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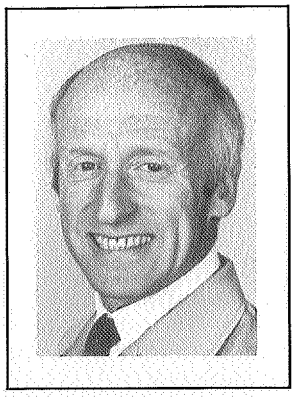

Localisation of the unerupted maxillary canine

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Abstract: The need to localise unerupted teeth is a common clinical problem. Inspection, palpation and radiographic views are discussed. This paper concentrates on the radiographic localisation of the unerupted maxillary canine. Emphasis is given to the reduction of exposure of the patient to ionising radiation by (i) using a minimal number of radiographs and (ii) offering alternatives to the vertex occlusal radiograph.

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MeSH words†: Radiography/dental; radiation dosage; dental arch; maxilla; vertical dimension; dentition; cuspid

Key words: Localisation, unerupted maxillary canine, radiographic technique

INTRODUCTION

Orthodontists are frequently required to localise unerupted teeth, especially the maxillary canine. The localisation of this tooth will be discussed in detail although *the principles of position determination can be extended to any unerupted tooth.*

It is important to localise teeth to aid in treatment planning because

(i) it is a sound rule to never extract a well-placed tooth to make space for a very badly positioned one. If a well-placed tooth is preserved, treatment time may be shortened considerably and the result is more certain. The reverse also holds true. If a tooth that is poorly placed is kept and one that is in good alignment extracted, then treatment time will be prolonged and the result is less sure;

(ii) due to an error in localisation, a flap could be raised and a removal or an uncovering attempted in the wrong area, e.g. on the labial when the tooth was palatal;

(iii) the orthodontist must be able to estimate the difficulty involved in uncovering a displaced tooth for which access is difficult. Uncovering a malposed tooth may be more hazardous to the adjacent teeth than extracting it.

METHODS

The methods of localisation are:

A. inspection
B. palpation
C. radiographic means.

A. Inspection

The first test to be carried out in an examination of a patient to localise an unerupted tooth is inspection, i.e. one looks at the area under investigation and this may provide much of the information required.

One may see —

(a) the bulge of the unerupted tooth and/or
(b) the position of adjacent teeth being influenced by the unerupted tooth.

The top model in *Figure 1* shows the crown of 22 being pushed palatally and its apex labially by the unerupted 23 which therefore must be palatal. The bottom model confirms that this deduction is correct.

The position of upper lateral incisors is influenced by impacted upper canines far more frequently than the first bicuspids' position being affected. This is because most impacted canines (i) are mesio-angular impactions and (ii) have migrated mesially as well (Wolf and Mattila, 1979).

† (For MeSH words, see Journal Overview)

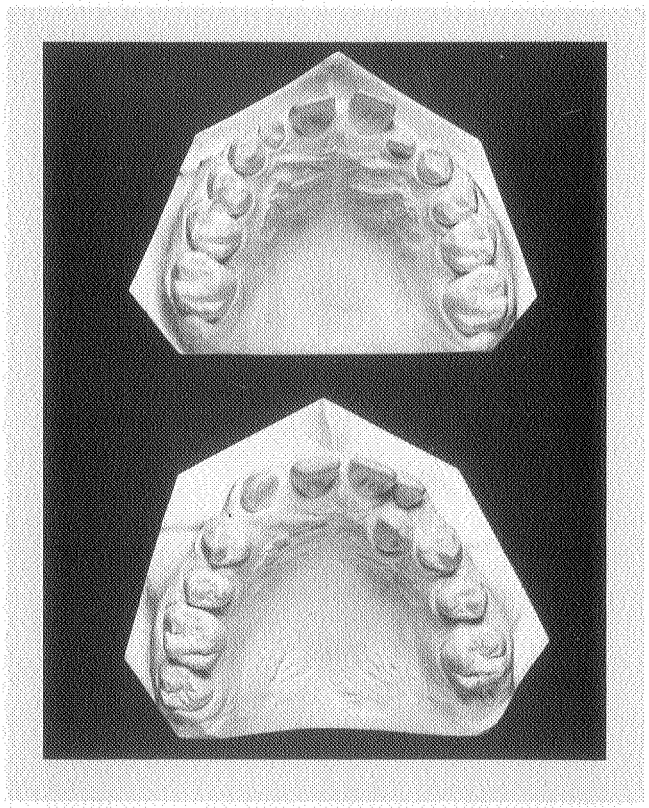

Figure 1. Inspection. Top model shows 22 crown displaced palatally and apex labially by unerupted 23. Bottom model shows 23 is in palate.

