Combined Cephalometric and Transcranial Radiography of the Rat Condyle

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A technique for using implants to superimpose oriented transcranial and cephalometric images for the study of mandibular growth in the rat.

KEY WORDS: • CEPHALOMETRICS • GROWTH • IMPLANTS •
• RAT • TRANSCRANIAL RADIOGRAPHY •

Mandibular growth is commonly studied with a variety of techniques, including craniometry (SCOTT 1967, ENLOW 1968, AND HILDYARD AND MOORE 1976), histology (BHASKAR 1953, CLEALL ET AL. 1971, CARLSON ET AL. 1978), histochemistry (DUTERLOO AND JANSEN 1969), autoradiography (BLACKWOOD 1966, OBERG ET AL. 1969, AND JOONDEPH 1972), either alone or in combination.

Clearly, cephalometric radiography (BROADBENT 1931 AND SPENCE 1940) is the method of choice for longitudinal studies, especially in combination with metallic implants (BJÖRK 1955, FULLER 1974, BERNABEI AND JOHNSTON 1978, AND WHETTEN 1979). The use of implants, however, is currently proscribed in humans in the United States, and because of the scarcity and expense of primates, craniofacial biologists must now rely heavily on smaller animals.

Unfortunately, rats, guinea pigs, and the like have tiny and delicate facial skeletons, the details of which are difficult to capture in radiographic images. Indeed, this drawback has often led to the use of less appropriate experimental techniques merely because of their presumed better reliability. For example, if individual condyles could be seen clearly in cephalometric radiographs, it is doubtful that many would be willing to accept such indirect indicators as the thickness of the condylar cartilage or its uptake of tritiated thymidine as valid measures of mandibular growth. Clearly, a more direct measure would be highly desirable.

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It has been demonstrated that contact radiographs provide an excellent picture of condyle morphology. Used in conjunction with implants and standardized cephalometric radiographs, they can be the basis for precise measurements of condyle morphology and position, and overall mandibular growth (KILLIANY 1984). Indeed, given the directness of the technique, its accuracy would seem almost a foregone conclusion, but its applicability is quite another matter.

Contact radiography requires that the neck of the condyle be divided surgically, so that the corner of a small dental film packet can be placed directly under the condyle head. This approach is practical only if condylotomy is planned as an integral part of the study (FULLER 1974, WHETTEN 1979, YOZWIAK 1979 AND KILLIANY 1984).

Clearly, a less invasive, more generally applicable approach to the problem of condyle imaging could be of considerable utility in mandibular growth studies.

The purpose of this report is to present and validate a technique that employs transcranial radiography to enable reliable measurement of the shape of the condyle.

Radiographic Technique

A standard animal headholder fitted with ear rods and an incisor bar is used to orient the anesthetized animal. The ear rods are fitted with millimeter scales to assist in centering the midsagittal plane. They are angled 15° forward, so that their image does not overlap the condyle image.

From a dorsal view, the film is held against the temporomandibular joint at a 10° angle to the midsagittal plane (Fig. 1). In the coronal plane, the angle is 20° (Fig. 2). Given this orientation, the image of the opposite condyle is displaced postero-inferiorly, eliminating overlap of the two sides. An intraoral film (Kodak Ultra-speed DF-58) is exposed at 10mAS and 50 kVp at a target-film distance of 47cm.

Error Study

The basic purpose of these condyle radiographs is to augment the information from lateral cephalographs. Metallic implants are placed in the condyle so that the outline obtained from the contact or transcranial radiograph can be added to the cephalometric tracing by direct superimposition. This makes it possible to measure condyle position in relation to the various structures that can normally be seen on the cephalograph.

Two questions come immediately to mind:

1) Does the noninvasive transcranial approach produce results that are equivalent to those of a contact radiograph?

2) Is the technique reproducible?

To examine these questions, measurements of condyle position taken with the aid of transcranial radiographs were compared to similar measurements obtained from *post mortem* contact condyle radiographs.

