Radiography of the Temporomandibular Joint in Orthodontics[1]

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Within the past quarter of a century, radiography has established itself as an essential adjunct to the specialty of orthodontics. Those in the field of research freely acknowledge the vital part played by radiography in their investigations, while in the office of the practicing orthodontist, pre-treatment radiographic examinations have become a routine procedure.

In 1931, Broadbent devised the Broadbent-Bolton Cephalometer[1], for the taking of identical and scientifically accurate radiographs of the heads of living individuals over any chosen period of time. This made it possible to conduct radiographic investigations on growth and development which have had a widespread influence in the changing of concepts and treatment of orthodontic problems.

The complexity of the Broadbent apparatus, necessitated by investigative purposes for which it was designed, led to its installation mainly in teaching institutions and research centers. The orthodontist, however, recognizing the wealth of information that could be gained from cephalometric radiography, demanded less complex equipment which could be incorporated for use with the dental radiographic machine. This resulted in the development of head-holders of varying designs, which have proven their practical worth as substitutes in dental offices for the Broadbent-Bolton instrument.

Today's orthodontist, aided by the information gained from intra-oral, extra-oral, and cephalometric radiographic examinations, is more certain of his diagnosis, which in turn assures a more logical treatment plan. There is, however, another anatomic structure, intimately associated with the human denture, that requires radiographic examination if the information is to be complete. That structure is the temporomandibular joint.

The procedure commonly followed for lateral or profile radiography of the joint is to place the side to be radiographed on a film which has been angulated at 15 degrees toward the body by means of an angle board. The rays are directed at 90 degrees to the floor, from a point ½ inch anterior to and 2 inches above the external auditory meatus of the opposite side, using a varying anode-film distance of 14 to 30 inches. In other techniques the angle board is eliminated and the patient sits upright; the film is held parallel to the sagittal plane and the rays are directed from the same point 15 degrees downward toward the joint being radiographed.[2 3 4 5]

Radiographs obtained by following this technique are not always satisfactor since the amount of superimposition of intervening structures, along with the projection of the tissues from the opposite side, combine to produce poor results. In many instances, the outlines of the joint parts are indiscernible and lost in the mass of blacks, grays, and whites that appear on the film in the joint region. There is no doubt that these poor results have discouraged many who would have continued their investigations had the radiographs been more satisfactory.

[1] Read before the Fifteenth Biennial Meeting of the Edward H. Angle Society of Orthodontia, Skytop, Pa., October 22, 1951.

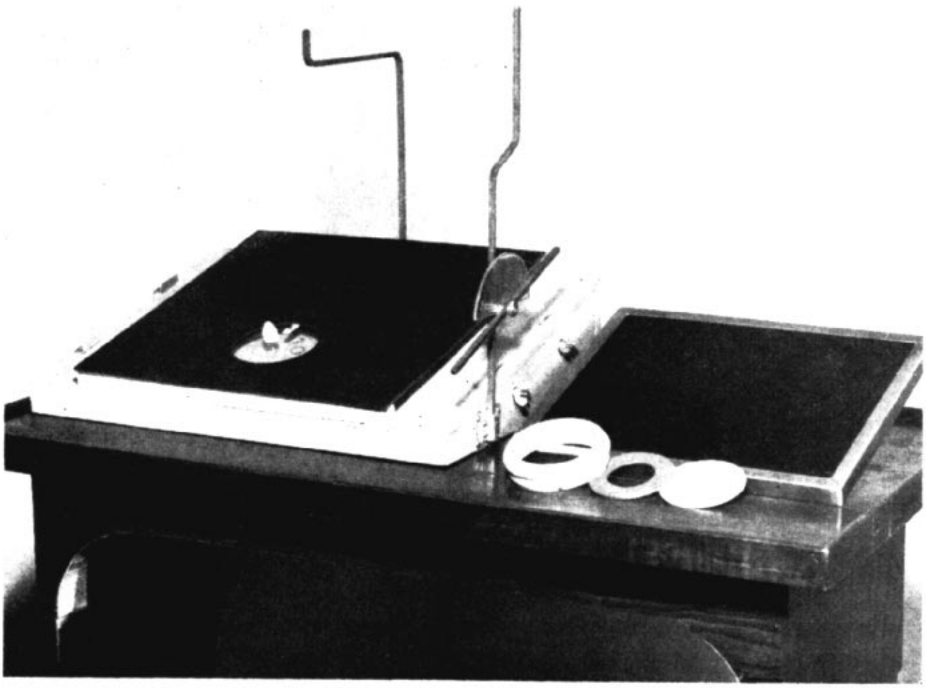


Fig. 1. *ACCESSORIES* — 15 degree angle board (16 x 12 inches) with plastic slide tunnel (12 x 12 inches) covered with leaded rubber mask.
Ear positioner and identifying letter in 3 inch circular opening of mask.
Aligning rods at top and side of board. Head position recorder on side rod.
8 x 10 inch cassette containing slow-speed intensifying screens.
Retainer-lead diaphragm-aluminum filter combination.