B. Palpation

The next test to be carried out is palpation. Usually, perhaps 70 percent of the time, an impacted tooth can be palpated. Occasionally, however, the bony canine eminence has been confused with the tooth and so the fact that a canine is impacted has been missed. Usually a properly erupting canine can be palpated by nine years of age. The clinician should manipulate the deciduous canine to determine if it is mobile. If it is, this indicates that its root has undergone significant resorption. This then can be taken as some evidence that the permanent canine is erupting in the desired direction (Mills, 1982 page 110).

C. Radiographic means

For perhaps 30 percent of cases radiography is the only means of determining the position of the impacted

canine. Recently more stringent legislation has come into force in some States concerning the use of ionising radiation and the public is becoming more aware of the hazards of exposure to radiation.

It is intended in the remainder of this paper to show how to localise teeth utilising a minimal number of radiographs which may have been taken already. Reducing the number of radiographs will result both in less exposure and less cost for the patient.

There are *three accurate methods of radiographic localisation.* These entail using
(a) two films with different planes of reference;
(b) the principle of tube shift;
(c) stereoscopy.

(a) **Two films with different planes of reference.** It is possible to ascertain the position of many objects by taking two views, one at right angles to the other. An example is the localisation of an unerupted maxillary canine by means of a posterior-anterior cephalogram and a lateral cephalogram. This is a combination favoured by Mills (1982 pages 112-114).

Figure 2(a) illustrates that the posterio-anterior cephalogram gives the labio-palatal position and the height of the canines, and *Figure 2(b)* shows that the lateral cephalogram gives the antero-posterior position and the height of the canines.

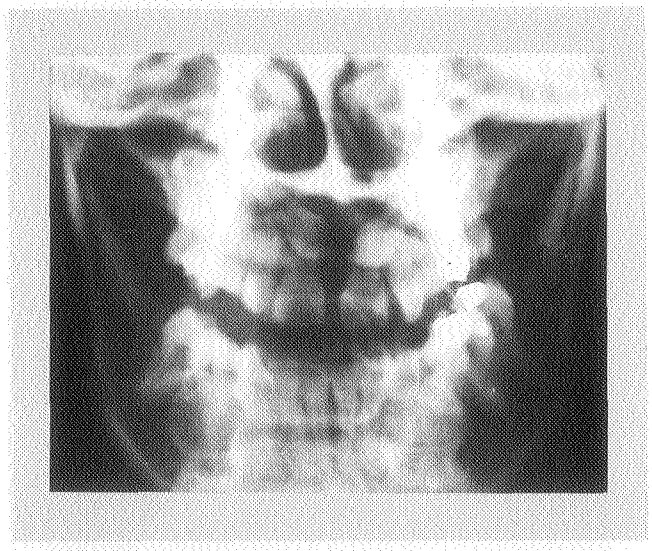

Figure 2(a). Part of postero-anterior cephalogram. It shows 13 is closer to the mid-sagittal plane than 23.

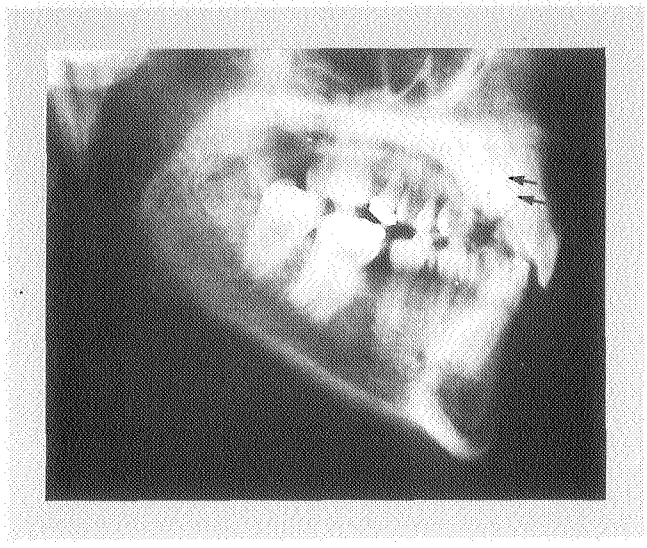

Figure 2(b). Part of lateral cephalogram of the same patient. The right arrow points to the right maxillary canine.