Two rats, one young (130gm) and one mature (510gm), were anesthetized with sodium pentobarbital, and a pair of implants placed in one condyle. Each animal was then positioned in the headholder and a transcranial radiograph taken of the implanted condyle (Fig. 3).

To examine reliability, the animals were removed from the headholder and the entire radiographic procedure repeated an additional 14 times. At the end of the experiment, standard lateral cephalographs were taken, the animals killed, the mandibles dissected out, and contact radiographs taken of the condyles.

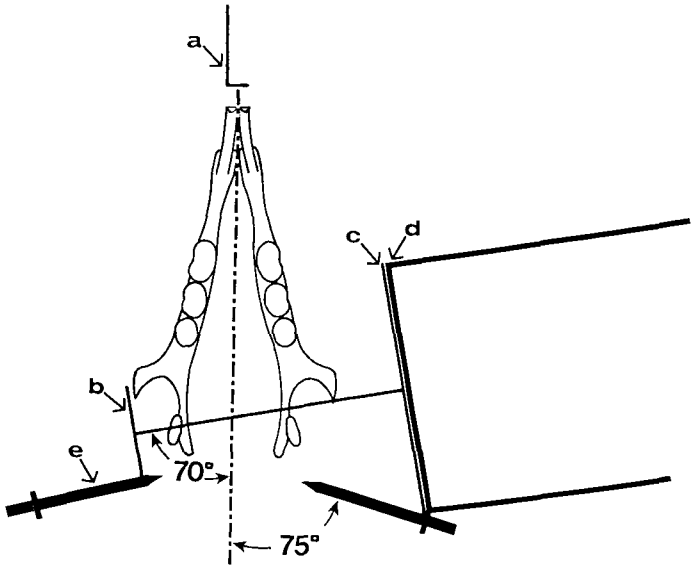

Fig. 1 Headholder and filmholder as viewed from directly above the device.

a — maxillary incisal rest
b — film holder
c — x-ray beam alignment guide (d — cone)
e — adjustable ear rod

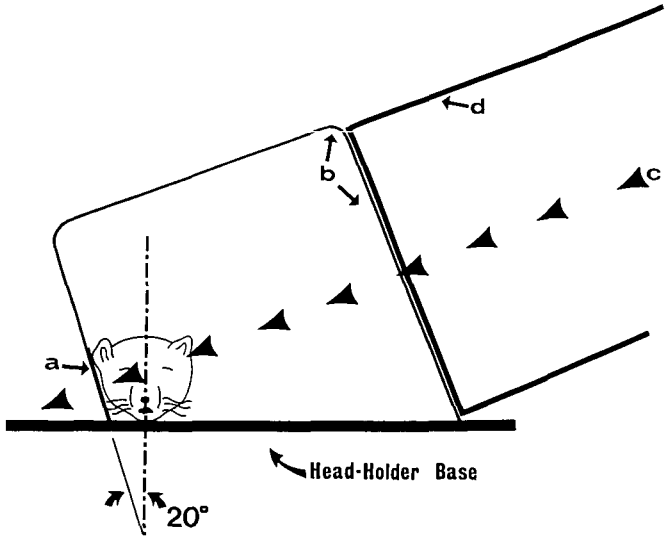

Fig. 2 Frontal view of the film holder and the x-ray beam. The film is held at a 20° angle to the midsaggital plane.

a — film holder
b — beam alignment guide
c — central ray
d — x-ray cone

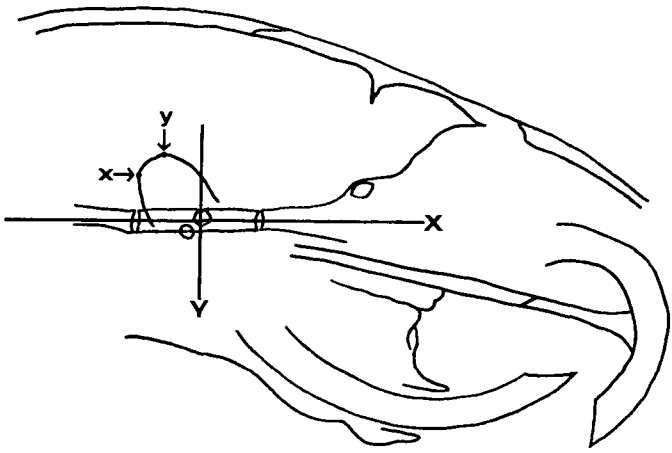

Fig. 3 Transcranial condyle radiograph.

