Identification Of Landmarks In Cephalometric Radiographs

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For the past twenty-eight years skull radiography has been used extensively in both clinical orthodontics and research. In order to interpret these radiographs, an adequate understanding of radiographic anatomy is essential.

Anatomical details on radiographs are often obscured by overlapping images of individual bones and by differences in their thickness and density, which makes the interpretation of skull radiographs difficult.

The radiographic image produced by a dry skull is more distinct than one obtained from the head of a living person, thus facilitating the identification of anatomical features. Etter[1] disarticulated a skull to make radiographs of individual bones. With the knowledge obtained, he was able to recognize many lines and shadows on an image of the entire skull.

A study of the atlases of Etter[1] and Goldhamer[2] contributes to an understanding of radiographic anatomy. However, the interest of the orthodontist is focused primarily on the development of the maxilla and mandible as related to the development of the cranium, while the radiologist is more interested in pathology. Skull radiographs in norma frontalis and lateralis, taken by the orthodontist with the aid of a cephalostat, also differ from the projections favored by the radiologist. It is necessary, therefore, to obtain specific information for the orthodontist to facilitate interpretation of cephalometric radiographs of the living.

Krogman and Sassouni[4] have already presented valuable descriptions of landmarks in cephalograms, but an attempt has been made in the present study to obtain more detailed information of particular value for the research worker interested in growth and development.

METHODS

A dry skull was positioned in a Broadbent cephalostat and radiographed in norma frontalis and norma lateralis. In order to identify the many lines and shadows, a series of radiographs was made of this skull after successive applications of a radiopaque paste, consisting of amalgam shavings and vaseline, to various bony ridges or landmarks and around different foramina on the right side of the skull. The untouched left side was studied and compared with the right side.

Radiographs of a living subject were obtained also, and landmarks were identified with the aid of the radiograms of the dry skull.

The definitions of anthropometric landmarks by Martin and Saller[5] were used in this study and *Gray's Anatomy*[3] has been followed for nomenclature.

FINDINGS

Norma Lateralis (Figs. 1 and 2)

The semicircular outline of the sella turcica can be divided into three parts; anteriorly the tuberculum sellae (1) dorsal to the chiasmatic groove, cen-

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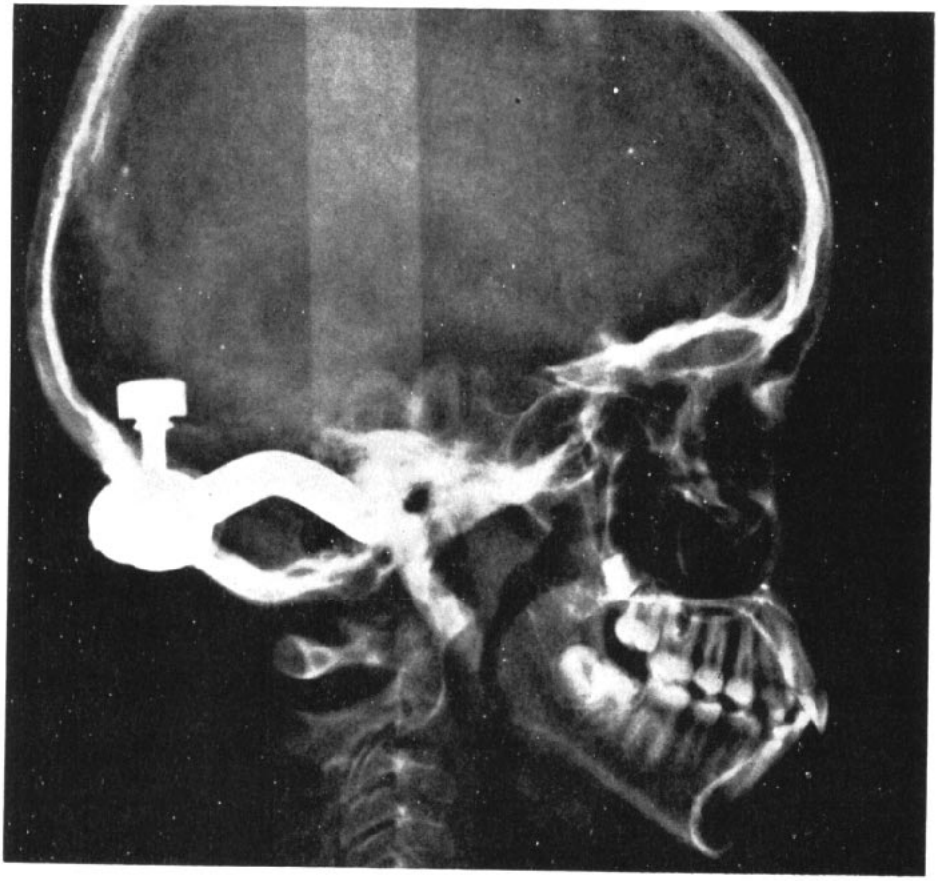