* Siemens, Erlangen, W. Germany

It can be deduced from these radiographs that the canines are high and in the palate, and *Figure 3* confirms this.

Other combinations of films can be used to obtain views with different planes of reference.

A single panoramic tomogram such as an orthopantomogram (OPG)* is a very useful radiograph to determine the position of unerupted canines.

It is frequently available as an initial radiograph. An OPG gives a good indication of the height of the canine, its relation to the mid-sagittal plane and often accurately reflects its inclination.

The tendency is for the angle of the misplaced tooth to be slightly greater on the OPG than on a posterior-anterior cephalogram and also for the canine to be a quarter of a tooth width further away from the midline on the OPG. (Coupland, 1984).

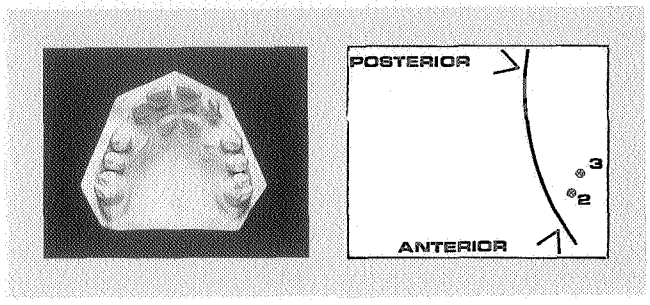

Figure 3. (left) Model of the same patient in Figure 2.

Figure 4. (right) The canine when viewed from the anterior position of the tube is obscured by the lateral incisor. However, when viewed from the more posterior position of the tube the canine is closer to the tube than the lateral incisor, i.e. the palatal canine has moved in the same direction as the tube shifted.

(b) **The tube shift principle** (parallax method, Clark's method, buccal object rule).
The tube shift principle was first described by Clark (1910). This second main method of localising teeth utilises the fact that *the farther away of two objects moves in the same direction as the x-ray tube* and the closer object moves against the direction of shift of the tube.(*Figure 4*)

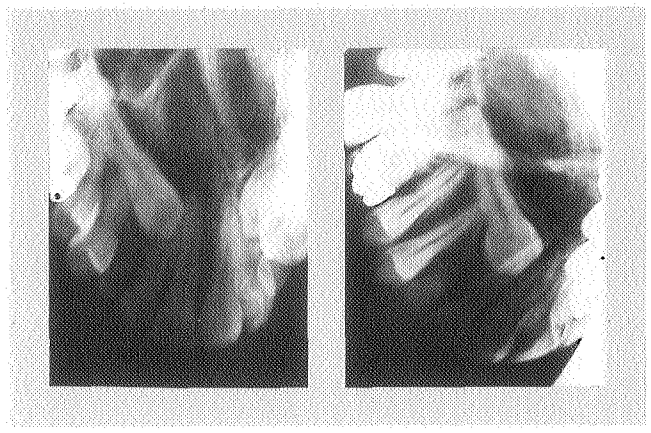

Figure 5. Anterior occlusal (left) and posterior occlusal (right).

The clinician can always refresh his memory about which tooth does what by extending two index fingers *vertically* in front of him at eye level with one finger obscuring the other. When the operator moves his head from one side to the other it will be seen that the finger further away comes into view, i.e. moves in the same direction as the viewer's head. This is a tube shift in the *horizontal* plane. Tube shifts can also be executed in the *vertical* plane. Again one can recall which tooth does what by using the two index fingers. These are held

horizontally at eye level with one finger hiding the other. Then the fingers are moved downwards and once again the further away tooth comes into view. Moving the fingers is equivalent to moving the teeth, not the tube. For illustrative purposes it is more comfortable to move one's fingers (which represent the teeth) rather than one's head (which represents the tube).