All films were enlarged five times, traced, and the condyle outlines (15 transcranial and one contact for each animal) added to the cephalograph by superimposition on the implant images. A cranial base plane (X) and an arbitrary perpendicular (Y) provided coordinates from which to measure the location of the height of curvature of the superior (y) and posterior (x) condyle outlines (Fig. 4).

Standard descriptive statistics calculated for the 15 replications of the transcranial measurements are summarized in Table 1. The values of x and y from the contact film are included as a comparison standard.

— Discussion —

Although the the methods do not produce identical results, it is clear from the data presented here that noninvasive condylar radiographs can produce a reasonable approximation of the data available from a contact radiograph. As judged by the relatively small variation among replicates, the technique in its entirety (positioning, exposure, tracing, superimposition, and measurement) also would seem to be quite reliable.

From a technical standpoint, it is simple and requires little more in the way of equipment and preparation than does the

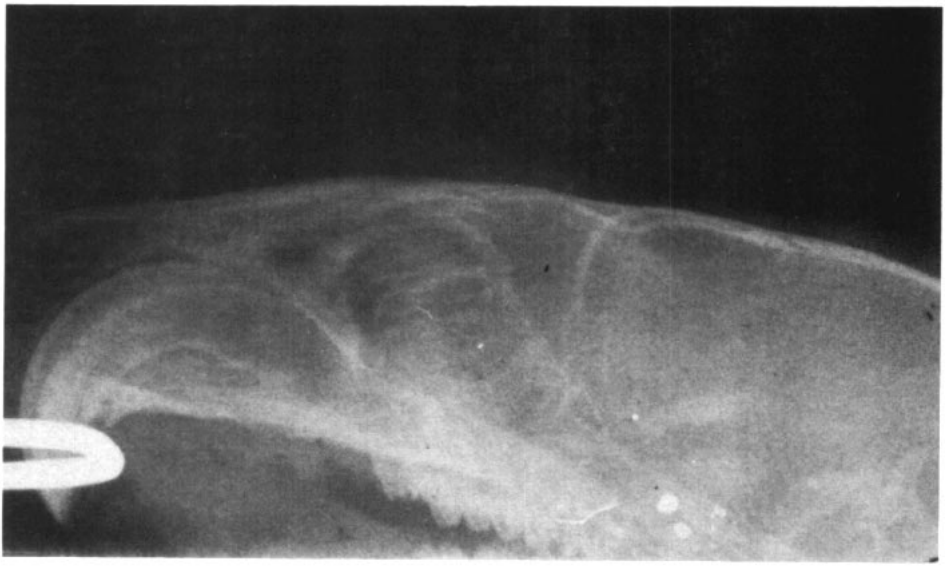

Fig. 4 Lateral cephalometric tracing enhanced with the transcranial condyle outline.

X — Cranial base plane Y — Perpendicular
x — Height of curvature of the posterior condyle outline
y — Height of curvature of the superior condyle outline

Table 1

Statistical Reliability
of Transcranial Radiography
(Millimeters)

Condyle Dimension	Contact x-ray N=1	Transcranial Radiographs N=15			
		Mean	S.D.	S.E.	Coeff. var.
Young rat					
x	−3.08	−2.79	0.12	0.03	4.28%
y	2.55	3.01	0.15	0.04	5.07%
Mature Rat					
x	−3.83	−4.41	0.24	0.06	5.38%
y	3.48	3.32	0.08	0.02	2.48%

lateral cephalograph with which it is used.

The only complication is the fact that implants are a necessity, both for the longitudinal comparison of condyle outlines and for using the images to augment other radiographs. However, given the potential utility of this technique in the study of mandibular growth, the need for implants would seem to constitute a small and acceptable inconvenience.

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