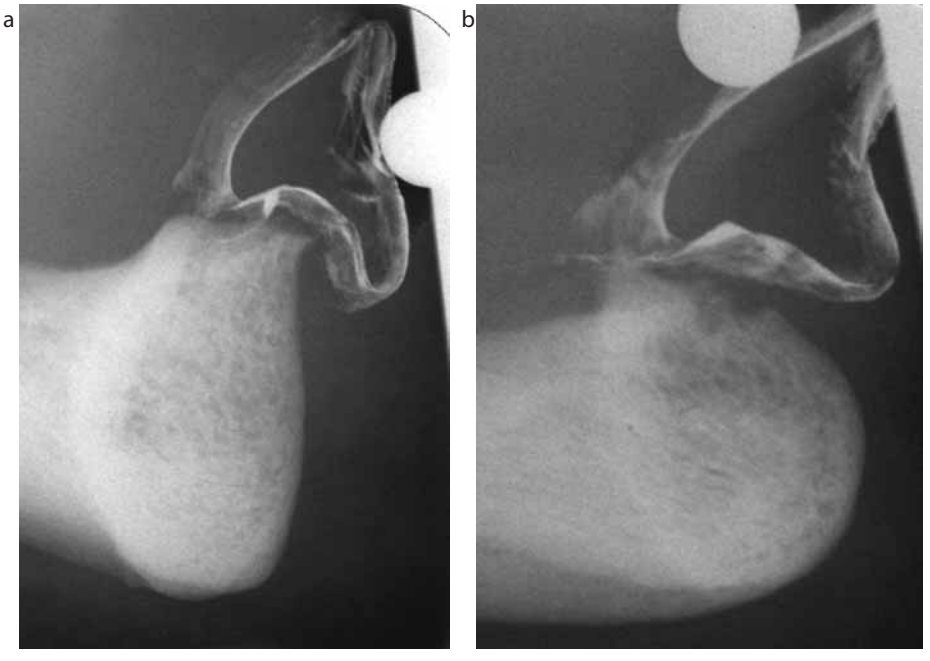


Figure 8. (a, b) These views suggest increased difficulty with the positioning of dental implants.

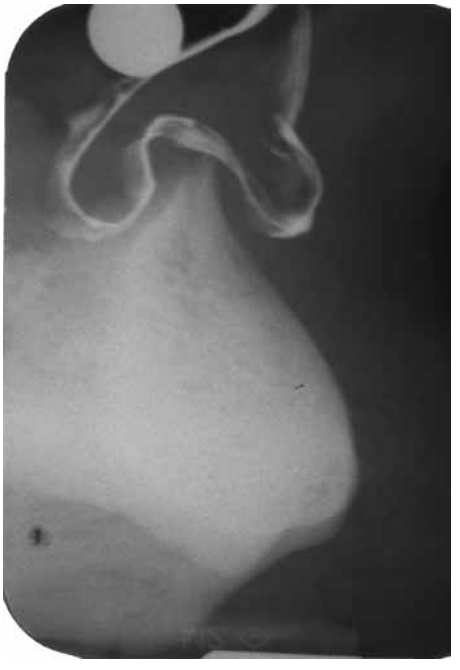


Figure 9. This view shows a knife edge ridge which would complicate implant placement.

5 mm steel ball. The patients were asked to close on their dentures in their 'usual bite' to ensure that the lower denture was held in its functional position for each individual patient (Figure 6).

The film holder was positioned, the rectangular collimator was attached to the tube and the films were exposed at 60kV and 7mA for 0.739 seconds. The machine used was a Trophy Atlantis x-ray set.

Dose calculations

No dosimetry was performed, but a reasonable assessment of dose can be made on empirical grounds. The primary beam passes through the chin, involving hard and soft tissues, but then passes out of the patient. For a periapical radiograph of this region, the primary beam passes through the same tissues, but continues to pass through the patient in an antero-posterior direction, eventually to emerge at the back of the head/upper neck. Thus, although the exposure time for the transymphyseal projection is 2–3 times longer than a periapical, it exposes a smaller volume of the patient. It is also likely to produce less scattered radiation than a periapical radiograph. A conservative estimate is, therefore, that the Effective Dose associated with the transymphyseal projection is around twice that of a periapical radiograph taken with rectangular collimation, equivalent to around 1–2 μSv. This would be a little less than a lateral cephalometric radiograph (3 μSv) and substantially lower than CBCT or CT, which are likely to have doses 10 and 100 times as great, respectively.