Another way of remembering the tube shift principle is to recall the acronym SLOB which is short for Same (direction of movement as the tube then the tooth is) Lingual Opposite (direction of movement to the tube, then the tooth is) Buccal (Goaz and White, 1982, page 105).

The clinician should use the tube shift principle not only to determine the position of the crown of the unerupted tooth but *also the position of the root.* Occasionally a maxillary canine lies across the arch and use of the tube shift principle will elicit this.

Which radiographs are used?

A favoured combination of radiographs is two occlusal radiographs — an anterior and a posterior occlusal. The tube shift is in the horizontal plane because vertically both films are taken at the same angle of 60°.

If the teeth are aligned regularly in the mouth then on the radiographs the teeth with *no overlapping contact points indicate that the central beam has been aligned through these teeth.*

In *Figure 5* the anterior occlusal on the left has overlap free contacts between 11 and 21 but there are overlapping contacts between 14 and 15. The posterior occlusal on the right exhibits the reverse situation with no overlapping between 14 and 15 and jumbled anteriors. So it can be determined that the tube movement between the anterior and posterior occlusals has been distal.

The 13 in the anterior occlusal does not touch the 11 but does so in the posterior occlusal, i.e. as the tube shifted distally the 13 moved in the opposite direction i.e. mesially. Therefore the 13 is labial.

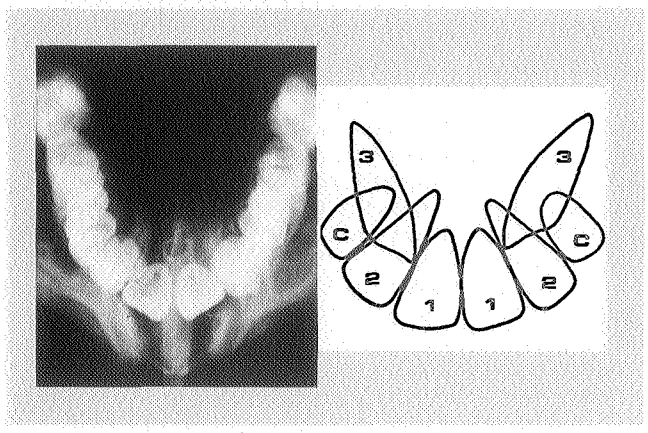

Figure 6(a). Vertex occlusal of patient in Figure 5.
Figure 6(b). Tracing.

Figure 6 shows a vertex occlusal of the same patient as in *Figure 5.*

It is not easy to see the exact position of the 13. A few observations about the vertex or true maxillary occlusal radiograph. There are disadvantages with this view:

(1) a long exposure is required with the ordinary dental apparatus and the patient may move and spoil the film;
(2) the film is always rather indistinct owing to the superimposition of various structures in the area;
(3) the absorbed dose to various radio-sensitive organs is substantial for the brain, the pituitary, salivary glands, thyroid and the lenses of both eyes receive unnecessary exposure (Berge and Wohni, 1981), and
(4) it is particularly deceptive when the lateral incisor is lying obliquely.

There is a tracing in *Figure 6(b)* of the teeth in *Figure 6(a).* Occasionally tracing a radiograph, especially a vertex occlusal, has proven helpful in determining the position of the teeth in question.

The 13 can be seen to be lingual to the 12 crown but labial to its apex. *Figure 7* shows that the two teeth could be related in either position A or B. The 13 would have been erupted in position B if it were anatomically possible to be in such a position. As was explained previously, the tooth is in position A.

Thus it can be asserted that if on a vertex occlusal the apex of the lateral incisor can be seen palatal to the crown of the impacted canine then the canine must be on the labial, although the reverse does not always hold true.