Fig. 1.

trally the saddle or sella proper (2) where the hypophysis is lodged, and posteriorly the dorsum sellae (3). Radiographically, the tuberculum sellae and dorsum sellae may form a continuous shadow with the anterior (4) and posterior (5) clinoid processes, respectively, but in most instances the latter can be clearly distinguished. The opaque image of the anterior clinoid process and the mesial half of the edge of the lesser wing (6) of the sphenoid bone form a continuous outline. The roofs of the orbits (7) can be readily identified in the radiograph.

The sphenoid planum (8) containing the chiasmatic groove is ventral to the tuberculum sellae and extends forward into an image of a bony ridge formed by the lateral margin of the ethmoid and the frontal bone (9). Below, the cribriform plate of the ethmoid bone can be seen as a faint line (10). The outline of the posterior clinoid processes continues caudally and dorsally to the spheno-occipital synchondrosis (11) which becomes ossified in later life, and it terminates at basion (12) — the lowermost point on the anterior margin of the foramen magnum in the sagittal plane. Basion can sometimes be located readily by its proximity to the tip of the odontoid process(13) of the second cervical vertebra (14). The ventral surface of the basilar part (15) of the occipital

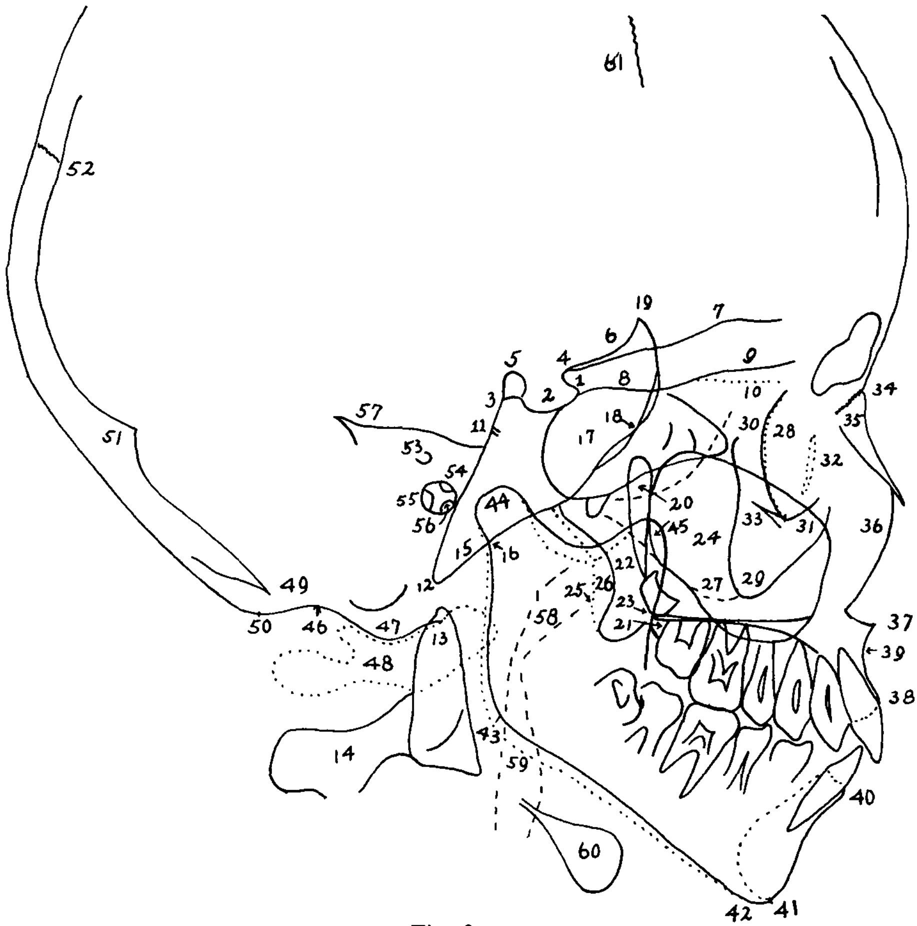

Fig. 2.

bone intersects the posterior border of the mandibular ramus at a point which Björk named articulare (16).

