The Use of a Mobile Source of Light in Radiography.

By

YRJÖ V. PAATERO.

Everyone who has radiographed human anterior teeth is well aware that not more than two or three teeth can be satisfactorily seen on one film. The outermost teeth are always obliquely projected, "stretched" in the horizontal direction, and often superimposed, in addition. This difficulty in radiographing the incisors is due to the shape of the dental arch, viz. the curve of its anterior part. Largely on account of this anterior part of the dental arch 10—16 films must be made to obtain a full mouth survey, dental films of the common size 3 × 4 cm. being used.

As this method of radiographing the upper and lower teeth requires much time and film material, I began to design a simpler method for full mouth examination. Continuing my studies I finally found a method, which appeared good at least in theory and seemed to be possible to realize.

As the accuracy of a full mouth survey is, in a manner, directly proportional to the number of the separate images, the best combined image would be obtained if the number of the separate images were indefinite. And it may be imagined that an indefinite number is attained by allowing a very narrow vertical cluster of rays to move slowly and equally along the set of teeth to be radiographed. If a demi-wave roentgen outfit is available — and most dental roentgen outfits are probably of this type — the maximum speed with which the cluster of rays moves is determined by the frequency of the alternate current; if the speed is too great a linear image will be obtained. Besides, the speed of the film and the intensity of radiation are of course factors to

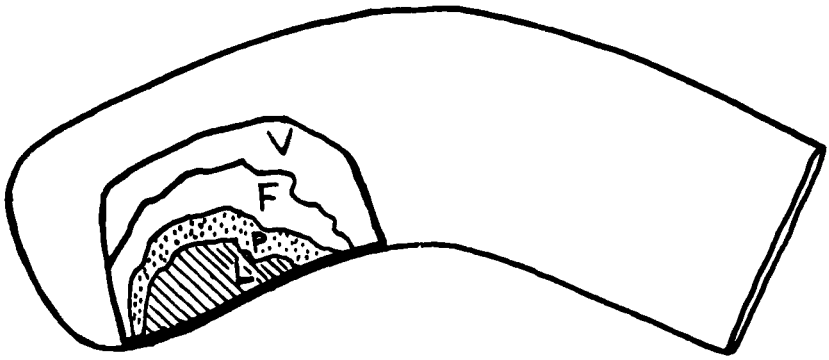

Fig. 1. The use of the film in the tests in the lower jaw, diagrammatically presented. The intensifying screen (V), the film (F), the black paper (P) and the lead plate (L) have been closed into a casette of thin rubber.

be considered when determining the speed of the movement. The cluster of rays should, when moving, always be perpendicular to the alveolar process. By this means a full mouth survey is made in which every tooth, and even each detail of tooth, is orthoradially projected on the film. Thus, by the use of this method the usual thickening of the teeth is avoided, but, on the other hand, the teeth in the curved anterior part of the alveolar process appear slightly narrower than they actually are, as a result of the curve of the film being shorter than the corresponding alveolar arch. From the point of view of diagnosis a slight narrowing of this kind probably causes no disadvantage as a rule. The extent of the narrowing naturally depends on the shape of the jaw to be radiographed. The narrower the anterior part of the jaw, the greater is the narrowing of the teeth in the image.

As the new method is based on the equal motion of the roentgen focus and the patient in relation to each other during exposure, it remains to be decided, which of the two, the roentgen tube or the chair on which the patient is sitting, is to perform this motion. Without going deeper into the question it may appear simpler to construct a mobile roentgen tube which rotates around the patient's jaw and turns in a suitable manner. On closer consideration it is easily observed that construction of a mobile chair is, however, much easier. In addition, roentgen examinations may then be made by the new method with any roentgen equipment to which a slit director tube is fitted. The movement of the chair may of course be brought about in different ways. In the in-