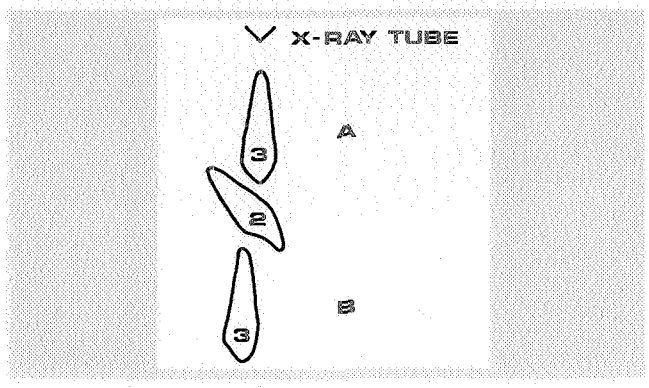

Figure 7. Possible positions of 13.

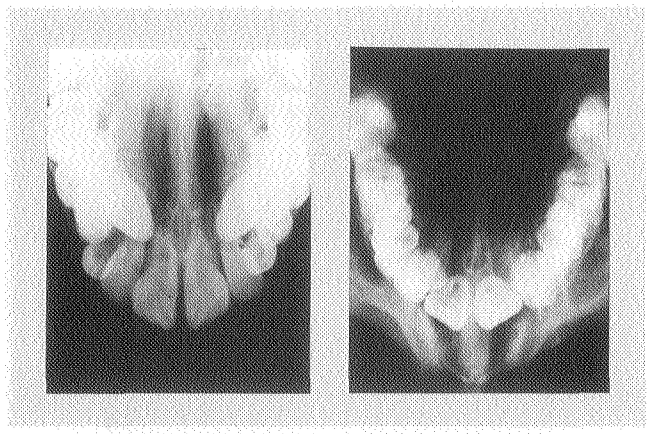

Figure 8. Anterior occlusal (left) and vertex occlusal (right) exhibiting a vertical tube shift.

The anterior occlusal radiograph in *Figure 8* was accompanied by a referral letter which stated, 'The enclosed radiograph reveals 13.23 lying in the palate.' The vertex occlusal was taken subsequently. *Figures 6 and 7* illustrated one means of deducing where the upper canines are.

Another method is to use the principle of tube shift. A vertical tube shift can be demonstrated between the two radiographs. As the tube shifted up from the bridge of the nose to the vertex of the head (i.e. from the position of taking the anterior occlusal to the position of taking the vertex occlusal) the canines moved down the roots of the lateral incisors (i.e. the canines moved in the opposite direction to the shift of the tube). Therefore once again it can be deduced that the canines are labial.

The horizontal tube shift technique utilising two occlusal views does not show as dramatically as does the vertex occlusal how far the crown of the canine is displaced from the arch. It can be deduced to some extent by the fact that the larger the movement of the impacted canine between the two views the more displaced from the arch it is (i.e. if the canine moves little between the two views then it is in the line of the arch or close to the line of the arch).

Usually periapical radiographs are seen in illustrations of tube shift. *Two occlusal films are far superior because* (i) the tube can be moved much more between the two exposures (and the integral absorbed dose is comparable to that of periapicals). The more the tube is shifted the more the impacted tooth will move in relation to its neighbour and the more certain is the diagnosis of its position; (ii) frequently part or all of the crown or the root of the impacted tooth is not captured on one of the two periapical films which are smaller than occlusal films, i.e. the periapical films are more difficult to take well.