Results

The transymphyseal x-ray technique yielded clear images of the superimposition of the symphyseal region

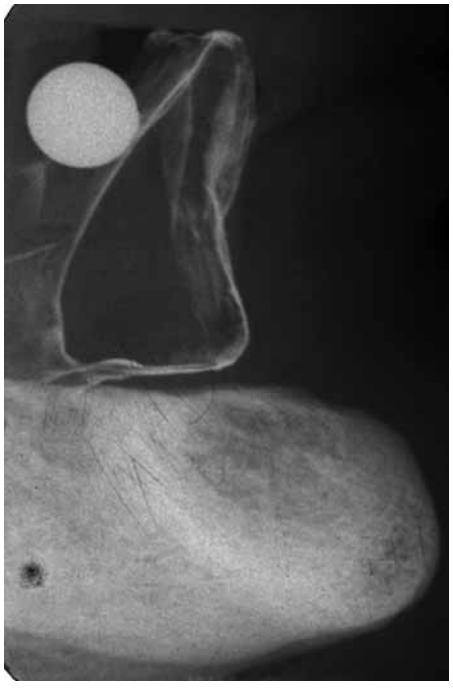
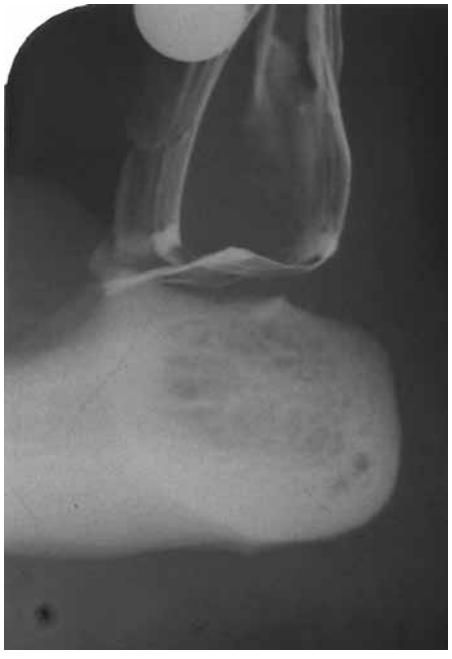


Figure 10. This radiograph demonstrates that adequate implant orientation would be impossible with a denture in the present position.

and of the outline of the existing dentures. The radiographs revealed significant variation in the form of the symphyseal region, especially in relation to the position of the existing lower complete denture. Magnification of the view was consistently at around 20%, as measured by the magnification of the 5 mm steel ball. Some cases demonstrated that ideal positioning of dental implants was possible so that attachments could be centred within the lower complete denture. Other cases showed that this was impossible. Results from seven patients are shown (Figures 7–11). Figure 11 shows the use of a panoramic radiograph supplemented by the transymphyseal view; 5 mm steel balls on a radiographic guide mark the proposed position of implants on the panoramic radiograph.

Figure 12 demonstrates the use of a transparent overlay to assist in planning. These overlays are supplied by implant manufacturers and are printed with the outline of dental implants of different dimensions and magnifications. In this case, a magnification of 130% was chosen, which was the nearest available magnification above the estimated 120% measured from the radiographs.

a



b

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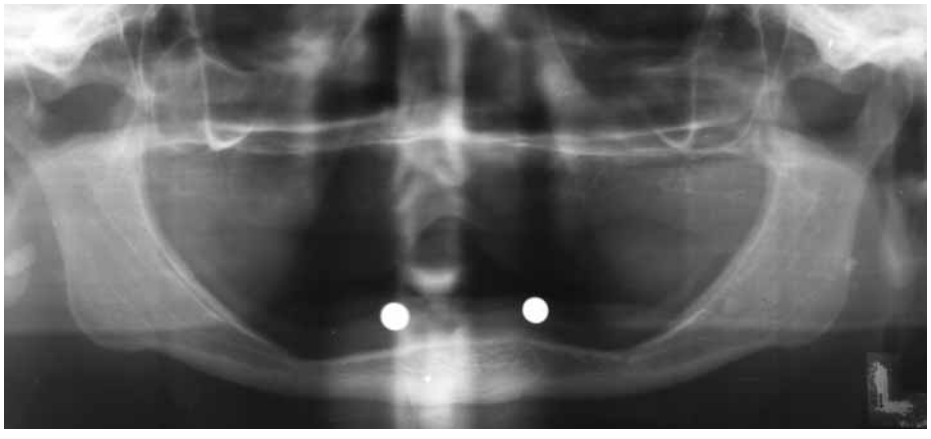

Figure 11. (a, b, c) A panoramic radiograph supplemented by a transymphyseal view is used to plan dental implants in the anterior mandible. In this case, 5 mm steel balls on a radiographic guide mark the proposed position of implants on the panoramic radiograph.