In 1947, the writer[6] presented a radiographic technique that overcame, for the most part, the above objections and insured the operator of consistently satisfactory films. This technique incorporated a shortened anode-film distance, slow-speed intensifying screens and an angle board with positioning lines and rods to facilitate alignment of tube, patient, and film.

Within the past three years this technique has been modified and the accessories refined (Fig. 1). They now consist of a 15 degree angle board with a plastic slide tunnel which permits multiple exposures without changing the position of the patient's head (Fig. 2), threaded plastic ear positioners of different lengths to change the relationship of the head to the film which gives varying aspects of the condyle (Fig. 3), a plastic protractor and rod assembly to insure duplication of the patient's head position at subsequent examinations (Fig. 4), and a diaphragm-filter combination that replaces the cone of the machine (Fig. 5).

Technique

A table with the angle board upon it, is placed at the side of the dental chair and the patient is seated facing the board. The adjustable stop at the right of the angle board is lowered to permit insertion of the loaded 8 x 10 inch cassette beneath the plastic. The cassette contains *slow-speed, high-definition* intensifying screens. The stop

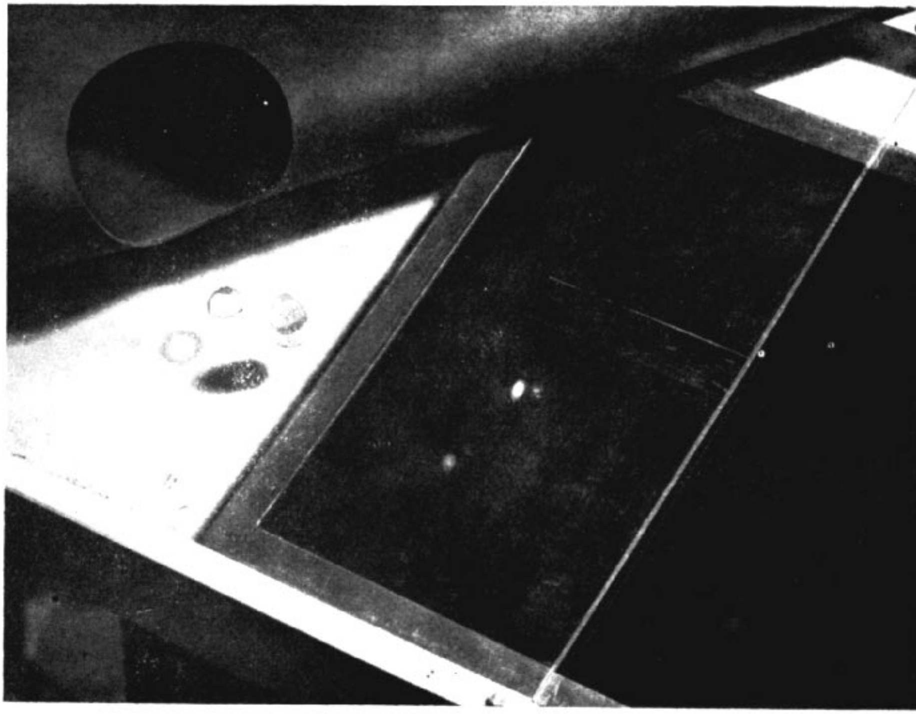
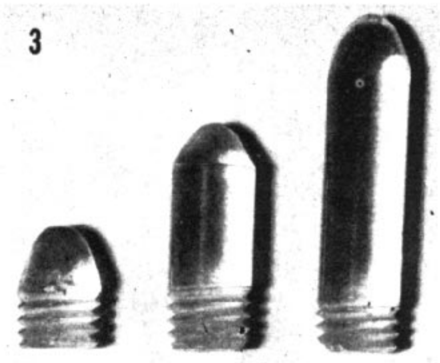


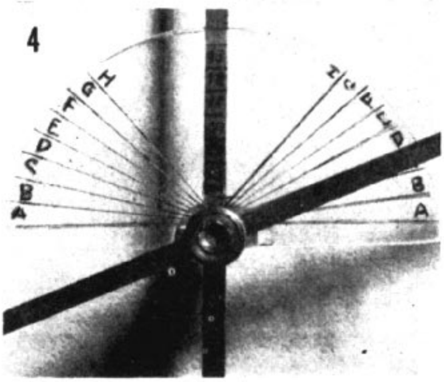
Fig. 2. Close-up of plastic slide tunnel beneath which the cassette can be positioned to permit multiple exposures without disturbing the patient-machine relationship. *Note*: leaded rubber mask which covers plastic is turned back.

is then raised and the cassette brought back to the extreme right against it. The plastic ear positioner is screwed into the left receptacle for the left joint or into the right receptacle for the right joint. The proper lead identifying letter is placed at the top of the opening (Fig. 6).

In positioning the patient's head, the external auditory meatus of the side being examined is placed over the ear positioner and the head directed so that it rests flat on the plastic and is supported at three points: the external auditory meatus, the zygoma, and the area adjacent to the angle of the mandible. This should be a natural, comfortable and unstrained position. The head position is recorded by raising or lowering the protractor-rod assembly until the adjustment screw is aligned with the nose tip. This will give a height reading on the vertical rod. The moveable horizontal rod is then aligned with the sagittal plane of the patient and a reading obtained from the plastic protractor. For example 6F — the 6 indicates the nose tip height, the F indicates the position of the sagittal plane (Fig. 7). This record makes possible the duplication of the head position within practical limitations at subsequent sittings. In many instances the head position for one side will differ from that of the other.

