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SOME APPLICATIONS OF RADIOGRAPHIC ANATOMY* TO CEPHALOMETRIC TRACINGS**

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INTRODUCTION

Various points or areas are used for the superimposition of serial cephalometric tracings with the objectives of assessing previous growth, future growth potential or changes induced by treatment procedures. The increased emphasis on the cranial base structures, their morphology (Moss 1959) and relationship to prediction of growth potentials (Ricketts 1955) has precipitated the decline of reliance solely on isolated points (e.g. sella, nasion) as "stable reference points." Many cranial base structures require verification of precise radiological appearance and surety of prompt reproducability in tracing to facilitate their use in cranio facial research and particularly before their ready acceptance in clinical practice.

MATERIAL AND METHOD

A dried adult skull had wires placed in various positions summarised in Figs. 1 and 2, and was x-rayed in a Bolton Broadbent Cephalometer. Where the placement of the wires did not coincide with the radiological images suspected, the wires were moved and radiographs retaken until precise coincidence occurred. The anatomical structures were then identified and checked with wires on other skulls aged approximately 4 years and 9 years. All radiographs had a microline (80/1) grid and exposures for the adult, 9 year old and 4 year old skulls using Kodak Royal Blue film were respectively:

(1) Lateral skulls:—65, 63 and 61 KV at 100 m/amps. for 0.3 secs.

(2) Antero Posterior skulls:—80, 76 and 72 KV at 100 m/amps. for 0.3 secs.

RESULT AND DISCUSSION

(1) Anterior Cranial Base.

The relative stability of the contour of anterior cranial base was first suggested for dried skulls (Keith and Campion 1922) and a similar tendency for the growing child has been documented, radiologically, particularly after 7 years of age (De Coster 1951, Bjork 1955).

Although anterior cranial base is defined by Krogman (1951) as "anterior contour of sella turcica, roof of the cribriform plate and internal wall of the frontal bone," accurate radiological identification of specific areas is desirable.

Anterior Cranial Fossa.

(a) Internal wall of Frontal bone.

The internal or cranial walls of the frontal bone are identified on the lateral radiograph as bilateral white structures which anatomically coincide with that edge of cortical bone situated approximately one centimetre laterally from the mid-line frontal crest (the crest is rarely observed on the lateral radiograph). Note the coincident wire is not mid-line but is positioned in (a) in Figs. 1 and 2.

On the radiograph of the adult skull (Fig. 3) these internal walls of the frontal bone may be identified slightly behind the posterior wall of the frontal sinus, where the sinus is enlarged between the tables of the frontal bone. In the child the frontal sinus enlarges considerably around 6 - 8 years of age and again at puberty and therefore the relationship of the internal walls of the frontal bone and the sinus will change slightly in configuration with age. The right and left sides of the internal walls of the frontal bone tend to become superimposed radiologically as they descend to define the lateral extent of the cribriform plate and finish at the spheno-ethmoidal suture, Fig. 3.

The cribriform plate (Figs. 1 and 2) has various perforations produced by the olfactory

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nerves and these help determine the relative clarity of its radiological image. In the adult the image of the plate is frequently masked and mistaken posteriorly for the overlying dense cortical edge of the internal walls of frontal bone as they continue posteriorly, lateral to the cribriform plate, and provide the medial and anterior floor of the cranial fossa, in (a) of Figs. 1 and 2. The cribriform plate begins at the spheno-ethmoidal suture and then dips slightly inferiorly (providing a good indication of the position of the spheno-ethmoidal suture) whilst the medial margins of the frontal bones bordering the cribriform plate are situated more