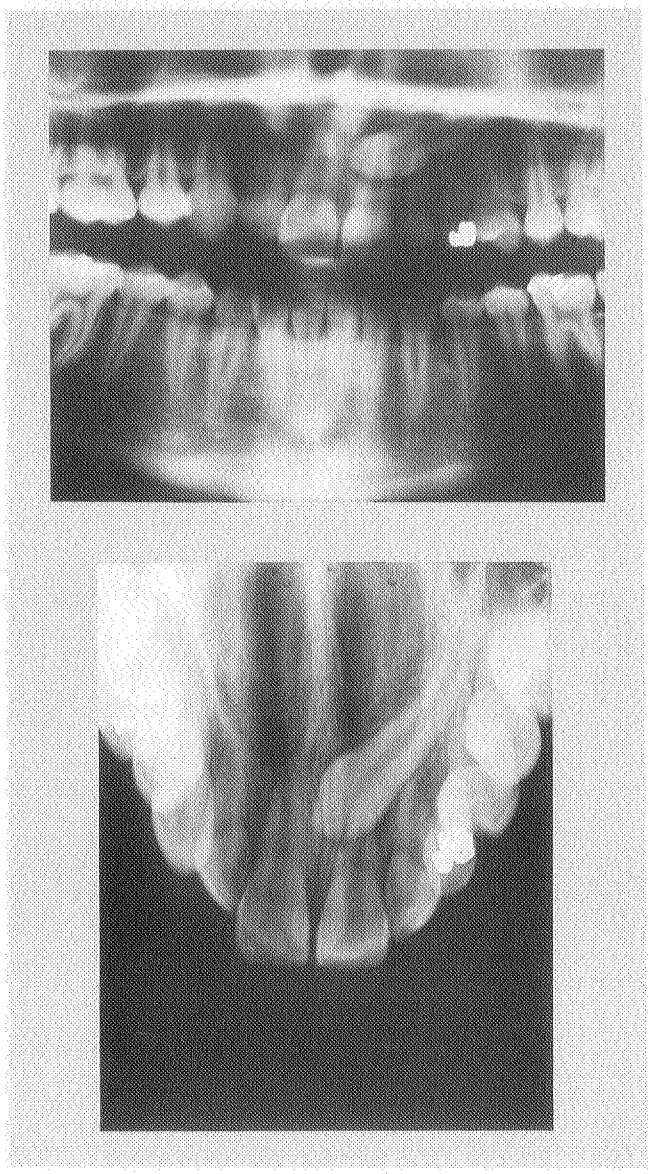

Figure 9(a). Part of OPG with impacted 23.

Figure 9(b). Anterior occlusal of same patient. A vertical tube shift between the films shows 23 is palatal.

A tube shift can also be executed with another recommended combination of radiographs, namely an OPG plus an occlusal radiograph (Keur, 1986). The shift is in the vertical plane, because an OPG is taken at an effective angle of +7° to the occlusal plane, the occlusal at +60°. In *Figure 9(a),* the OPG, the top of the 23 crown is level with the apex of 21. In *Figure 9(b),* the occlusal, the top of 23 crown is well above the apex of 21 i.e. the 23 has moved with the tube. Therefore it can be deduced that the 23 is palatal. However this combination of films can have limitations when contrasted with a horizontal tube shift employing two occlusal films, because

(1) sometimes the apices of the incisors which are used as reference points are unclear on the OPG due to the superimposition of various structures;

(11) the amount of tube shift is less and so the amount of movement of the image of the impacted tooth is reduced;

(111) since the reference tooth (usually the lateral incisor) is in the same plane in which the tube shift is performed the image of the reference tooth can be distorted. It is usually foreshortened on the occlusal radiograph and this can make interpretation of the direction of movement of the image of the impacted tooth difficult.

Similarly the vertical tube shift of *Figure 8* is not as easy to discern as is the horizontal tube shift in *Figure 5.*

(c) **Stereoscopy** (Stereoradiography)

Stereoscopy has been practised for many years. Clark, in 1910, stated that he introduced the tube shift principle because it 'is especially useful for fidgety nervous children, where a stereoscopic view is quite impossible, because it does not matter in the least if the child moves about between the taking of each radiograph.'

Two intra-oral periapical films are taken at the same vertical angulation but one film is at 10° to one side of a true perpendicular projection and the second film is taken at a horizontal angulation that is 10° to the other side of the perpendicular. The two films are then examined through a special viewing device. Wolf and Mattila (1979) stated that it is a simple and reliable technique in spite of some drawbacks.

Two less accurate methods of localisation are to use the principles of

(a) image magnification and

(b) image sharpness.

(a) **Image magnification**

According to Goaz and White (1982 page 99) the enlargement of the image over that of the object is caused by the divergent paths of the photons in the x-ray beam. One factor in determining the magnification is the object to focal spot of the x-ray tube distance, another is the object to film distance.

If two objects are of equal size then the *object closer to the focal spot and further from the film will produce a larger image* on a film than an object further from the focal point and closer to the film.

Theoretically a single OPG may be used to determine the labio-palatal location of an impacted canine. Teeth situated at the palatal aspect of the dental arch, i.e. closer to the tube and further from the film become enlarged, while those on the labial side are diminished when compared to the size of teeth in the line of the arch.