The machine, having the cone replaced with the retainer-diaphragm-filter combination, is then positioned against the patient's head, is aligned with the rods on the board and the exposure made (Fig. 7). The exposure at 60 kilovolts and 10 milliamperes varies from 1½ to 3½ seconds.





Figs. 3 & 4. Plastic ear positioners cut from ½ inch rod, threaded to fit tapped openings in plastic slide tunnel. Lengths vary from ½ inch to 2 inches.

Head position recorder consisting of plastic protractor and scribed and lettered and attached to movable piece which slides on metal vertical rod, which is also scribed and numbered. The horizontal metal rod is adjustable to the protractor. This assembly fits into receptacles on sides of board for right and left exposures.

For the second exposure, usually an open view of the same side, the patient and machine remain in the same position, the cassette is slid beneath the tunnel to the extreme left against the stops, a mouth prop of the desired size is inserted in the patient's mouth, and the second exposure is made.

For the third and fourth exposures the cassette is removed from the tunnel, reversed, re-inserted and the same procedure is followed for examination of the opposite side.

After processing, the finished film should be cut longitudinally, the top half reversed and rejoined to the bottom half with cellulose tape. This will align the joints in their proper relationship for interpretation (Fig. 8).

It is possible to make six exposures on one film by using rectangular openings in place of a circular opening in the lead mask (Fig. 9). The same technique as just described is followed, except for the second exposure. For this, the cassette is slid to the center of the board and the exposure is made, after which the cassette is moved to the extreme left for the third exposure. The cassette can then be reversed and the procedure repeated for three additional exposures. (Fig. 10).

As an aid in checking the excursions of the condyle as well as comparing the condylar-fossa relationship in functional positions of the mandible, orientation rods can be attached to the plastic tunnel (Fig. 9). These will appear as opaque base lines on the radiograph from which measurements can be made (Fig. 11).

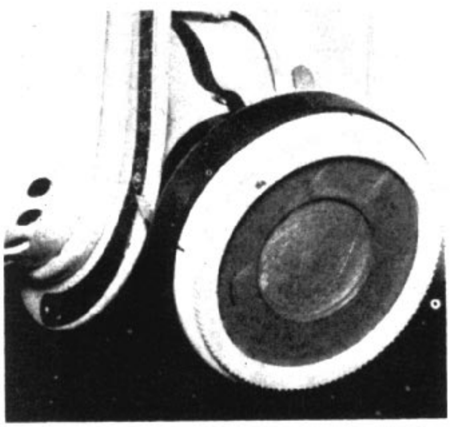


Fig. 5. Retainer-diaphragm-filter combination which is substituted for the cone. The retainer is made by cutting off the pointed portion of the cone, the diaphragm is cut from sheet lead to fit inside retainer, and a 1½ inch opening is cut from its center, while the filter is cut from 1 millimeter sheet aluminum to fit inside retainer.

The limitations as well as the accomplishments of this or any procedure should be considered before one adopts it. In order to evaluate this technique, its advantages and disadvantages must be presented. However, only by actual trial will its simplicity and uniform results be appreciated.

Advantages

1. Produces sharp distinct images with clear outlines of the parts (Fig. 12). The short anode-film distance used in this technique results in an enlargement and distortion of the parts nearest the tube making them indistinct without visibly affecting the definition of the side being examined. This procedure, along with the projection of the ray through the relatively thin temporal and parietal bones and the use of a double diaphragm, reduces superimposition and gives a clear portrayal of the joint. Distinctness of outline, particularly of the articular head of the condyle and the eminence, is dependent, to some extent, upon the degree of calcification. This accounts for the difficulty in obtaining distinct radiographs of the young child, which can be partly overcome by using a lower kilovoltage to produce more contrast in the image.

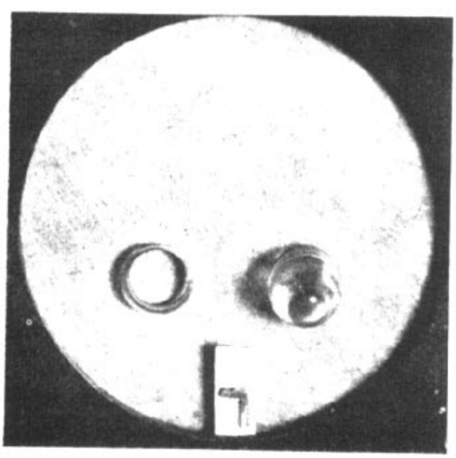


Fig. 6. Close-up of 3 inch opening in leaded rubber mask with ear positioner and lead identifying letter in place for exposure of left side. Positioner must be changed to right receptacle for exposure of right joint. (Receptacles are 3¼ inches from bottom of board and ½ inch to right and left of center).

