Report by the Commission of Neuroradiology
(World Federation of Neurology)\(^1\)

The first full meeting of the Commission opened on 16 June 1961 in the Department of Radiology of the University of Milan. The Chair was taken by Professor Lenzi. Also present were Drs. Appel, Bull, Canossi, Decker, Dilenge, and Fischgold.

The different problems of neuroradiological nomenclature and the radiographic projections were discussed in the following order:

Classification of landmarks and lines and planes used for the radiographic study of the skull; classification of the most important routine projections of the skull; classification and analysis of special projections of the skull.

The members of the Commission decided to classify the landmarks and the lines into three groups:

1. The lines and the points which are used for the execution and/or interpretation of a certain projection:
2. The lines or points which need only be used as landmarks for the reading or interpretation of the radiograph.
3. The lines or points which are of little importance in skull radiography.

The points, lines, and planes which have been retained by the Commission must fulfil the following three criteria:

1. Have radiological importance.
2. Have a simple definition; the localization of both bony and soft tissue points must be easily definable; the bony landmarks can be used either in the reading or in the execution of the radiograph.
3. Be in current use.

CLASSIFICATION OF LANDMARKS

1. Landmarks used for the execution and/or interpretation of a particular projection:

- Infra-orbital point, nasion, bregma (landmark used descriptively but not radiographically); vertex; lambda (same as bregma); inion (external occipital protuberance); external auditory meatus (a, the centre of the canal or axis of the meatus, b, the superior border of the meatus); the outer canthus of the eye; centre of the orbit.

2. Points which can be used only as landmarks in the reading or interpretation of the radiographs:

- Gonion, glabella, basion, pterion, asterion, posterior border of the hard palate, the lowest point of the occiput, opisthion, digastic sulcus, mastoid tip.

3. Points which have little importance in skull radiography:

- Superior border of the orbit; nuchal fossa.

\(^1\)Reprints of this report may be obtained from the Editorial Secretary, Journal of Radiology, 32 Welbeck Street, London, W.1, price 1s. 3d. each.

LINES

The Commission chose three lines which appeared to them to be fundamental for skull radiography.

**BASAL LINE** Two base lines are used by most neuroradiologists:

A. The basal line accepted at the Munich Congress in 1877, also known as the line of Frankfurt, or Reid’s base line. It is the line which joins the infra-orbital point to the superior border of the external auditory meatus and is also known as the anthropological base line.

B. The orbito-meatal line which joins the outer canthus of the eye to the central point of the external auditory meatus.

To avoid any confusion in the nomenclature and to eliminate proper names, Dr. Bull suggested that the following names should be used:

A. The anthropological basal line and B, the orbito-meatal basal line. These two lines meet at an angle of about 10°.

The Commission accepted the nomenclature.

**AURICULAR LINE** This line is perpendicular to the anthropological basal line and passes through the external auditory meatus.

**INTER-ORBITAL OR INTER-PUPILLARY LINE** This is the line which joins the centre of the two orbits or the two pupils. It is perpendicular to the median-sagittal plane.

The infra-orbital line (which joins the two infra-orbital points) and the superior horizontal line (parallel to the basal anthropological line, which passes through the upper border of the orbit) were considered to be used less frequently.

The Commission considered that the lines and the angles of the base of the skull described by anthropologists and used in the study of semiology could not be included.

**PLANES**

The Commission suggested the following four planes:

1. The median-sagittal plane; this is the plane which divides the skull symmetrically in half.

2. The horizontal plane of Frankfurt; this plane contains the bilateral anthropological base lines (anthropological plane).

3. The frontal bi-auricular plane; this plane is perpendicular to the horizontal plane of Frankfurt and passes through the centre of the two external auditory meatuses.
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FIG. 1.  1 Infra-orbital point, 2 nasion, 3 bregma, 4 vertex, 5 lambda, 6 inion, 7a centre of the external auditory canal or axis of the external auditory meatus, 7b superior border of the meatus, 8 superior border of the orbit, 9 centre of the orbit, 10 pterion, 11 asterion, 12 lowest point of the occiput, 13 mastoid tip, 14 glabella.