Wolf and Mattila (1979) did an investigation into the reliability of localisation based on a single OPG. Two observers determined in a blind test from a single OPG the labio-palatal location of the impacted canine and verified their findings on stereo-radiographs and by the use of tube shift. When determining the labio-palatal location of the impacted canines from OPGs on the basis of magnification, one of the examiners made a correct assessment in 88 percent of the cases, the other in 89 percent. The greatest accuracy was achieved with regard to palatally located teeth, 95-99 percent of which were correctly localised. Of the teeth located in the line of the arch about two thirds were correctly localised; of those located labially, only about half.

It was considered easy to localise the tooth on the basis of the OPG in about 60-65 percent of the cases in which the differences in magnification seemed obvious. Accuracy in these cases was 93-94 percent.

In one third of the cases it was difficult or impossible to localise the canines because the differences in magnification were slight. The assessment was particularly difficult if the teeth to be compared were rotated.

Wolf and Mattila concluded that the determination of the labio-palatal location of impacted teeth based on a

single OPG is therefore unreliable and the method is not suited for clinical use. In *Figure 9(a)* the principle of image magnification could not be used to determine that 23 is palatal.

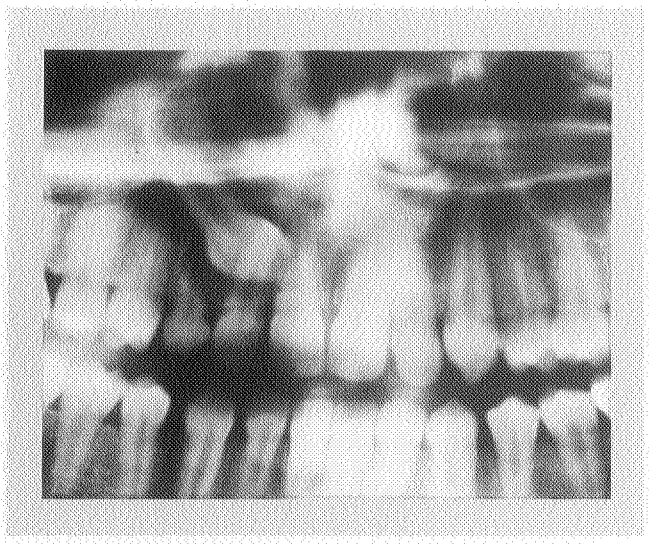

Figure 10. Part of OPG illustrating magnification of 13.

Nevertheless, image magnification can be a helpful supplementary tool for localising teeth. In *Figure 10* the impacted 13 is much larger than the adjacent 14 (and the 23) and so it can be concluded that the 13 is palatal and *Figure 11* shows this deduction is correct.

Figure 12 has been included to illustrate the differences in magnification when one canine is labial and the other palatal. The image of the labial 23 is much smaller than that of the palatal 13. *Figure 13* shows the teeth when they have been uncovered.

Before attempting to use the image magnification principle to localise impacted canines the clinician should compare the size of the erupted teeth on the left and the right of the mouth to ensure that there has been no distortion. This can occur because the patient was not centred correctly in the OPG machine.

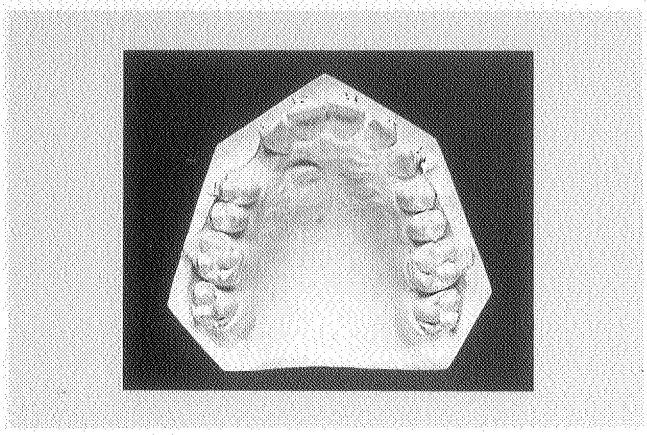

Figure 11. Model shows 13 is palatal.