The sphenoidal sinus (17) is situated immediately beneath the sella turcica. It often consists of several compartments. The anterior wall of the middle cranial fossa (18) shows as an opaque line. The radiographic projection of the middle cranial fossa forms a continuous line with the lateral edge of the lesser wing of the sphenoid bone (19).

The pterygomaxillary fissures (20) are slender and triangular-shaped shadows, and they are formed by the maxillary tuberosities (21) and pterygoid processes (22). The posterior nasal spine (23) is frequently obscured by the unerupted permanent maxillary molars. However, it can be located at the point where the hard palate is intersected by an extension of the pterygomaxillary fissures. Anterior to the pterygomaxillary fissure is the maxillary sinus (24), and posterior to this fissure are the lateral (25) and medial (26) pterygoid plates.

The outline of the zygomatic arch (27), the posterior border of the orbit (28), the zygomatic process of the maxilla or key ridge (29), the frontal

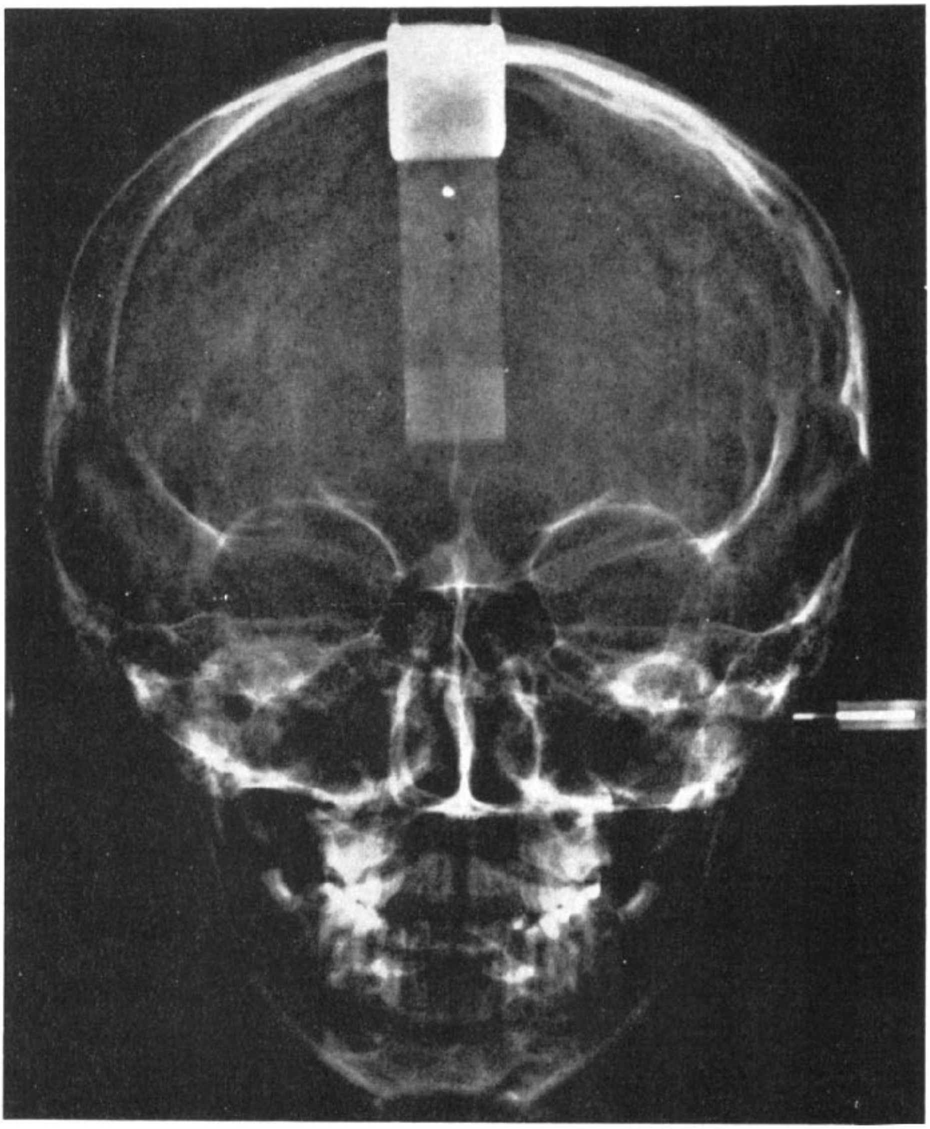

Fig. 3.

process of the zygomatic bone (30), the infraorbital ridge (31) and the lacrimal notch (32) can also be identified. The anterior half of the infraorbital groove (33) can sometimes be seen inside the outline of the maxillary sinus.