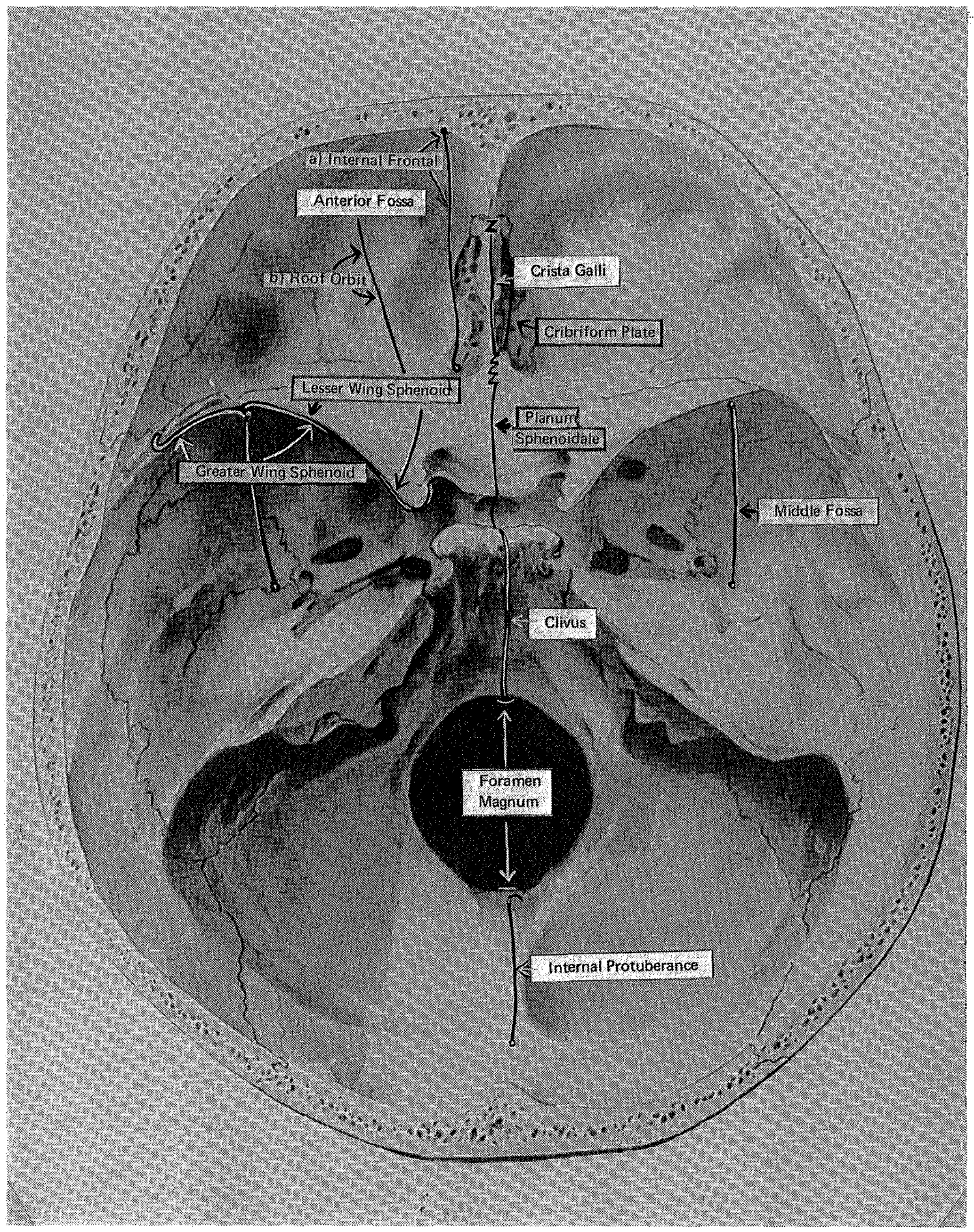

Fig. 1: Internal view of base of skull illustrating wire positions.

superiorly and produce more regular curves (Fig. 3). The dimensions of the cribriform plate vary in different morphological types and particularly the dimensions and contours of the radiological image varies with age. In the child (Fig. 4) the cribriform plate is more obvious and is slightly inferior to this medial and rather indefinite floor of the anterior cranial fossa. As the child approaches puberty the frontal bone on the lateral aspect of the cribriform plate develops a distinct cortical edge and then begins to mask the white shadow, particularly of a fine cribriform plate at its posterior end. Anteriorly the cribriform plate ascends towards the foramen caecum and this aspect of the plate begins to be overshadowed by the dense external aspect of the zygomatic process of the frontal bone and the edges of