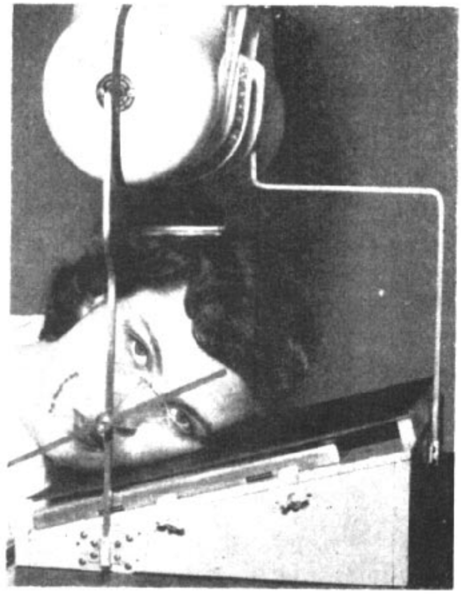


Fig. 7. Recording of head position. The nose-tip height is recorded on the numbers of the vertical rod while the position of the sagittal plane is recorded by aligning the horizontal rod with the saggital plane on the letters of the protractor.

2. The accessories for this technique can be simply and inexpensively constructed by the dentist himself and can be adapted to any dental radiographic machine (Fig. 1).

3. This technique makes possible two or three exposures without changing the tube-patient-film relationship (Figs. 2, 8, 10).

4. Duplication of films at subsequent sittings is assured (Fig. 7).

5. Orientation rods attached to plastic tunnel will appear as opaque base lines on the radiograph for checking condylar-fossa relationship and condylar excursion. (Fig. 11).

6. No special skill is required in this technique since the patient is easily positioned, the tube can be readily

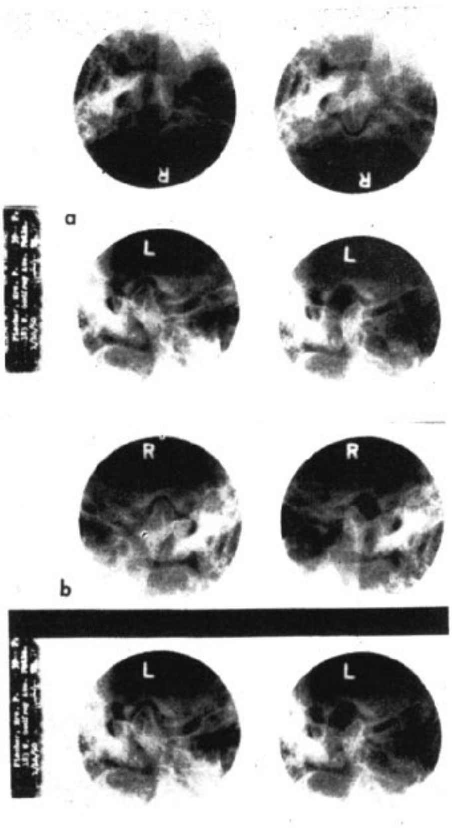


Fig. 8. A — Finished four exposure film before cutting.
B — Film cut, reversed and rejoined to align exposures for interpretation. (These views illustrate the reversal procedure; see larger reproductions for typical film quality.)

aligned, and the results assured. Junior dental students with no previous experience, after being shown the technique, have little difficulty in producing very satisfactory films.

Disadvantages

In considering the disadvantages, comparison is made with other lateral aspect techniques of single plane radiography.

1. The angulation which is necessary to reduce superimposition of the parts produces some distortion. The anatomic limitations encountered in periapical radiographic examinations compel the use of an angulation technique which produces some distortion, but that procedure is widely accepted and followed. To condemn radiography of the temporomandibular joint because the anatomic limitations demand angulation in order to produce more discernible images would be no different than to condemn the entire procedure of periapical radiography for the same reason. The slight distortion must be recognized and evaluated accordingly.

2. The anatomic differences of individuals argues against the fixed angle technique (15 degree angle board) for all examinations. Schier[7] has investigated this problem and found that

> "if a flat plane is laid against the skull contacting the high point of the zygoma, the gonion, and the junction of the external oblique line and lower border of the mandible, a line at right angles to this plane would run parallel to the transverse direction of the condyle head, or in the extreme, to the descending inclination of the superior surface."

He has designed an apparatus that will accomplish this film-patient-tube relationship and overcome the "fixed angle" approach. It is true that in the technique presented in this paper, a 15 degree board with a 90 degree angulation of the rays are used, and, as mentioned in the previous paragraph, a certain amount of distortion is unavoidable. However, it will be noted that when the patient's head is placed on the board the sagittal plane is *not* parallel to the film but is positioned in such a manner that the external auditory meatus, zygoma, and the area adjacent to the angle of the mandible support the skull and are parallel to the film very much as in the technique advocated by Schier.

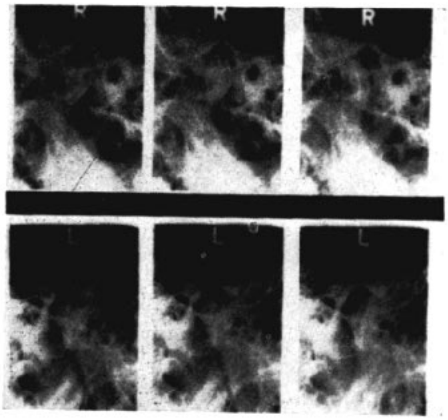


Fig. 10. Resultant radiographs using mask shown in Fig. 9.