A The anthropological basal line on lateral view; the infra-orbital line on antero-posterior view.
B The inter-orbital or inter-pupillary line.
C The superior horizontal line.
D The orbito-meatal basal line.
E The auricular line.

FIG. 2.  1 Digastric sulcus.

FIG. 3.  2 Posterior border of hard palate, 3 basion, 4 opisthion.
4 Orbital-meatal plane; this plane contains the bilateral basal orbital-meatal lines.

The first three planes are anthropometric and perpendicular to each other; the fourth is a radiological plane.

**TERMINOLOGY AND NOMENCLATURE OF NEURORADIOLOGICAL PROJECTIONS OF THE SKULL**

The radiological projections of the skull were divided into two groups, general projections and special projections.

The Commission decided to give the general projections an anatomical and geometrical definition, and the special projections a definition based on the particular area to be radiographed.

**GENERAL PROJECTIONS**

The Commission agreed that the following four projections were fundamental in obtaining a general survey of the skull.

**Lateral projection** The median-sagittal plane is parallel to the film. The central ray is perpendicular to the median-sagittal plane and centred on the auricular line, 3.0 cm. or 4.0 cm. above the external auditory meatus.

**Basal or axial projection** The head is placed in hyperextension and the anthropological plane should be parallel to the film. The central ray is perpendicular to the anthropological plane and passes along the bi-auricular plane. This is the true axial projection.

If the central ray is perpendicular to the orbital-meatal plane, the projection may be called sub-axial.

**Postero-anterior projection (inclined)** The forehead and nose touch the film, the median-sagittal plane being perpendicular to the film. The orbital-meatal plane is also perpendicular to the film. The central ray is directed cranio-caudally to form an angle of 15° with this plane (or about 25° to the anthropological plane). The point of exit of the central ray is the nasion; however, the Commission noted that if the point of exit is on the infra-orbital line, it coincides with the centre of the radiograph.

**Antero-posterior, half-axial projection** The head rests on the occiput. The median-sagittal plane is perpendicular to the film. If the orbital-meatal plane is perpendicular to the film the central ray makes an angle of 25°–30° cranio-caudally to the plane. If the anthropological plane is perpendicular to the film the central ray makes an angle of 35°–45° cranio-caudally. The true half-axial projection will be defined by obtaining an angle of 45°. The central ray, which coincides with the median-sagittal plane, passes through the midpoint of a line which joins the two external auditory meatuses.

**SPECIAL PROJECTIONS**

In actual fact almost all the problems of special projections are connected with the study of a limited area of the base of the skull.

To classify the special projections clinically, the Commission suggested dividing the base of the skull, from front to back, into certain areas which are involved in frequent and important syndromes. It is frequently possible to link these syndromes with lesions of the cranial nerves.

Putting aside, for the time being, the anterior fossa and the olfactory groove, important though they are because of their connexion with the sinuses, the Commission studied the following regions: Apex of the orbit, sella turcica, petrous bones, jugular foramen and foramen magnum.

The choice of projections depends on practical criteria; the Commission gave preference to projections which were both simple to use and displayed the anatomical region or formation required with the greatest certainty, consistency, symmetry, and accuracy.

The Commission restricted the study to criteria of general orientation. An inventory of proper names and of the techniques and projections, with their synonyms, would mean exhaustive and thorough bibliographical and historical research.

**Apex of the orbit** The Commission differentiated the projection of the optic canal, which is important in lesions of the structures within the canal, from the projection of the apex of the orbit, which is also important in lesions situated outside the canal.

1. The projection of the optic canal is obtained when the central ray coincides with the central axis of the canal. Under these conditions the canal is projected in its usual shape, without distortion, into the infero-lateral quadrant of the orbit.