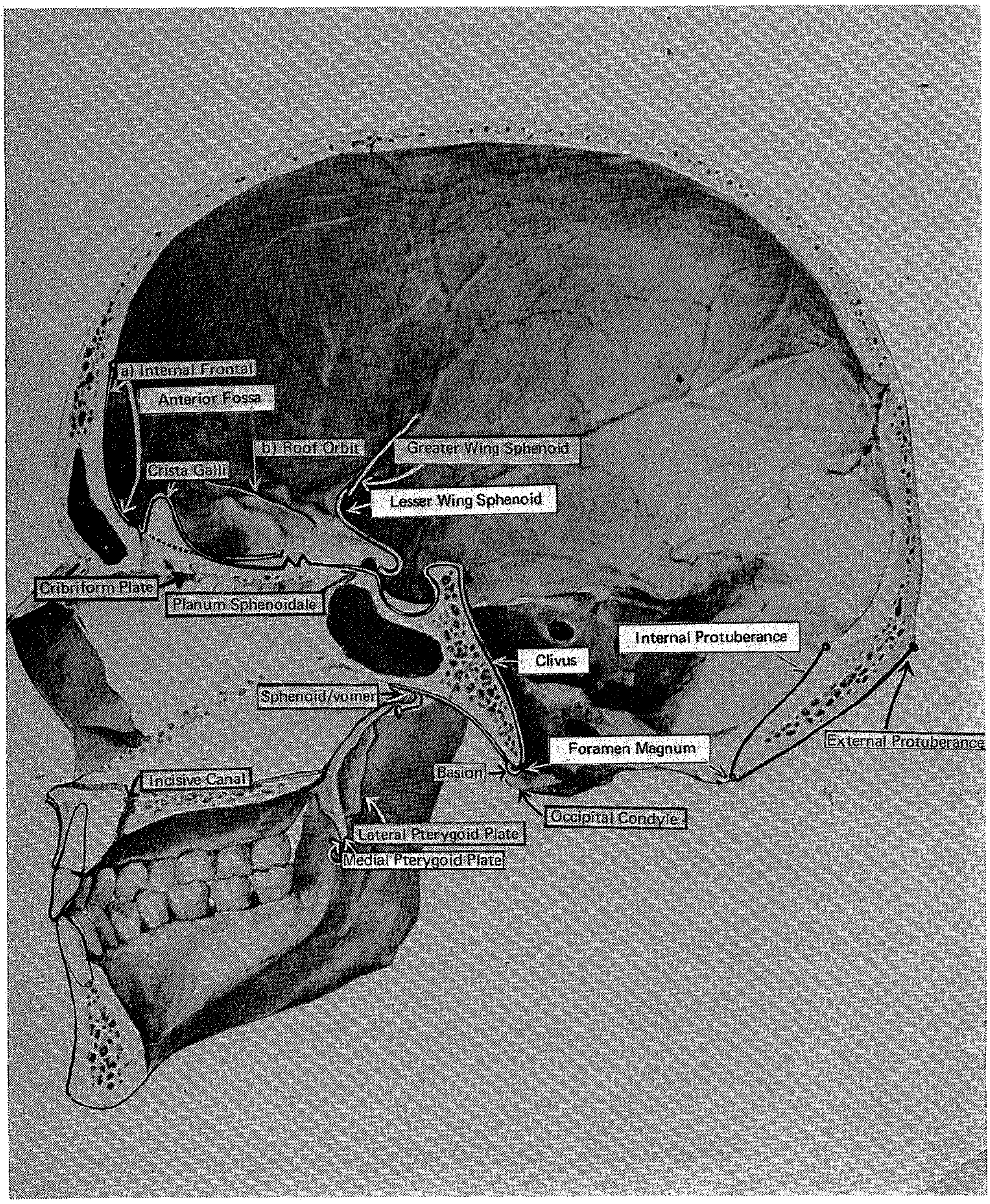

Fig. 2: Sagittal section skull to the right of midline illustrating wire positions

the zygomatico frontal suture. Hence the ease of identification of anterior and posterior limits of cribriform plate will vary with age and morphological type, and tracing of both cribriform plate and the internal and medial walls of frontal bone are particularly desirable for superimposition of the contours of "anterior cranial base."

(b) Lateral Floor—Roof of Orbit.

The lateral radiograph outlines two or more bilateral white lines, "Roof of Orbit" in Fig. 3, superior to the position of the medial floor of anterior cranial fossa ((a) in Figs. 1, 2 and 3) and these are also the anterior cranial fossae floor but the cut edge of bone is lateral to (a) and approximates the roof of the orbit. The roofs of the orbit (b) should not be mistaken as forming part of the anterior cranial base and may be readily identified because not only are they more superiorly placed but also they are more irregular in outline, as well illustrated anatomically in Fig. 2. They vary in shape and number dependent upon the convolutions of the orbital sulci and gyri of the brain which of course vary considerably in different individuals.

(c) Crista Galli.

The crista galli (a fine crest-like projection superiorly of the ethmoid bone) is illustrated by the coincident wire in Figs. 1 and 2. The wire has been inserted anteriorly in foramen caecum, traverses the crest-like surface of the crista galli, and merges with cribriform plate prior to the spheno-ethmoidal suture. The crista galli varies considerably in size and shape and the fine radiological shadow of the crista galli, outlined by the coincident wire in Fig. 3, is seen only rarely on cephalometric radiographs because, although it lies superior to the previously described shadows of the anterior cranial fossae floor, (a) in Figs. 1 and 2, the superimposed shadows from externally of the zygomatic process of the frontal bone (Fig. 3) dominate the area and these usually mask the crista galli's precise position. Foramen caecum and the beginning of the crista galli are sometimes more readily identified as they are not overshadowed and are positioned on the radiograph within the superior outline of the orbit and adjacent to the posterior wall of the frontal sinus.