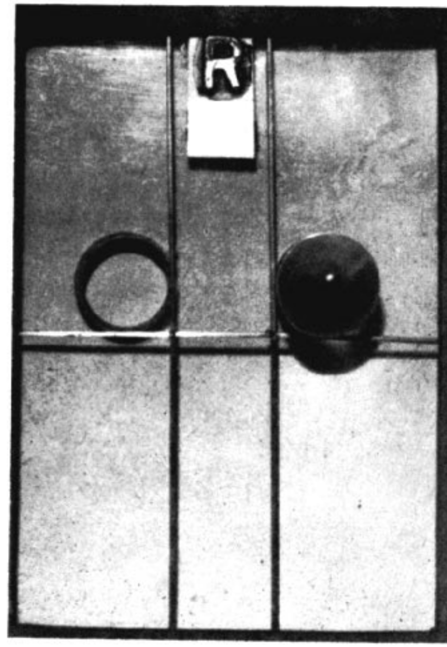


Fig. 9. Rectangular opening 2 x 2¾ inches in leaded rubber mask. This makes possible 6 exposures on one film.
Orientation rods, (022 inches) attached to plastic surface of slide tunnel.

3. Radiographs of the temporomandibular joint should be taken with the head of the patient in an upright position, since by tilting and resting it on the angle board the pressure produces a displacement of the mandible toward the opposite side and gives a false portrayal of the joint in the rest or opened positions. This assertion is questionable if the head is correctly positioned with the tissues external to the joint, zygoma, and angle bearing the entire weight of the skull. It takes considerable force applied at the angle of the jaw to produce a lateral displacement since the leverage at this point is markedly less than at the symphysis. Practical experimentation will prove this.

It is usually advisable to make the first exposure with the teeth in centric relationship to assure a firm head position and then to shift the cassette and make the second exposure in the rest position. If one is making three exposures, one should take the open position last. Little difficulty is encountered in securing the open position since a prop of the desired size may be placed between the incisors to stabilize the mandible. In securing rest position our most satisfactory results have been attained by first explaining to the patient what is desired of him, then using the word "Mississippi", and practicing until the rest position is assured.

The techniques presented by Lindblom[8], Higley[9], Schier[7], and others, should be investigated by the reader and then evaluated according to his needs.

Temporomandibular radiography has played a minor role in the specialty of orthodontics up to the present time. Investigations by Higley and Logan[10], Riesner[11], Boman[12], Schier[13], Thompson[14], Schweitzer[1], and others have materially contributed to the fund of joint knowledge, but examination of current literature still reveals a widespread controversy as to the functional movements of the joint, its form, its constancy throughout life, its relationship to the occlusion, and other ana-

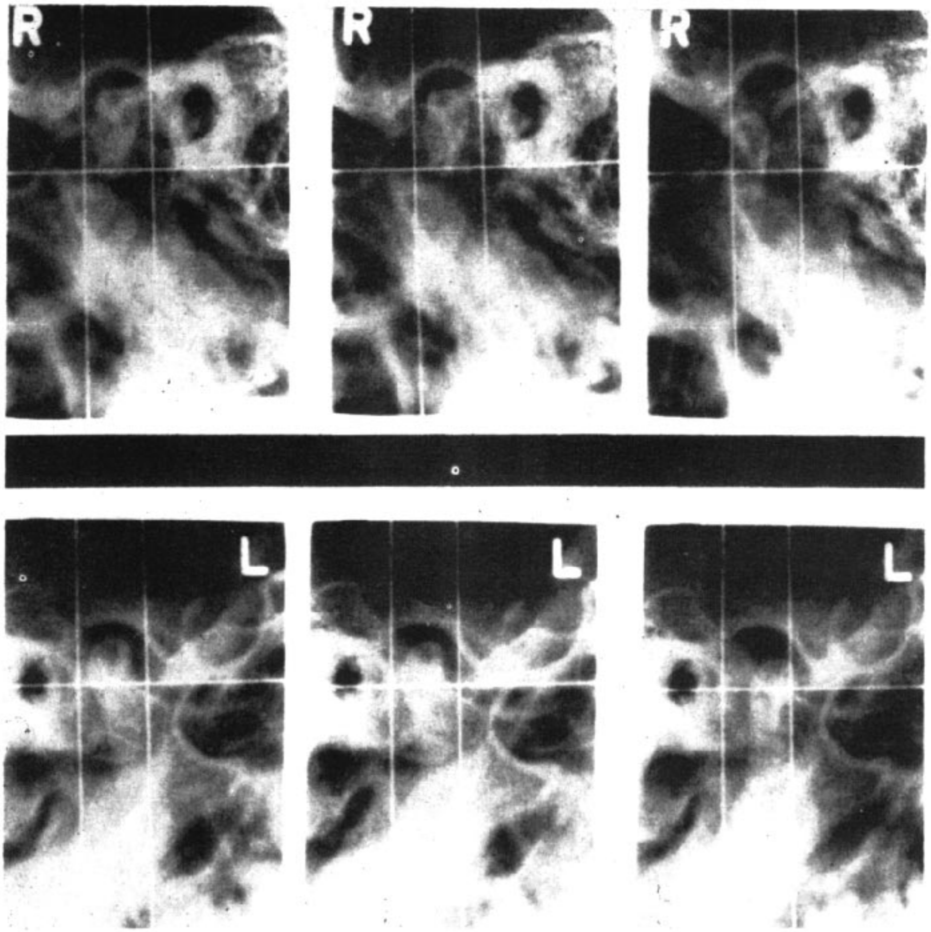


Fig. 11. Radiographs demonstrating the use of orientation rods which aid in checking condylar movements and condylar-fossa relationships.