Discussion

Despite the relatively long exposure, no movement artefacts were found. This was felt to be due to the film and holder being placed extra-orally, with dentures in occlusion thus producing no discomfort for the patient. On the other hand, it is found that intra-oral views sometimes produce movement artefacts, owing to the discomfort of positioning a film, for example, deeply in the lingual sulcus.

Either labial or lingual placement of the steel ball was used in order to find the position where it would be most reliably included in the image. It was found that, where the denture fitted lingually to the alveolar ridge, labial placement gave the best result. Where the denture was more labial to the alveolar ridge, then lingual placement of the steel ball would be more appropriate.

Undoubtedly, CT or the newer CBCT give the best images available for planning dental implants. However, for the assessment of the anterior mandible, when it is planned to place just two implants in the canine regions, the expense, inconvenience and dose of a CT scan or other tomography may not be justified. In such cases, the transymphyseal radiograph may be a useful alternative to the lateral cephalometric view in general dental practice. The technique has a number of advantages. First, it uses equipment and materials readily available in most dental practices. Thus it is relatively inexpensive and it is not necessary to refer to a specialist centre. Secondly, the radiation exposure is limited only to the area of interest, especially if rectangular collimation is used.

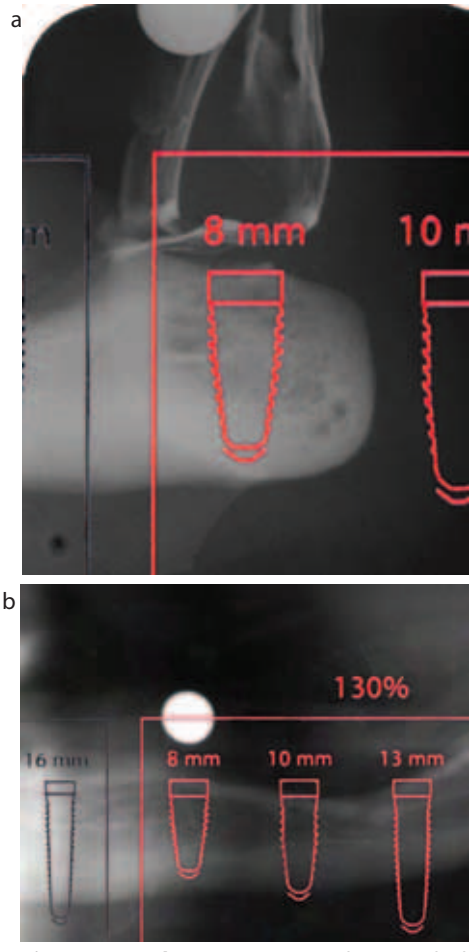

Figure 12. (a, b) Transparent overlays supplied by implant manufacturers can be used on both panoramic and transymphyseal radiographs to assist in planning. The overlay shown is by Nobel Biocare.

The x-ray beam passes only through the symphyseal region. The detail on intra-oral film exceeds that of a lateral cephalometric view and no special processing facilities are required. The radiation dose is estimated to be relatively low, even though conventional (x-ray sensitive) film is used. However, the technique is equally applicable to digital radiography, assuming that reliable sensor/imaging plate holders are available. This should further reduce the dose.

The principal disadvantage of this technique is the lengthy exposure time which, with the equipment used here, was around three-quarters of a second. Nonetheless, in practice no movement artefacts were observed. Obviously, equipment using higher mA would allow shorter exposure times to be used, while digital imaging would further reduce the risk of movement artefacts. In this trial, the x-ray set was used at 60kV. A shorter exposure time would also have been possible with higher kVs. The equipment used in the trial did offer a 70kV option but, in the preliminary work with the dry mandible, a subjectively based judgement was made that image quality was less satisfactory. The relative advantages and disadvantages of using a higher kV might be usefully explored in further work.

While the projection described is directed perpendicular to the sagittal plane ('true lateral'), being modelled on a lateral cephalometric projection, it would be relatively straightforward to rotate the film holder in either direction to obtain views that are tangential to the curve of the dental arch in the region of the implant. This should give a more exact cross-sectional image at the proposed implant site and will be explored in future work to see if this offers any significant advantages over the basic method. Empirically, there seems no reason why this technique should not also be applicable to the anterior maxilla. This will also be the subject of further investigation.

It is felt that, using the technique described, the transymphyseal radiograph gives a reasonable prediction of the form of the anterior mandible and thus of potential anatomical difficulties. This may be sufficient in many cases for planning the placement of two implants in the canine region to support an overdenture, while offering considerable advantages to the patient and surgeon in time saving and reduced costs.

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