(d) Planum Sphenoidale.

The superior or cranial surface of the body of the sphenoid (Planum sphenoidale) is outlined by the wire positioned in Figs. 1 and 2 and illustrates the anatomical continuation of

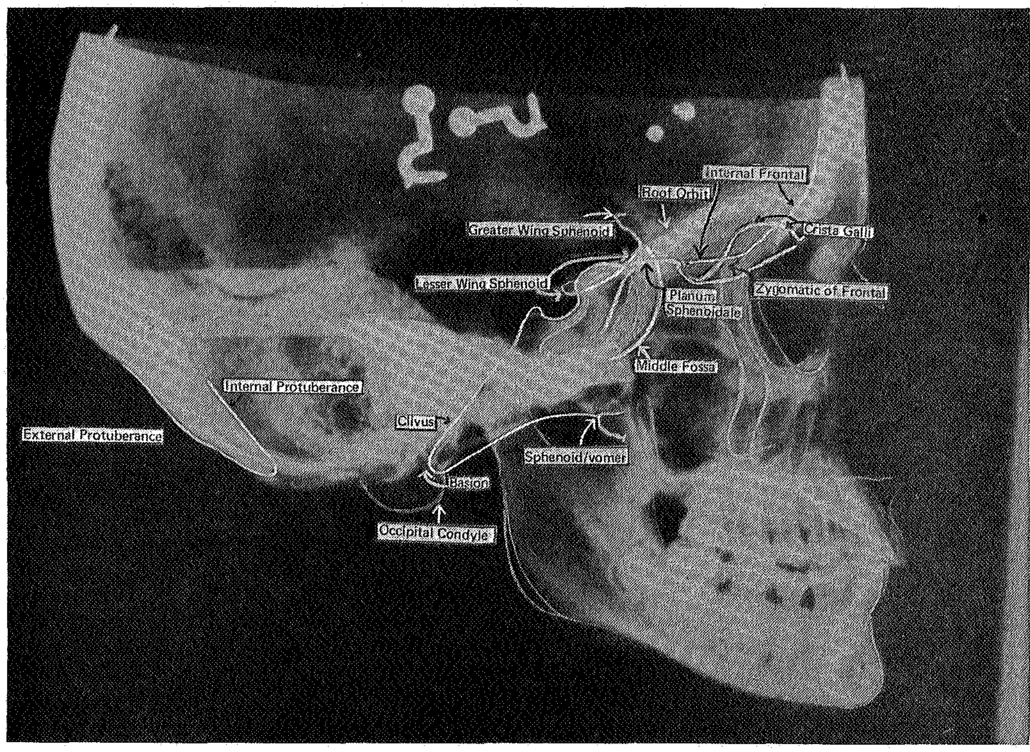

Fig. 3: Lateral cephalometric radiograph illustrating wire positions of cranial base.

anterior cranial base. The coincident wire (Fig. 3) begins at the spheno-ethmoid junction and continues over the planum sphenoidale, crosses the optic groove and continues across the tuberculum sellae and into the hypophyseal fossa. (Figs. 1, 2 and 3). Particular attention should be drawn to the antero posterior position of the spheno-ethmoidal suture and on Fig. 3 of the positions where middle cranial fossa outline [see (4)] and greater wing of sphenoid [see (3)] intersect the planum sphenoidale.

(e) The Hypophyseal or Pituitary Fossa.

The boundaries of the hypophyseal fossa (Fig. 5) are anteriorly the tuberculum sellae, posteriorly the dorsum sellae, antero laterally the anterior clinoid processes (the medial projection of the lesser wing of the sphenoid) and postero laterally the posterior clinoid processes (the lateral projection of the dorsum sellae).

It is important to understand that a tracing of the anterior cranial base for purposes of superimposition does **not** include either the unstable anterior or the posterior clinoid processes (Figs. 5 and 6). A tracing of anterior cranial base begins posteriorly with the hypophyseal fossa floor and continues anteriorly with the white shadow of the tuberculum sellae which is identified lying inferiorly to the outlines of the anterior clinoid processes, (labelled "lesser wing of sphenoid" in Fig. 3). Many "normal" anatomical variations of the hypophyseal fossa are possible producing various alterations in radiological appearance, e.g. there may be a middle clinoid process or, the anterior and posterior clinoid process may be joined (Pendergrass 1956), but these variations almost always allow recognition of the tuberculum sellae, the starting point for anterior cranial base superimpositions. There is a change in contour of tuberculum sellae with age as the fusion between pre sphenoid and post sphenoid occurs at this level and this may be noticeable in some skulls until 11 or 12 years of age (Fig. 7).

