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ORTHOROENTGENOGRAPHIC MEASUREMENT OF LONG BONES

By

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As operations checking the growth of the lower extremities in children are becoming more common, the need for an easy and reliable roentgenographic method of measurement is increasing.

Direct measurement on teleroentgenograms still seems to be the method mostly used. It is useful for comparison of matching bones at a certain time, but it results in some enlargement, increasing with the growing object-film distance. Therefore it is not satisfactory for comparing measurements at intervals of some length.

Green, Wyatt & Anderson (3) have shown that orthoroentgenograms ought to be preferred, and they have constructed a cassette for the purpose. An improvement of their method is *Goldstein & Dreisinger's* (2) "spot orthoroentgenography", which is very good and accurate. According to this method an isolated exposure is made of each joint on one large film (14″ × 36″) by means of a long cylindrical "cone". Both extremities are on the same film, and the measurement is made directly on the film. By the former method a film of similar size is used, and direct measurement also, but matching joints are exposed simultaneously, which can be a source of inaccuracy. Both methods are expensive, as a film of such size in Norway costs more than 20 kr. a piece, and the necessary cassette with screens probably about 1000 kr. Moreover, our ordinary X-ray departments do not usually have the dark room equipment necessary for treatment of such giant films.

Earlier *Merril* (1) constructed a grid for orthoroentgenographic measurements of bones with markings consisting of parallel copper wires one inch apart. He exposed each pair of joints simultaneously; inaccuracies may also arise if the axes of the extremities are not parallel and perpendicular to the markings.

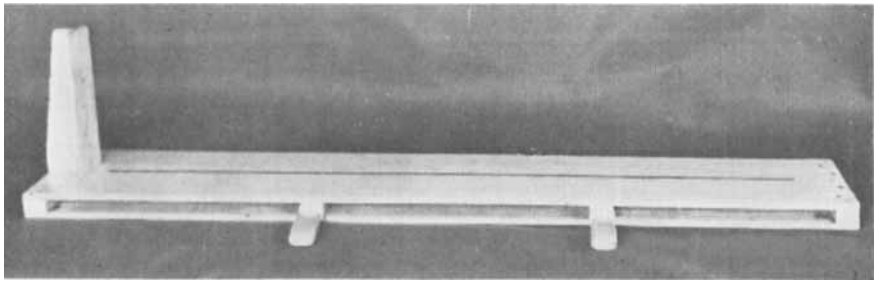

Fig. 1.
Measurement tunnel made of 7 mm. plywood, length 116 cm., breadth 20 cm., space between top and bottom plate 2 cm. Corresponding to the dark stripe along the center of the top plate, and facing the space of the tunnel, a ruler with roentgenopaque markings for each centimeter and ciphers for every 5 cm. is inserted.

Formerly I tried to use an orthoroentgenographic method of measurement employing an ordinary ruler with roentgenopaque markings placed under the extremity to be measured, and the film in the Potter-Buckey diaphragm. However, I did not find the method satisfactory.

After having studied the paper of *Goldstein & Dreisinger*, I made a "measuring tunnel" which, in my opinion, gives practically the same accuracy as "spot orthoroentgenography", but is more suitable, as small films are used which are cheap and easy to handle. The tunnel (Fig. 1) is made of 7 mm. plywood, length 116 cm, breadth 20 cm., distance between top and bottom plate 2 cm. It is open longitudinally on both sides. Inlaid in the top plate, facing the opening of the tunnel, is a ruler, 100 cm. long, with markings at each cm. and ciphers at every 5 cm. Ordinary ball-bearing balls, 1.6 mm. diam. are used for markings. The ciphers are made of lead-wire. Two movable intermediate pieces serve to prevent the roof of the tunnel being pressed against the film cassette. One end of the top plate is furnished with a footpiece to steady the patient who is fixed to the X-ray table in the usual way (Fig. 2).

For measurement the patient is placed on the tunnel, the longitudinal axis of which should coincide with that of the extremity. The foot ought to be fixed in slight inward rotation. The X-ray tube ought to be focused over each joint by means of a lead line, and there ought to be on the tunnel a corresponding lead marker for later control that the adjustment has been correct. One exposure is made on a separate film of each joint necessary for the measurement. If more of the bone is wanted on the roentgenogram, any size of film can be placed in the tunnel. – For calculation the extremity of the joint-end on the roent-