tomic, physiologic and pathologic factors in the joint itself and in relation to associated structures. Radiographic investigations of the joint carried on in the field of orthodontics in conjunction with other established radiographic procedures, would go far in clearing up some of this controversy by separating fact from fallacy through indisputable radiographic evidence.

Radiographic investigation of condylar-fossa relationships in mandibular movements for individuals with normal occlusion as compared with those exhibiting malocclusions might reveal a remarkable adaptability of joint parts. This investigation could be extended into a possible correlation of joint form and relationship with the Angle classification of occlusion (Fig. 13). Radiographic studies of the growing joint from infancy to senility, combined with cephalometric evidence could determine the question as to constancy of the joint throughout life. (Fig. 14). Is McCollum[16] correct when he writes that the temporomandibular joint reaches its permanent form by the age of 10, or is Riesner[17] nearer the facts when he states that development of the joint is not complete until 25 years, up to which time the jaw has the char-

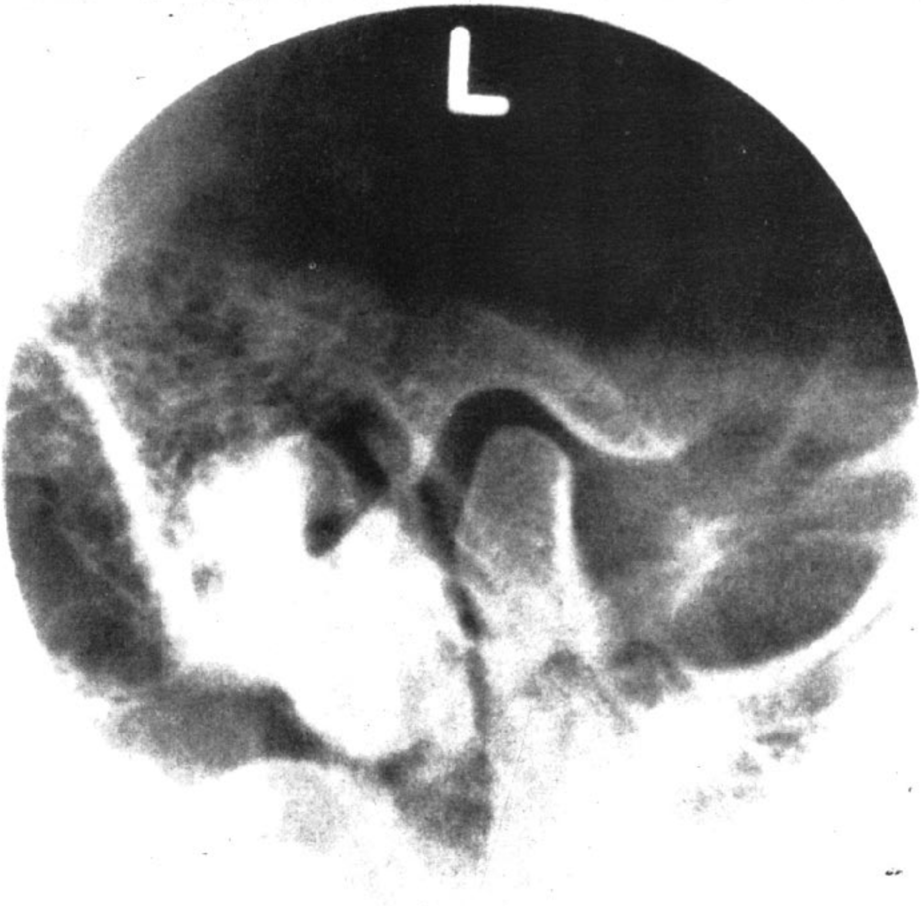


Fig. 12. Lateral aspect radiograph of the temporomandibular joint.

acteristic of building up articulating surfaces and developing simultaneously with the denture, with the form of the mandibular fossa being subject to function and to cusp formation?

A radiographic study of the joint of patients undergoing orthodontic treatment might confirm the experiments done by Breitner[18] on rhesus monkeys in which he found definite changes taking place in the condyles and the fossa, as well as in the angle and around the teeth. It would be very interesting to observe the joint radiographically before, during and at the completion of the treatment of a Class III occlusion, particularly if occipital anchorage were used (Fig. 15).