Lying inferior to the outline of the tuberculum sellae and occupying much of the body of the adult sphenoid is the sphenoidal air sinus.

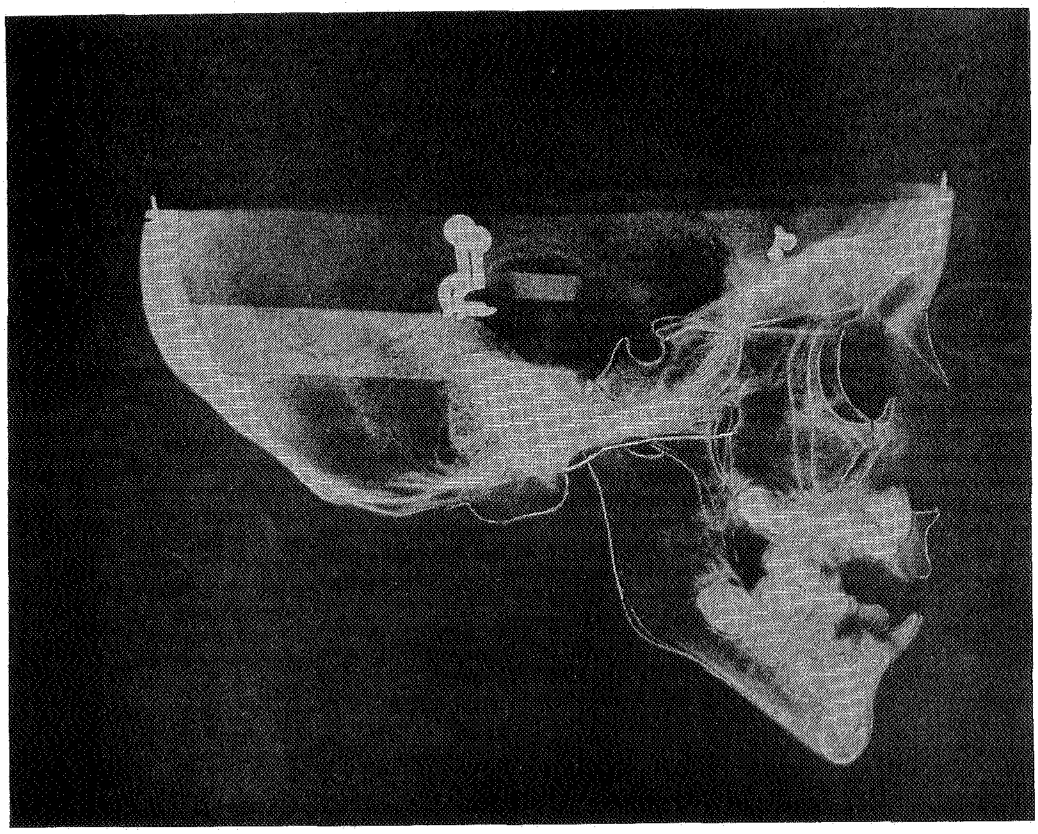

Fig. 4: Lateral cephalometric radiograph of 9 year old skull (note wires on cribriform plate below internal wall of frontal bone).

When the sinus is large the superior wall of the sphenoidal air sinus (Fig. 6) may be mistaken postero-superiorly for the tuberculum sellae and antero-superiorly for the planum sphenoidale. If there is any confusion of identification of these white lines of the tuberculum sellae, planum sphenoidale and the wall of the sphenoidal air sinus, an initial tracing of the sphenoidal sinus in its entirety will eliminate much of the confusion. (Figs. 6 and 8). Notice the sphenoid sinus is absent in the 4 year old skull (Fig. 7) and is beginning to enlarge in the 9 year old (Fig. 4).

(2) The Lesser Wing of the Sphenoid.

The wire shown in Figs. 1 and 2, illustrating the lesser wing of sphenoid begins, on the medial aspect of the anterior clinoid process (near the optic foramen), then loops around the posterior aspect of the anterior clinoid process and continues along the free edge of the lesser