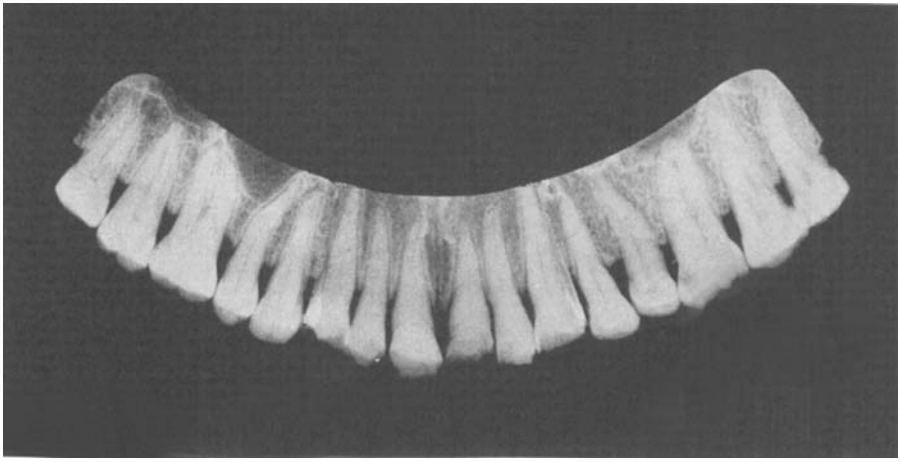

Fig. 2. A radiograph of the upper jaw, taken by proper motion.

terest of economy a construction as simple as possible should be aimed at in order that the new method might become extensively used. As regards the question of motive power, the chairs could be wroked either by hand or by motor, in which latter case the motor could be electrically connected with the roentgen outfit, in such a way that also the chair could be set in motion by pressing the button of the timeswitch. Such a syncronization of motion and exposure would perhaps be practical and easy to realize.

When carrying out my experiments I have not had a chair of this kind at my disposal, *i. e.* one moving linearly forward and backward as well as around its vertical axis. Therefore I have used only a rotatory motion and the images cannot consequently be nearly as good as when the patient's motion corresponds to the shape of the dental arch.

The row of teeth (alveolar arch) is generally straight from the wisdom tooth to the first premolar. Then follows a regular circle (c. 130 degrees), the centre of which is on the line of intersection of the medial plane and a vertical plane passing through the mesial surfaces of the first molars.

If an exposure is to be made by the slit method without the proper chair being available, fair results may be obtained in some cases, as shown by the attached radiographs (Fig. 3), by moving the chair only around the vertical axis, a suitable point on the line of intersection of the medial plane and a vertical plane passing

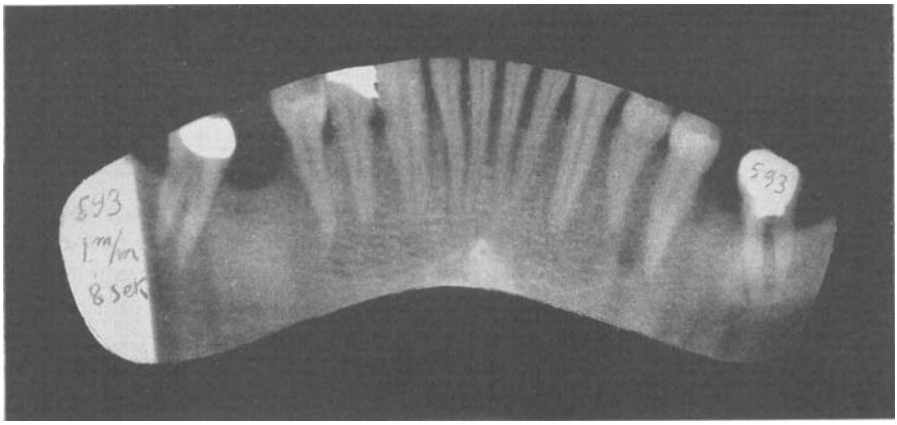

Fig. 3. A radiograph of the lower jaw, taken by rotary motion.

through the second molars being chosen for the centre of the rotatory movement. The definitive location of the point is determined by the shape of the dental arch in each case.