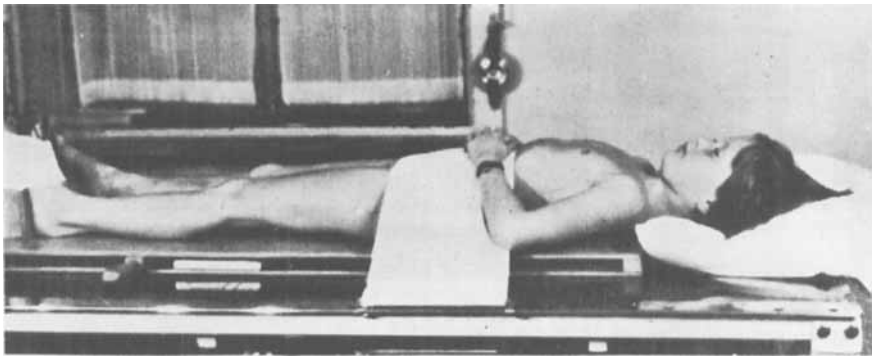

Fig. 2.
Patient placed on the tunnel, fixed to the footpiece of this and to the X-ray table. Filmcassette under the knee-joint, the joint-line marked, corresponding lead marker on the top plate of the tunnel.

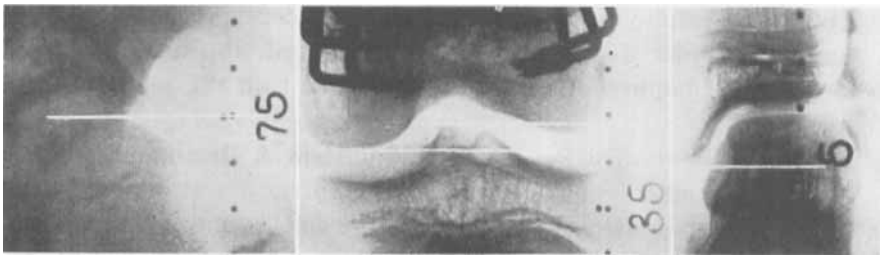

Fig. 3.
Roentgenograms for measurement of left femur-tibia. Femur: 75 — 36.2 = 38.8 mm. Tibia: 36.8 — 4.7 = 32.1 cm. Femur-tibia: 75 — 4.7 = 70.3 cm.

genogram is projected to the ruler by means of a square, "fine-measured" with a millimeter-scale, and the length of the bone, eventually the extremity, is found by simple subtraction (Fig. 3).

Most important for an accurate result is the centering of the X-ray tube perpendicularly over the joint space, and the coinciding of the axis of the extremity with that of the ruler. The difference in accuracy between this method and "spot orthoroentgenography" is very little, as the distance object–film is only about 10 mm more than it is in the latter method. The magnification of the ruler is inconsiderable, as the distance ruler–film is only about 5 mm, and the finer measuring on the film takes place inside the one centimeter hit by the central ray. In Martina Hansens Hospital the measurements are carried out with a anode–film distance of 120 cm.

Owing to correct centering the variations between different measurements of the same patient with a few days interval has not

exceeded one millimeter. (The method seems to permit measurement with an accuracy of half a millimeter, but we did not aim at an accuracy greater than one millimeter). For control of the method we made a direct comparison with roentgenographic measurement of a bone preparation placed at suitable height over the tunnel; the difference was one millimeter.

Measurement with this device is inexpensive, as measurement of two lower extremities with six exposures, two on 13 × 18 cm. films (hip joints) and four on 9 × 12 cm. films (knee and ankle joints) costs about 3 kr., and the device itself can be made at a low cost.

SUMMARY

A device for orthoroentgenographic measurement of long bones is described. It is of the tunnelcassette type with an inlaid roentgenopaque ruler. It is highly accurate, and is inexpensive in manufacture and operation.

RESEME

Description d'un procédé de mensuration orthoroentgenographique des os longs. Type de cassette-tunnel avec insertion de rouleaux roentgen opaques. Le procédé est extrêmement exact, peu coûteux à la fabrication et à la manipulation.

ZUSAMMENFASSUNG

Eine Einrichtung für die orthoröntgenographische Messung von langen Knochen wird beschrieben. Es dreht sich um die Tunnelkasettentype mit eingelegtem röntgenopaquem Masstab. Die Apparatur gestattet sehr genaue Messung und ist billig in der Anschaffung und Handhabung.

REFERENCES

1. *Merril, O. E.:* Am. J. Roentgenol. 1942: 48: 405.
2. *Goldstein, L. A. & Dreisinger, F.:* J. Bone and Joint Surg. 1950: 32 A: 449.
3. *Green, W. T., Wyatt, G. M. & Anderson, M.:* Ibid. 1946: 28: 60.