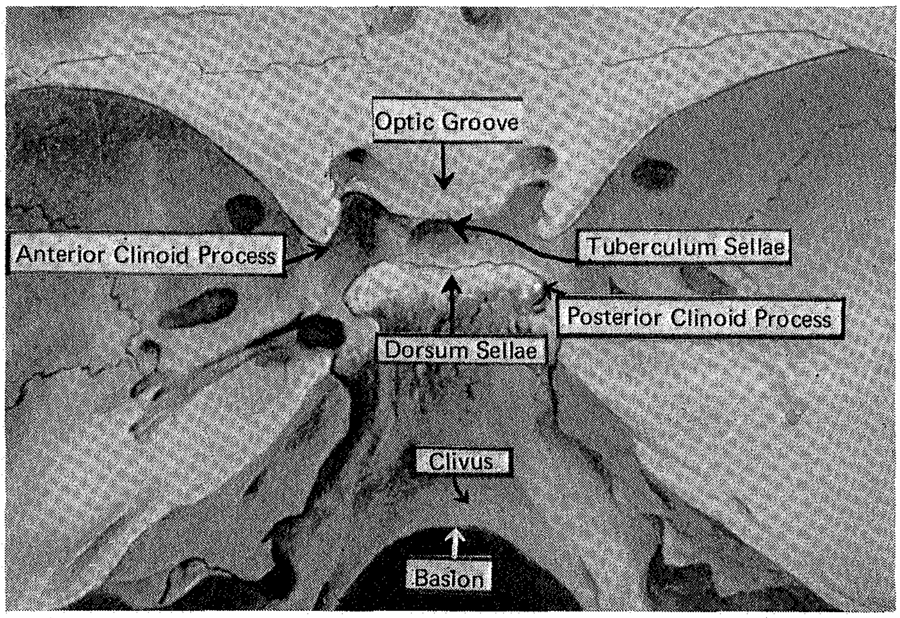

Fig. 5: Internal view of the borders of sella turcica.

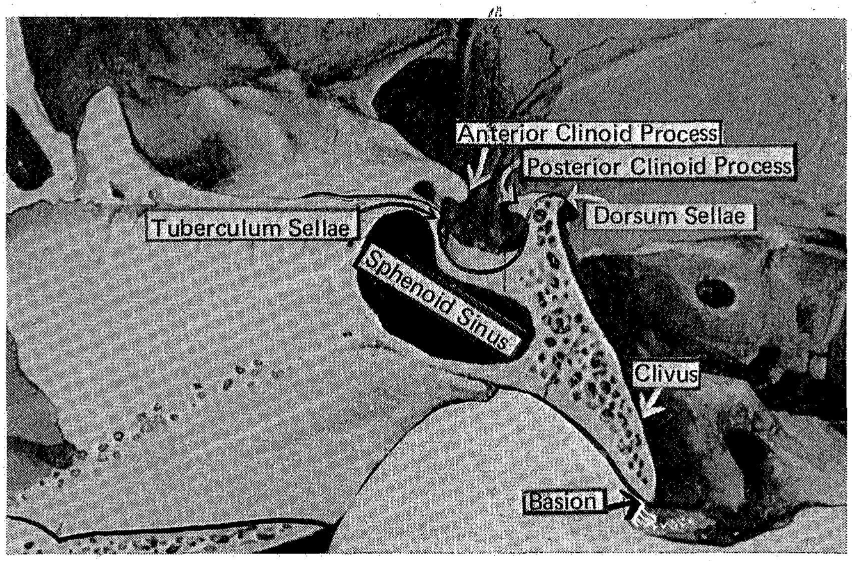

Fig. 6: Sagittal section of skull illustrating relationship of tuberculum sellae to roof of sphenoid sinus.

wing of the sphenoid bone, defining the posterior limit of the anterior cranial fossa. The coincident wire provides the radiological image illustrated in Fig. 3. Notice how the wire outlines the anterior clinoid process and is then continued laterally (below the level of both tuberculum sellae and planum sphenoidale) until it meets the greater wing of sphenoid in Fig. 1 and illustrated radiologically in Fig. 3.

In the antero posterior radiograph (Fig. 9) the lesser wing is distinctly seen within the outline of the orbital cavity as it provides the superior margin of the superior orbital fissure. The confusion of the greater and lesser wings of sphenoid on the radiograph should not occur if it is remembered that the lesser wing provides the superior margin and greater wing provides the inferior margin of the superior orbital fissure. The tracings outlined in some books (e.g. Enlow Fig. 128 A and B) are obviously incorrect.

(3) Greater Wing of the Sphenoid.