A radiographic study of the joint might be instrumental in settling the long-standing controversy over hinge movement vs. gliding movement. Does the condyle move forward simultaneously with the opening of the mandible, or does it rotate upon a hinge at the beginning of the opening action, the axis of which passes through the condylar head? This study would require radiographs of centric and rest positions of the mandible which, if taken with the or'entation markings as described in the technique (Figs. 9, 11)

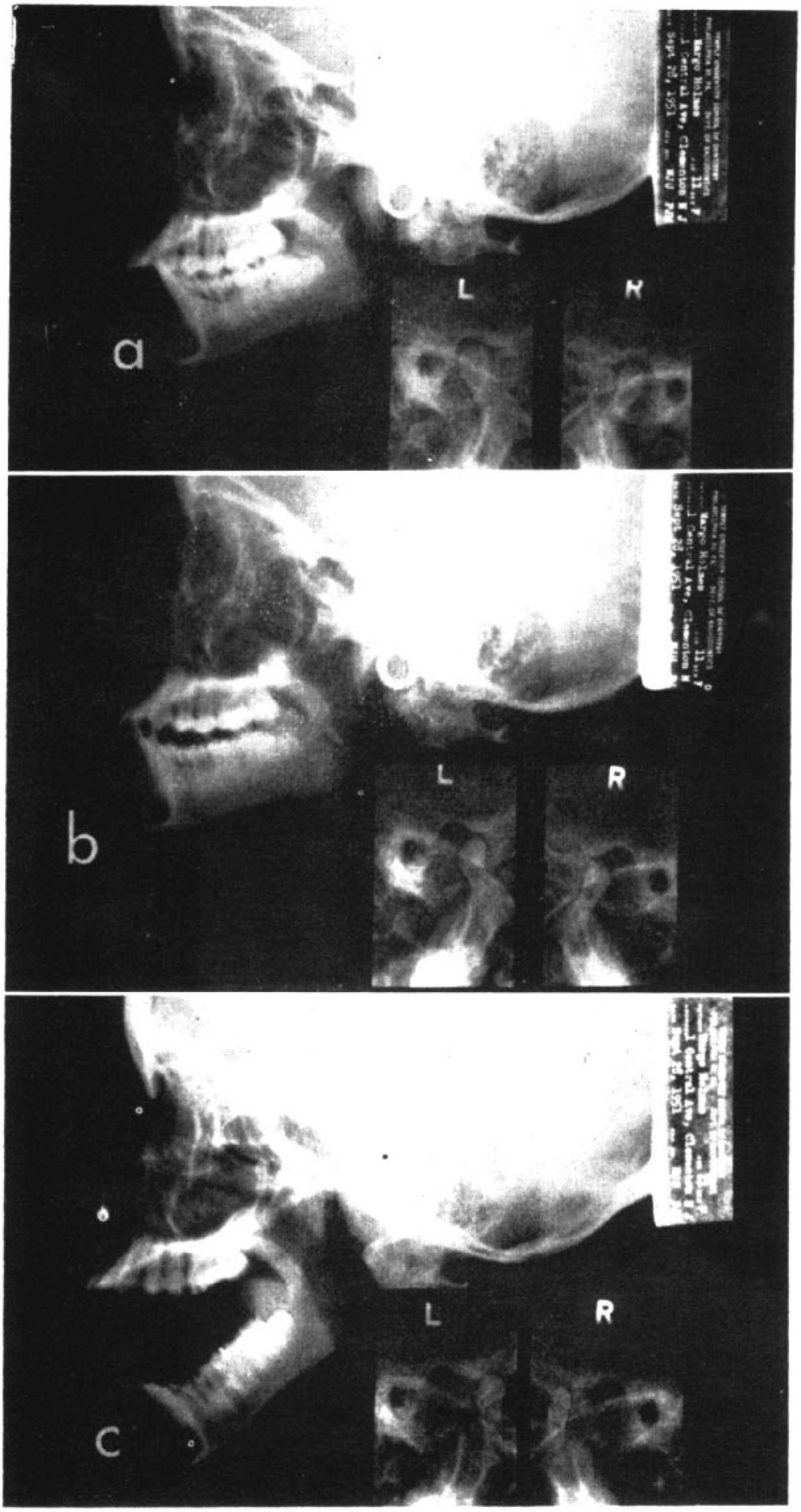


Fig. 13. Lateral head and temporomandibular radiographs of Class II malocclusion. (a) centric (b) rest (c) opened.

could be readily compared and analysed.

The important role of temporomandibular radiography at the chair and in the field of research cannot be ignored, and if this paper, with its simplified technique for radiography of the joint, stimulates a more widespread interest and investigation of the temporomandibular joint it will have served its purpose.

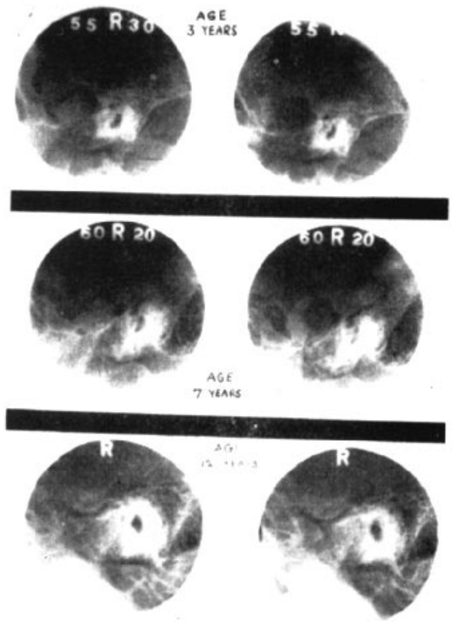


Fig. 14. Radiographs of joints of children, age 3 to 12.

