DENTAL ROENTGENOGRAPHY OF HIGH MAGNIFICATION (REPORT 1)

INDIRECT ROENTGENOGRAPHY OF 6-TIMES MAGNIFICATION

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It is the purpose of this paper to describe in detail our practical method of dental roentgenography of 6-times magnification and to discuss its diagnostic value.

METHOD AND MATERIALS

An X-ray unit of the usual full wave type was used. A rotating anode tube with a focus of 1.5×1.5 mm in size was attached to this unit and at the radiation mouth of the X-ray tube a long cone made of vinyl pipe, 120 cm in length and 4 cm in diameter, was applied.

A patient was positioned his head and abdomen on a dental chair and the body was fixed tightly with a bandage.

A dental film was placed just behind the back of the tooth to be radiographed by our film holder.

In this radiography the film is the key for success. As the Fuji nonscreen industrial film of type 80 can stand 6 times magnification without any graining of the images and the speed is a half of the usual medical X-ray film, this type of X-ray film was used.

To avoid the blurring caused by the penumbra the X-ray tube was situated 130 cm away from the film. The length of the penumbra was estimated by the magnification ratio $\times$ focus size $\times \frac{\text{object-film distance}}{\text{focus-object distance}}$.

As the thickness of the dental gum is estimated to be less than 3 cm, it will be sufficient to make the length of the penumbra less than 0.2 mm when the distance between the focal spot and the film is 130 cm and the film is placed close to the surface of the gum.

It is not recognizable when the blurring of the image is less than 0.2 mm, and such a small penumbra can be said to be neglible for clinical use.

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To asses the resolving power of this film an experiment was made with several types of test objects made of copper wires arranged parallel with intervals of the distance of the diameter of the wire. The wires used were 100 μ, 75 μ, 25 μ and 13 μ in diameter.

When the test objects were exposed under the exposure conditions of 60 kV, 5 mA, 2 seconds, focus film distance of 130 cm, and test chart-film distance of 3 cm, developed and magnified 10 times, the image of the wires on the film was resolved sharply without any marked grainness of the photosensitive emulsion with wires of up to 13 μ in diameter (Fig. 1). Following this basic experiment the actual dental roentgenography was carreid out.

For comparing our method with the usual dental radiographic method, dental radiography was undertaken with an Oralix (philips) using the usual dental X-ray film and the following exposure conditions, 60 kV, 1.5 seconds, focus film distance of 15 cm (Fig. 2).

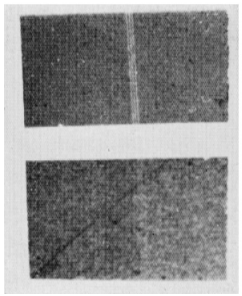

FIG. 1

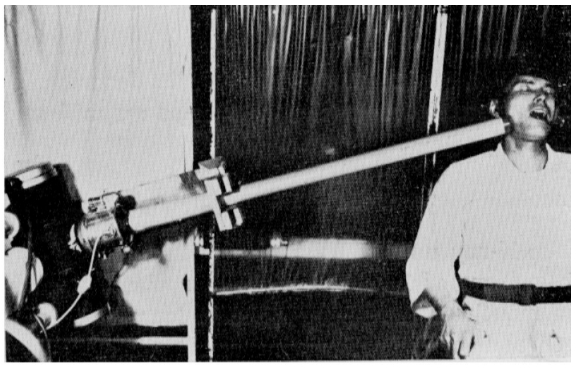

FIG. 2

FIG. 1. X-ray image of a test object made by three wires of 13 μ in diameter arranged parallel with each other at intervals of the diameter of the wire.

Top: Ten times magnified roentgenogram taken by our method.
Image of wires clearly resolved.

Bottom: Ten times magnified usual dental roentgenogram taken by the usual dental radiographic method.
Image of wires not resolved, but grainess of film disturbing observation.

FIG. 2. Our dental radiographic technique.

The central beam of the X-ray was directed perpendicularly on the center of the film by means of a long cone. Distance between the focal spot and the film was then made to be about 130 cm; the exposure factors were as follows, 60 kV, 200 mA, 3 second, for some cases 110 kV, 200 mA, 1 sec. Figure 2 shows the actual scence of dental roentgenography by our technique. The film was enlaged by a photographic enlarger 6 times.

RESULTS

Our technique was applied to the teeth equally of well the upper and lower

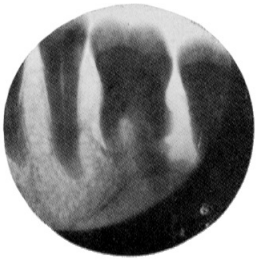

FIG. 3. Roentgenogram taken by our method.

FIG. 4. Roentgenogram of 6 times magnification enlarged indirectly by means of the roentgenogram of Fig. 3.