The greater wing of the sphenoid provides antero-medially the floor and antero-laterally the beginning of the side wall of the middle cranial fossa (Fig. 1). The anterior margin of this greater wing of the left sphenoid has been designated by a wire in Figs. 1 and 2. Notice the coincident wire begins by being inserted in the emissary vein foramen, situated at the junction of the greater wing laterally with the frontal and the parietal bones. The wire follows the free margin of the greater wing before it meets the lesser wing and then diverts under the free edge of the lesser wing outlining the inferior margin of the superior orbital fissure, the pear-shaped structure shown particularly well on the antero posterior radiograph (Fig. 9). The coincident wire illustrates the radiological image in the lateral radiograph (Fig. 3) as the greater wing begins where the wire hooks in the emissary vein foramen and the wire shows how the greater wing outline runs inferiorly on the lateral radiograph as it provides the inferior margin of the superior orbital fissure. Notice particularly in Fig. 3 how the radiological image meets first the lesser wing shadow, almost simultaneously it crosses the roof of the orbit outline (i.e. the anterior

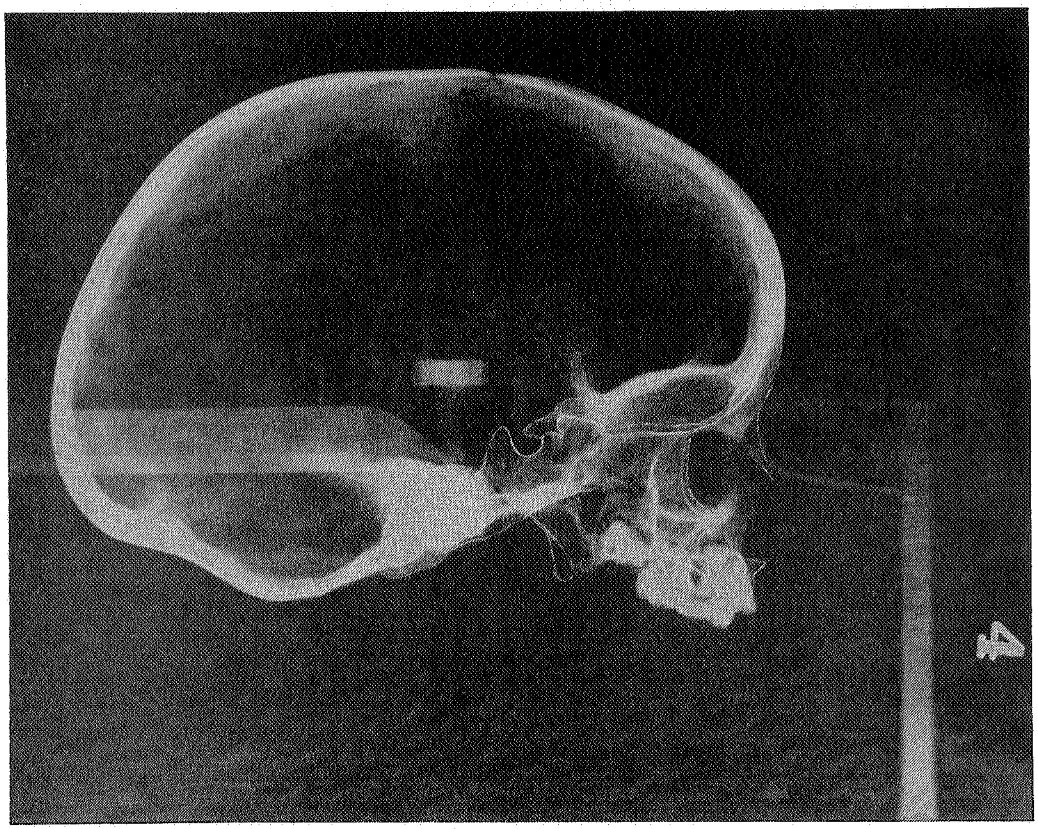

Fig. 7: Lateral cephalometric radiograph of 4 year old skull (note irregular outline of tuberculum sellae area due to lack of complete fusion of pre and post sphenoid.

cranial fossa floor) and then almost bisects the outline of the planum sphenoidale as it crosses into and within the outline of the sphenoidal sinus.

Attention should be paid to the relative antero-posterior positions in Fig. 3 of spheno-ethmoidal suture, middle cranial fossa, and greater wing of sphenoid, as these have sometimes caused confusion in the literature (e.g. Knott 1970). These structures all produce different radiological shadows and particularly spheno-ethmoidal suture may be in front of or behind middle cranial fossa. These relative relationships are important in assessing antero posterior development of the sphenoid bone. As morphological variations of sphenoid (depth of body and extent of greater and lesser wings) vary in different facial types and may be used clinically to assist in assessments of cranial base growth potential, precise identification of these margins is important.

The lateral margins of the greater wings of sphenoid (i.e. the lateral or side wall of the middle fossa) on lateral cephalometric radiographs would produce only a diffuse ill defined shadow as the x-rays would cut the cortical bone at right angles and there would be no edge of bone to provide a distinct radiological image. The radiological images of middle cranial fossa floor (confusingly illustrated by Hunter in Enlow, Fig. 128 as greater wing of sphenoid) has been confused with this lateral extent of greater wings of sphenoid (see 4 below).