(b) **Image sharpness**

This is a measure of how well the minimum details of an object are reproduced on the radiograph. One way by which *resolution can be increased is by decreasing the object to film distance.* Riordan (1957) mentions a phrase which apparently was frequently heard then as an aid to diagnosis: 'the nearer the clearer', i.e. the clearer the image of an object is, the closer it is to the film.

S.S.White. Dental Products International. Three Parkway. Philadelphia. Pa 19102 U.S.A.

He did some simple tests to show that this was not invariably correct. Although it is not an axiom that always gives the right answer the 'nearer the clearer' rule is useful as another extra aid in the localisation of misplaced teeth.

Figure 10 was used previously to illustrate the magnification principle to localise the 13. Comparing the sharpness of 13 with the sharpness of the 23 once again permits the deduction that 13 is palatal.

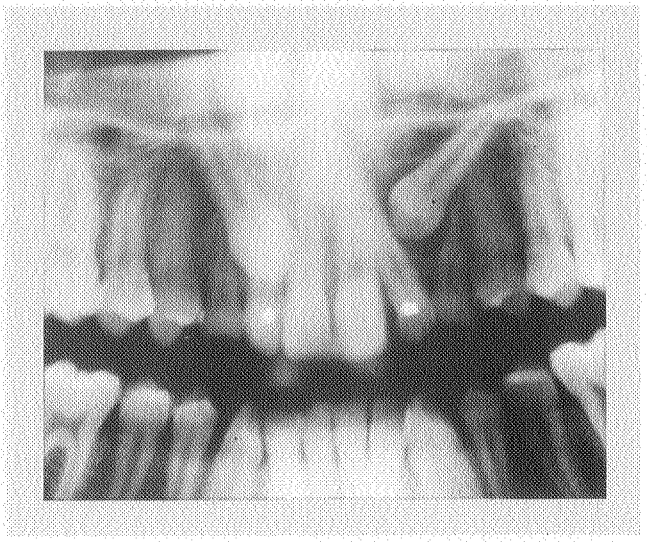

Figure 12. Part of OPG illustrating differences in magnification between palatal 13 and labial 23.

Figure 12 earlier employed the magnification principle to determine that 13 is palatal and 23 is labial. Comparing the sharpness of the images of the two teeth also suggests that 13 is palatal and 23 labial. (The difference in sharpness is more noticeable in the original radiographs than in their reproductions in *Figures 10 and 12.*)

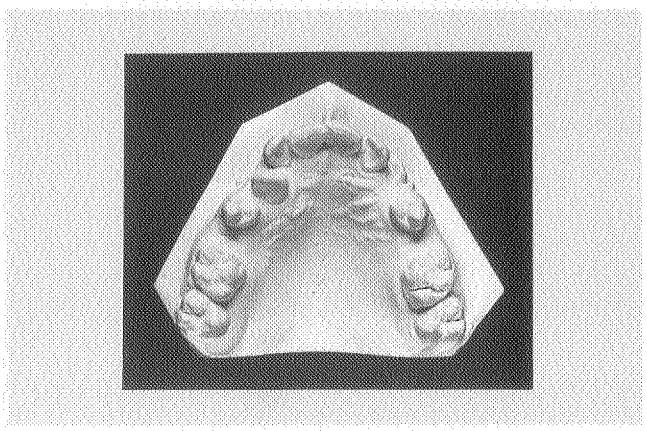

Figure 13. Model of same patient as Figure 12.

Turk and Katzenell (1970) explained how to localise impacted maxillary canines with a single panoramic tomogram produced with a Panorex machine #(S.S.White), using the two images of anterior teeth that are produced with the Panorex. However, Beeching (1982) warned that this technique may fail to ascertain the position in all cases. Beeching's warning is another example of the fact that if any tooth is hard to localise the clinician may need additional views, i.e. as is the case for any difficult diagnostic problem in dentistry or medicine, extra tests may be required.

CONCLUSIONS

For the significant percentage of maxillary canines that need radiographic views to localise their position, radiographs which have already been taken may provide sufficient information.

If they do not, the additional radiographs of choice are two occlusal radiographs, employing the tube shift principle.

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