2. If the optic canal is projected into the centre of the orbit, the surrounding structures such as the sphenoid fissure, anterior clinoid process, jugum and sphenoid sinus, are projected with the minimum of distortion at the expense of the optic foramen, which then appears oval in its vertical axis. The edges of the sphenoidal fissure can be seen in the postero-anterior projection of the skull.

**Sella turcica** The Commission decided to radiograph this area in the lateral and en-face projection.

The sella turcica appears with great detail in profile on the routine lateral projection. However, depending on clinical demands, it may be necessary to take a special lateral view. This is usually achieved by directing the central ray, which is perpendicular to the median-sagittal plane, on to a point situated about 2.0 cm. above and 2.0 cm. in front of the external auditory meatus.

To study the sella turcica en-face, two methods can be used:

1. The first projects the dorsum sellae within or behind the foramen magnum.

2. The second projects the cortex of the sella floor in the superimposed translucency of the ethmoid sinuses, sphenoid sinuses, and nasal cavities. However, more exact visualization will be obtained by frontal tomograms.

**Petrous bones** In neuroradiology, examination of the petrous bones must be separated from the rest of the temporal bone. The petrous bone has already been seen in the routine basal and antero-posterior, half-axial projections, which may sometimes need to be modified in certain cases (tilt of the ray, penetration). To these two general projections two more can be added: 1 Per-orbital projection, that is, the antero-posterior view of the petrous bones; and 2 the projection devised by Steners in which the long axis of the petrous bone becomes parallel to the plane of the film and perpendicular to the central ray.
Jugular foramen  The Commission agreed that, apart from tomography, the problem of demonstrating the jugular foramen and the condylar canal has not yet been settled satisfactorily, especially in view of the great anatomical variation and asymmetry of that region. Indeed the unilateral and bilateral projections recommended do not satisfy all the criteria mentioned above.

Foramen magnum and atlanto-occipital joint  As with the petrous bone, the foramen magnum will be seen in the routine survey of the skull: the lateral, the basal and the antero-posterior, half-axial. They show the structures as follows:

1. In the lateral projection, the clivus with the basion anteriorly, the squamous portion of the occipital bone with the opisthion posteriorly, the odontoid process in its relation to the clivus together with the two mastoid processes and the arch of the atlas.
2. In the basal view, the whole of the foramen magnum with reasonable accuracy.
3. In the half-axial, the posterior half of the foramen magnum more or less completely.

Apart from tomography, the clinical problems may require special projections. This may be carried out in two ways: 1, the central ray coinciding with the longitudinal axis of the foramen magnum, the head in flexion or extension; and 2, the central ray perpendicular to the long axis of the foramen magnum through the open mouth.

The Commission considered that the lines and landmarks of this region, which have been proposed by various authors, are not yet sufficiently unanimous to be included in these recommendations.

CONCLUSIONS

After three days' work, during which period numerous views were exchanged and numerous problems discussed, the members of the Commission of Nomenclature on Neuroradiology (World Federation of Neurology) arrived at results which it is hoped will be useful. They have aimed at clarification and simplification and sought to achieve: 1 Precise projections for skull radiology; 2 a clarification of similarities or differences in techniques which are not significantly important; 3 a divorce of numerous eponyms (proper names) belonging to an era where, unknowingly, due to lack of contact between countries, similar discoveries were made simultaneously.

The Commission has suggested a geometrical and anatomical nomenclature which, in the case of special projections, is based on the anatomy and clinical requirements of the region to be radiographed. In this way the Commission hopes to reduce the number of projections.

For the general survey projections of the skull, the Commission has tried to present the basic principles on which ideas may be devised and defined geometrically.

For the special projections of the base of the skull, the Commission decided upon simplification and clarification. A special projection must be simple to execute, easy to reproduce, constant in its results, and faithful in its reproduction of areas to be viewed.

The text of this report was subsequently submitted to the 18 members of the Problem Commission of Neuroradiology of the World Federation of Neurology and no objections were raised.
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