In order to produce the cluster of rays required for the application of the new method I have made experiments with different director tubes. My latest director tube is telescopic so that by extending and shortening it the focus-slit distance required in each case can be obtained. The tube may be of ebonite or some other insulating substance. Its interior surface is lined throughout with lead plate for the purpose of preventing the escape of roentgen rays from the tube. The outer end of the director tube is also fitted with a lead plate which has a narrow vertical slit, through which a narrow fanlike cluster of rays may issue. The width of the slit should be adjustable. The fact is namely that, when an object is radiographed on a straight film, the slit can be broader than if a curved film is used, as is the case for instance when exposures of the anterior teeth are made. On the basis of my experience to date, a slit, 0.5 to 1.0 mm. in width, must be used for the anterior teeth, whereas a good result is obtained in the molar area even with a slightly broader slit. When a whole set of teeth is radiographed it is of course necessary, for practical reasons, to use a slit which is suitable both for the anterior teeth and the molars.

It is of course advisable to try to keep the slit-film distance as small as possible during the exposures in order to obtain an image with sharp outlines in all details.

As regards the size of the vertical direction angle of the central beam, the rules which are used at present may be followed in the main. This angle must generally be bigger when incisor teeth are radiographed than in the case of molar teeth and attention must be paid to this requirement also in the new method. This may be realized in practice by bending the patient's head slightly forward for the upper-jaw examination and, on the contrary, slightly backward when the lower teeth are radiographed. When the beam director is in addition adjusted so as to form a definitive angle with the horizontal plane, the correct vertical direction of the central beam is obtained, on an average.

As the films required for the slit method are not yet available, strips of suitable shape and size have been cut from ordinary big films. Films of different shape are needed for the upper and for the lower teeth. As even the most rapid films available are not as such rapid enough, an intensifying screen has been used to increase the rapidity. Fig. 1 shows diagrammatically the use of the film in the tests. The intensifying screen (V), the film (F), the black paper (P) and the lead plate (L) have been closed into a casette of thin rubber. When thus used, this kind of film is adequately exposed during 8 seconds, and an image of the whole set of teeth is obtained by turning the chair only once.

For the purpose of keeping the film in position I have constructed a metal holder, the shape of which corresponds with that of the normal dental arch of man. This holder is placed in the mouth behind the teeth in such a way that the film will be between the holder and the set of teeth; thus the holder presses the film from the inside against the alveolar process and teeth along the whole length of the dental arch. On both sides in the area of the molars the holder has a small horizontal rubber-covered appendage. When the patient now closes the jaws these appendages remain between the upper and the lower teeth and the film remains firmly in position during the exposure. The holder is made of thin metal plate and it may thus be bent by hand so as to suit each mouth.

Application of the Slit Method in General Radiography.

Although my slit method was originally designed to simplify dental radiographic examinations, it is of course also suitable for roentgen examinations of other objects. By the use of this method an isometric image of an object is obtained in the direc-

tion of the motion, but in the longitudinal direction of the slit the usual phenomenon occurs that the image is larger than the radiographed object. This enlargement of the image is due to some well known factors.

Experiments have shown that, by the slit method, very accurate images are obtained on ordinary straight films and in that case

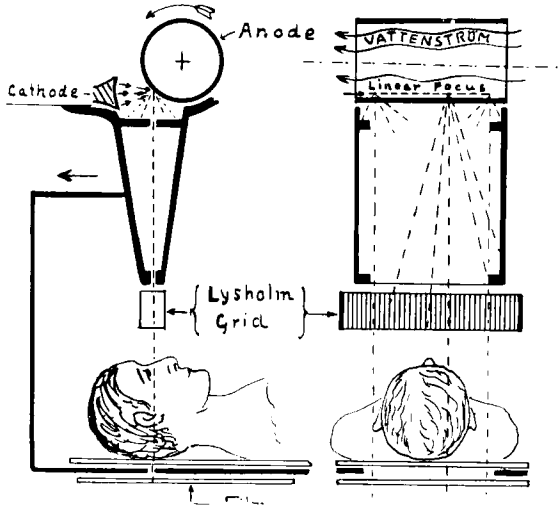

Fig. 4. Schematic diagram of a roentgen apparatus provided with a linear focus.

the distance between the various points on the object in the direction of the movement may be measured direct from the radiograph; in the longitudinal direction of the slit the required corrections must be made, however.