Nasion (34) is the most anterior point of the frontonasal suture, which runs obliquely upward and forward. From nasion downward the following anatomical landmarks can be seen: the outline of the nasal bone (35) and the nasal notch (36) of the maxilla, the anterior nasal spine (37), prosthion (38) — the intersection of the alveolar process and the maxillary central incisors — and subnasale (39) which is

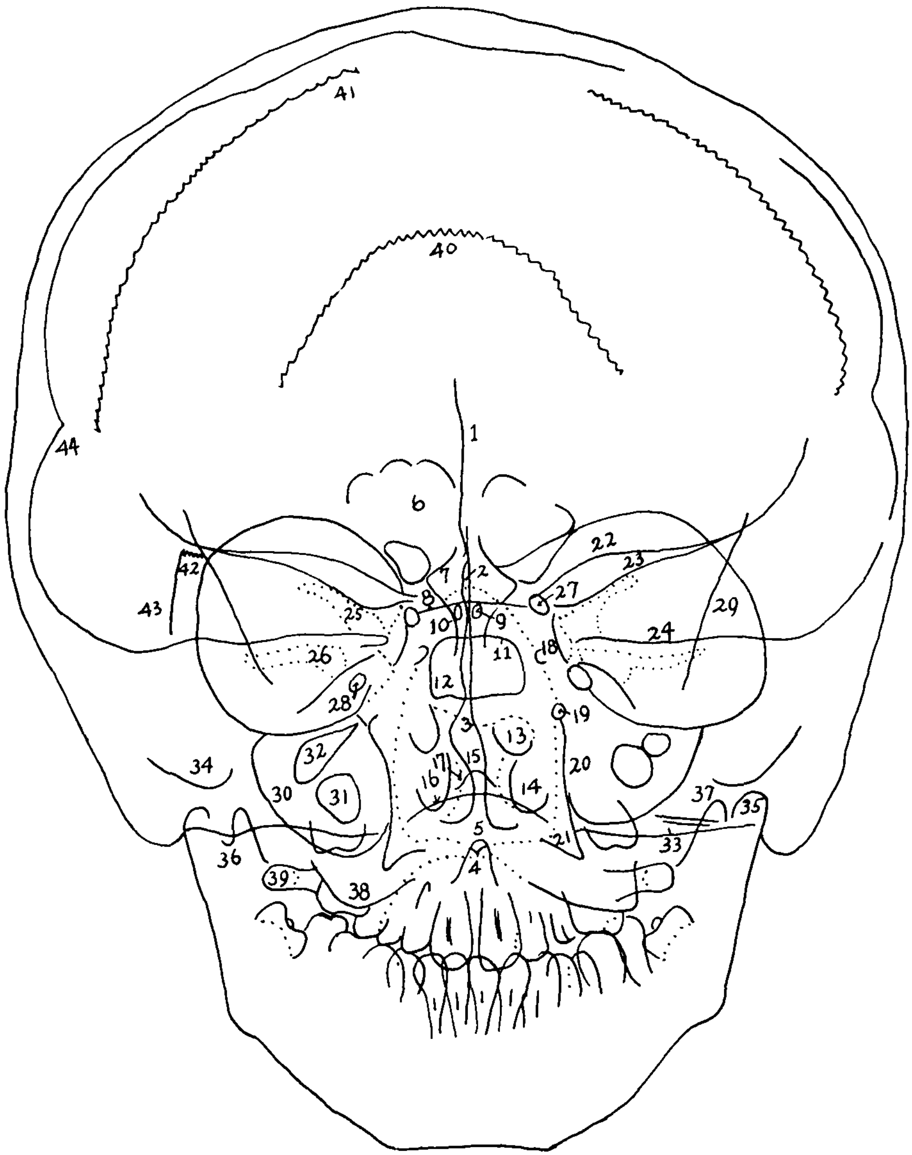

Fig. 4.

the deepest point of the curved outline from anterior nasal spine to prosthion.