FIG. 5. Roentgenogram taken by the usual dental roentgenographic technique.

FIG. 6. Roentgenogram of 6 times magnification enlarged indirectly by means of the roentgenogram of Fig. 5.

TABLE 1. Findings Obtained by the Dental Radiographs

Methods	Dental X-ray unit		Ordinary X-ray unit attaching long cone			
	Dental film		Dental film		Film type 80	
Region radiographed	Magnification × 1	Magnification × 6	Magnification × 1	Magnification × 6	Magnification × 1	Magnification × 6
Enamel	Homogeneous	Homogeneous	Homogeneous	Homogeneous	Homogeneous	Homogeneous
Cementum	Homogeneous	Homogeneous	Homogeneous	Homogeneous	Homogeneous	Homogeneous
Dentin	Homogeneous	Homogeneous	Homogeneous	Homogeneous	Homogeneous	Homogeneous
Border of enamel and cementum	Not defined	Not defined	Not defined	Not defined	Not defined	Distinguishable
Pulp	Not distinct	Not distinct	Not distinct	Not distinct	Slightly distinct	Slightly distinct
Dental canal	Zonular	Smooth margin	Zonular	Rough margin	Zonular	Rough margin linear calcification
Apex	Not distinct	Not distinct	Slightly distinct	Slightly distinct	Slightly distinct	Slightly distinct
Periodontal membrane	Partly distinct	Partly distinct	Linear but discontinuous	Linear but discontinuous	Linear	Sharp; definite relation to periost and cementum
Alveolar bone	Not distinct	Not distinct	Not distinct	Trabeculation discontinuous	Not distinct	Distinct
Intratrabecular spaces in "interalveolar septal space"	30	40	35	40	35	70

jaws. In this report our experience with the left upper second premolar and first molar of 65 year old female will be described in detail (Fig. 3, 4, 5 and 6).

No difference was seen in the findings of the inner structure of the enamel, cementum and dentin of a tooth, in the images on radiograms taken by the conventional or our method. Borders between these structures were, however, clearly defined much more with our method of radiography. Furthermore, the walls of the dental canal were imaged with irregularity, and in the intracanalicular space of the premolar, there was observed the linear image indicating calcification within the space.

The periodontal membrane between the cementum of the tooth and the alveolar bone was imaged as a clear line of negative shadow, indicated not always by an uneven contour with our method. The apperance of the contour was not imaged so simple but complicated when this method was used. The first molar tooth was imaged without a shadow of the periodontal membrane by both methods, probably due to destruction caused by an old periodontal inflammation. The absorption of bone tissue in the distal root as well as in the proximal root revealed a former abscess formation.

The X-ray image of the trabeculation of the alveolar bone was distinctly seen as net works. In order to compare the sharpness of the image on the radiograms taken by both methods, the number of networks of the trabeculation was calculated in the square of interalveolar septal space.

This square was made by joining four points, confront necks and apexes of the roots of the scond premolar and first molar.

On the 6-times enlarged radiograph there were 70 such net works, whereas, on the normal, not enlarged, radiograph by the usual dental X-ray unit there were seen only 30.

These data are shown in detail and summarized in Table 1.

DISCUSSION

Though an indirect method[1] of radiography of high magnification has been studied for the past ten years (Fletcher[2], Komiyama[3] and Giladoni[4]), there has appeared no detailed report of the technique applied to dental radiology for practical use.

Theoretically considered, indirect enlargement radiography could be used for magnifications of over one hundred times or of 30 times at least[4], but 5 or 6 times magnified radiograph will be the limitation for practical use, as greater magnification will become insignificant because of fading off the finer bone image caused by very small difference in of X-ray absorption.

Homogenous tissues, enamel, cementum and dentin of the teeth, were not imaged because the components of these tissue were too small to be magnified by the magnification ratio used and thus they faded out.

Linear calcification within the intracanalicular space, which failed to be imaged by the conventional method, was imaged by our radiography as a result of gap effect[5) 6) 7) 9)].

It can be thus considered to be correct that the increase of the number in trabeculation of the bone image on the enlargement radiogram was caused by

the gap effect as detailed in the previous paper[5)8)9)].

For simplicity, study of this radiograph with a magnifying lens or projector is recommended, as processing of this radiograph on photosensitive paper is troublesome and time consuming.

SUMMARY AND CONCLUSION

A method of dental roentgenography of 6-times magnification was described. For this, a fine granule film of relatively good sensitivity (Fuji industrial non screen film of type 80) and an ordinary roentgenographic unit with a long cone of 120 cm in length were used.

A comparison of our method with the usual dental radiograpic method was made. Our method was applicable for practical use and findings which were not imaged by the usual dental radiographic method, such as the details of the dental canal and periodontal membrane, were obtained.

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