As now the enlargement of the image in one direction is eliminated, thanks to the slit method, the thought occurred to me whether it might be possible to eliminate enlargement also in the other direction.

It can be made at least in theory by replacing a point-like focus by a linear focus, the length and direction of which equals those of the slit (Fig. 4). In this linear focus every point of course acts as a point focus issuing roentgen rays into different directions. Oblique radiation should thus necessarily be eliminated by allowing only those beams to issue through the slit which meet the film perpendicularly. This elimination of oblique radiation would perhaps take place most practically by means of a mobile grid (LYS-

HOLM) which, in my opinion, should be close to the slit of the director tube in order to prevent oblique radiation from reaching as far as the object to be radiographed. Motion of the grid would naturally be in the longitudinal direction of the slit.

In order that an effective cooling would be brought about, the anode could for instance be a rotating hollow cylinder of metal, through which the water would run.

After having developed my linear focus theory, reported above, on account of the good results I had achieved in the radiography of teeth, I noticed that Mr. ROBERT H. MILLWEE (Radiology 1937, vol. 28 n:o 4) had constructed a roentgen apparatus, the tube of which moves horizontally above the patient's table. If a roentgen apparatus like this was provided with a linear focus anode and a Lysholm grid in the way I mentioned, quite isometric radiographs could be taken. By means of two images taken in this way, perpendicularly to each other, the place of some extraneous object in the tissue could exactly be traced.

Summary.

On account of the positive experiences acquired by the author in the use of a mobile source of light for the radiography of teeth, he has thought of applying the same method to all medical radiography in the following way; out of a roentgen tube moving parallelly to the plane of the film and fitted with a linear focus, a cluster of rays is sent out of a narrow lead slit through the object in the direction of the film. The oblique primary rays are eliminated by a Lysholm-grid moving between the ray directing tube and the object. By proceeding in this way fully isometric roentgen pictures could be obtained.

Zusammenfassung.

Wegen der positiven Erfahrungen, die der Verfasser von der Anwendung einer beweglichen Lichtquelle bei der Röntgenphotographie der Zähne erworben hat, hat er sich die Anwendung derselben Methode bei jeder medizinischen Röntgenphotographie auf folgende Weise vorgestellt. Aus einer Röntgenröhre, die sich mit dem Plan des Films parallel bewegt und mit einem Linearfokus ausgestattet ist, sendet man, nach dem Film gerichtet, durch eine enge Bleispalte ein Strahlbüchsel quer durch das Objekt.

Ein Lysholm-Gitter, das sich zwischen der Richtungsröhre der Strahlen und dem Objekt bewegt, eliminiert die schiefen Primärstrahlen. Durch diese Methode könnte man vollkommen isometrische Röntgenbilder erhalten.

Résumé.

Se basant sur les expériences personnelles positives de l'emploi d'une source de lumière mobile dans la radiographie des dents, l'auteur propose l'application du même procédé à toute radiographie médicale de la manière suivante. D'un tube Roentgen, se mouvant parallèlement au plan de la pellicule et muni d'un foyer linéaire, on fait diriger vers la pellicule, par une fente de plomb étroite, un faisceau de rayons à travers l'objet. Un grillage de Lysholm, se mouvant entre le tube directif des rayons et l'objet supprime les rayons primaires obliques. Par ce procédé on pourrait obtenir des radiographies complètement isométriques.

Address:
Skarpskyttegatan 4 B,
Helsinki,
Finland.