Conclusion

Intra-oral, extra-oral, and cephalometric radiography are accepted prerequisites in orthodontic diagnosis. Because of the intimate association between the masticatory mechanism and the temporomandibular joint, radiographs of this part are essential for complete diagnosis. The simplified technique described in this paper can be readily followed without special training and without employing complicated accessories. The radiographic evidence collected from many individual investigations of the temporomandibular joint, should go far in clearing up the controversial issues concerning this structure.

Summary

1. Specialized techniques for radiography of the temporomandibular joint are not adaptable to the typical dental office. A practical, simplified, technique for general use is presented.

2. Advantages and disadvantages of this technique are discussed and comparison is made with other techniques.

3. Several applications of this technique in the field of orthodontics are suggested.

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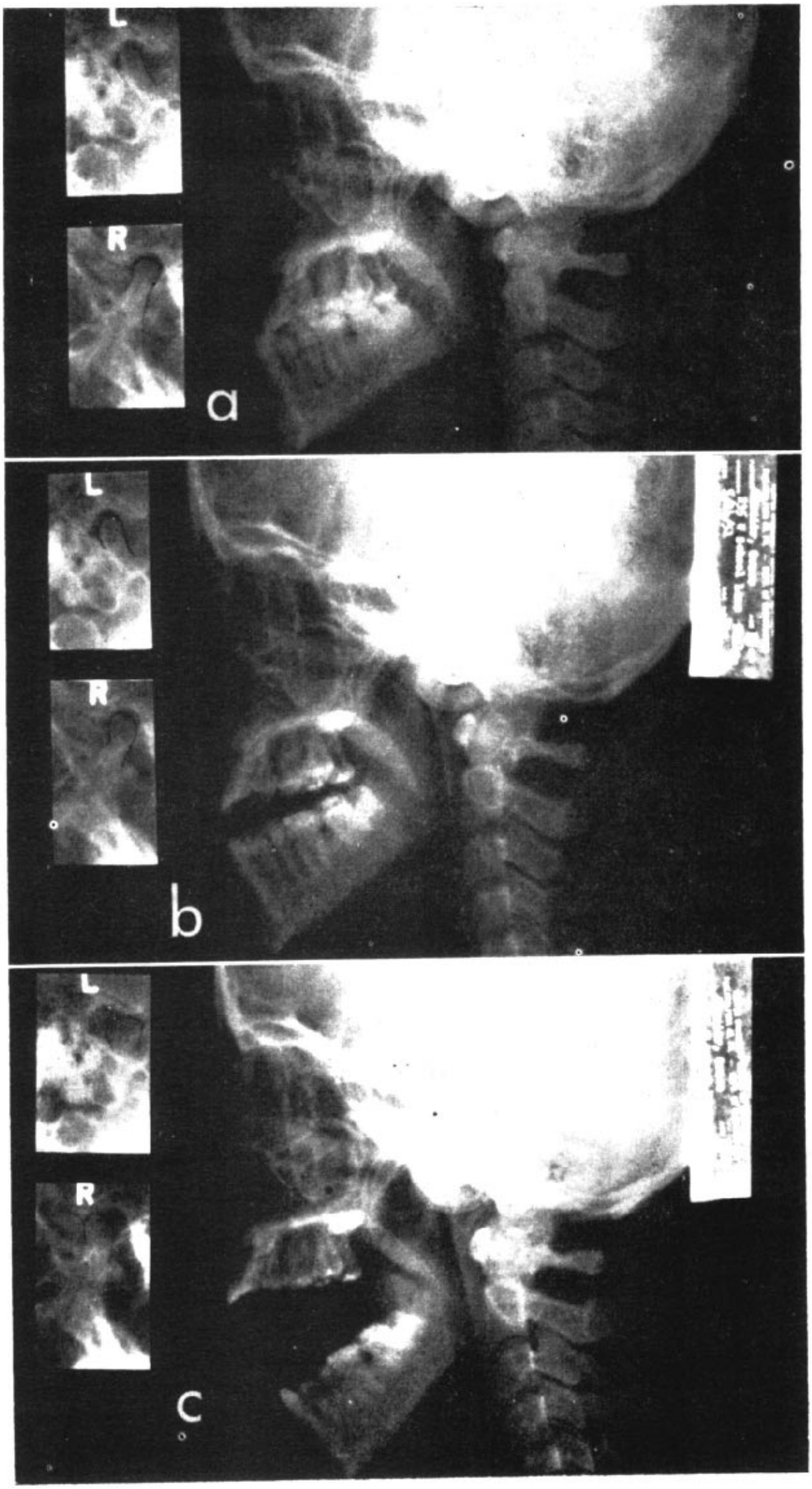
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Fig. 15. Lateral head and temporomandibular radiographs of Class III (Angle) malocclusion. (a) centric (b) rest (c) opened.