In the mandible, infradentale (40), the intersection of the alveolar process and the mandibular central incisors, pogonion (41) — the most prominent point of the chin, gnathion* (42) — the lowest point on the mandible where the curvature of the chin becomes confluent with the base, and gonion (43) — the most inferior and posterior point

*Some confusion exists regarding the definition of gnathion and menton as discussed by Krogman and Sassouni[4].

at the mandibular angle — can be distinguished. By following the continuous outline of the ramus, the condyloid (44) and coronoid processes (45) can be traced readily.

The Bolton point (46), the intersection of the occipital condyle (47) and the outline of the foramen magnum, can be located at the deepest point of the curve posterior to the occipital condyle which rests on the articular surface of the atlas (48). Opisthion (49) can be located at the midpoint of the posterior margin of the foramen magnum, situated above the floor of the posterior cranial fossa (50). The internal occipital protuberance (51) and the lambdoid suture (52) can be traced by following the intracranial surface of the occipital bone upward from opisthion.

The internal acoustic meatus (53) is situated superiorly to the external meatus. The latter consists of three radiolucent areas, the fenestrum vestibulae (54) situated superiorly, the fenestrum cochlea (55) posteriorly, and the promontory (56) anteriorly. The promontory is a round eminence of very thin bone curved by the first coil of the cochlea. Above the internal meatus the superior ridge of the pyramid of the temporal bone (57) can be located. It intersects the dorsal surface of the basilar part of the occipital bone.

The retropharyngeal space (58) and the oesophagus (59) give a radiolucent shadow crossing the ramus and the gonial angle of the mandible.

Norma Frontalis (Figs. 3 and 4)

From the vertex down, the head is divided into two halves by a vertical line which is composed of the images of the frontal crest (1) where the falx ceribri is attached, the crista galli of the ethmoid (2), the nasal septum (3), the anterior nasal spine (4), the odontoid process of the second cervical vertebra (5) and the midlines of the maxillary and mandibular dentitions. Structures on either side of this line can be identified at different levels. The frontal sinuses (6) are situated on both sides of the frontal crest, and the outer boundary of the lamina cribrosa or cribriform plate (7) is seen on either side of the crista galli.

At a lower level the horizontal opaque image of the sphenoidal planum (8), the openings of sphenoidal sinus (9), the ethmoid labyrinth (10), the floor of the sella turcica (11) and the boundary of the sphenoidal sinus (12) can be distinguished. The middle (13) and the inferior turbinate (14) bones are situated opposite the lower half of the nasal septum (15), composed of the crests of maxilla and palatine bones. Basion (16) and opisthion (17) are visible at the level of the inferior turbinate (14).

Along the outer boundary of the nasal cavity, the opening of the ethmoidal sinus (18), the sphenopalatine foramen (19), the pterygoid plate (20) and the hamulus (21) can be located.

In the orbital region, the roof of the orbit (22) and the posterior edge of the lesser wing of the sphenoid bone (23) sometimes give overlapping shadows as they extend laterally. The superior ridges of the pyramids of the temporal bones (24) not only divide the orbits approximately into two halves, but also the height of the entire head. The superior (25) and the inferior (26) orbital fissures are located above and below the pyramidal part of the temporal bones, respectively. Along the medial margin of the orbit, the optic foramen (27) and the foramen rotundum (28) can be seen. The temporal line (29), an opaque shadow crossing the orbit obliquely, is produced by the medial wall of the temporal fossa.

In the region of the maxillary sinus (30), the jugular foramen (31) and the foramen lacerum (32) can be readily identified. The floor of the posterior cranial fossa (33) either passes through the maxillary sinus or below its floor depending on the size of the sinus. The inferior border at the junction of maxilla and zygomatic bone (34) is located above the mandibular condyle (35), the sigmoid notch (36) and the coronoid process (37). The atlas is composed of a lateral mass (38) and transverse processes (39). The lambdoid (40) and coronal (41) sutures can be distinguished at different levels in the vertex, the latter lying above the former. The frontozygomatic suture (42) and the frontal process of the zygomatic bone (43) are observed lateral to the orbit. Following the pyramidal ridge of the temporal bone, a ridge (44) composed of the internal surfaces of frontal, a greater wing of sphenoid, temporal and parietal bones is readily observed.

Summary

A method has been described to identify the radiographic images of landmarks in the dry skull. The knowledge obtained can be applied to studying cephalograms of the living. Various anatomical landmarks seen in radiographic projections of the skull both in norma lateralis and frontalis, have been described and identified.

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