(4) Middle Cranial Fossa Floor.

The middle cranial fossa floor (Fig. 1) is seen as two curved white shadows (bilateral) on the lateral skull radiograph (Fig. 8) anterior to the radiological image of greater wing of sphenoid. Although this shadow has been referred to as greater wings of the sphenoid (Krogman and Sassouni 1951 and Enlow 1968), this is only true in part. This curved white line, as illustrated by the coincident wire, in Fig. 1, begins anteriorly by outlining the anterior limit of the middle cranial fossa, (i.e. the greater wing of the sphenoid where it meets the lesser wing) and then continues posteriorly on the greater wing as the middle cranial fossa floor, proceeds on to the squamous temporal as it now provides the middle cranial fossa floor and merges with the petrous temporal outline.

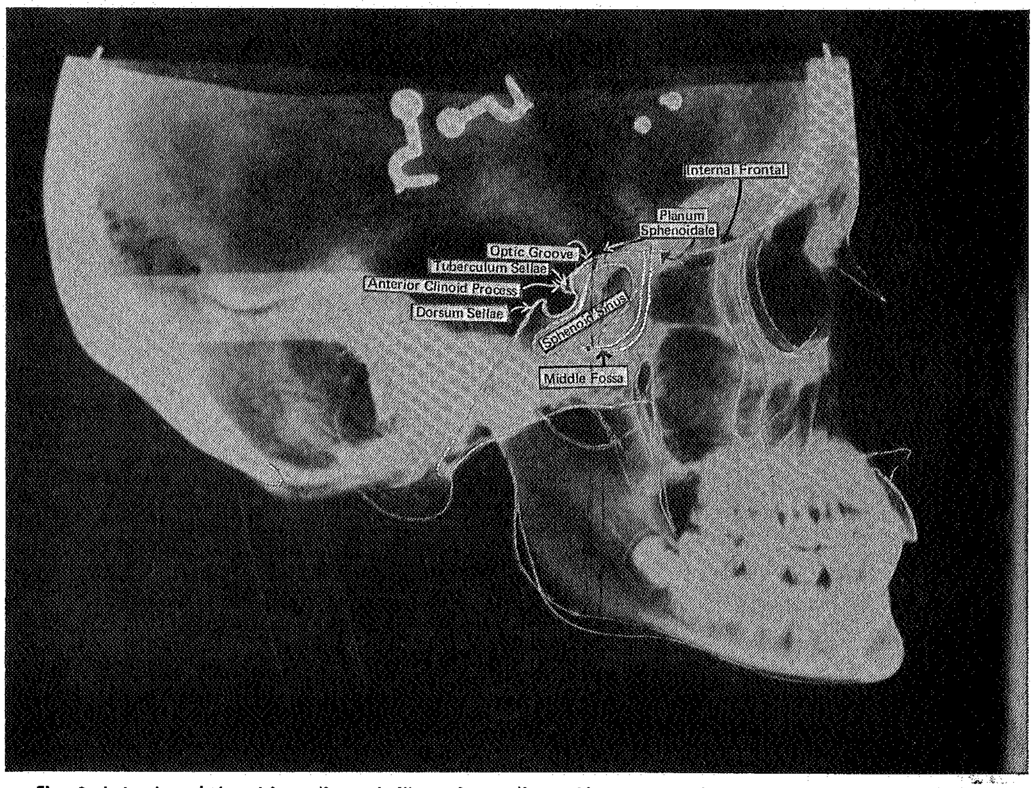

Fig. 8: Lateral cephalometric radiograph illustrating radiographic anatomy of sella turcica and sphenoid sinus.

The position of these curved white lines (Fig. 8 "middle cranial fossa") corresponds approximately with the groove on greater wing made by the middle meningeal artery. The two were coincident on the left side of the adult skull illustrated but on the right side the wire had to be positioned almost 8 mms. from this groove to become coincident on the radiograph. The curved white shadows truly represent the anterior extension of the temporal lobe of the brain and are consequently variable in individual skulls. It would be less confusing if the nomenclature "middle cranial fossa" was reserved for these curved bilateral white lines on the radiograph.

In no way do these curved radiological lines, shown in Fig. 8 correspond to the lateral extension of the greater wings of the sphenoid (B in Enlow Fig. 128) and certainly not to the drawings on the antero-posterior radiograph illustrated as "B" in Enlow's diagram, Fig. 128 (Identification of these is included under "Temporal fossa"). The relative positions of the wires coincident with the radiological images of the middle cranial fossa floor and

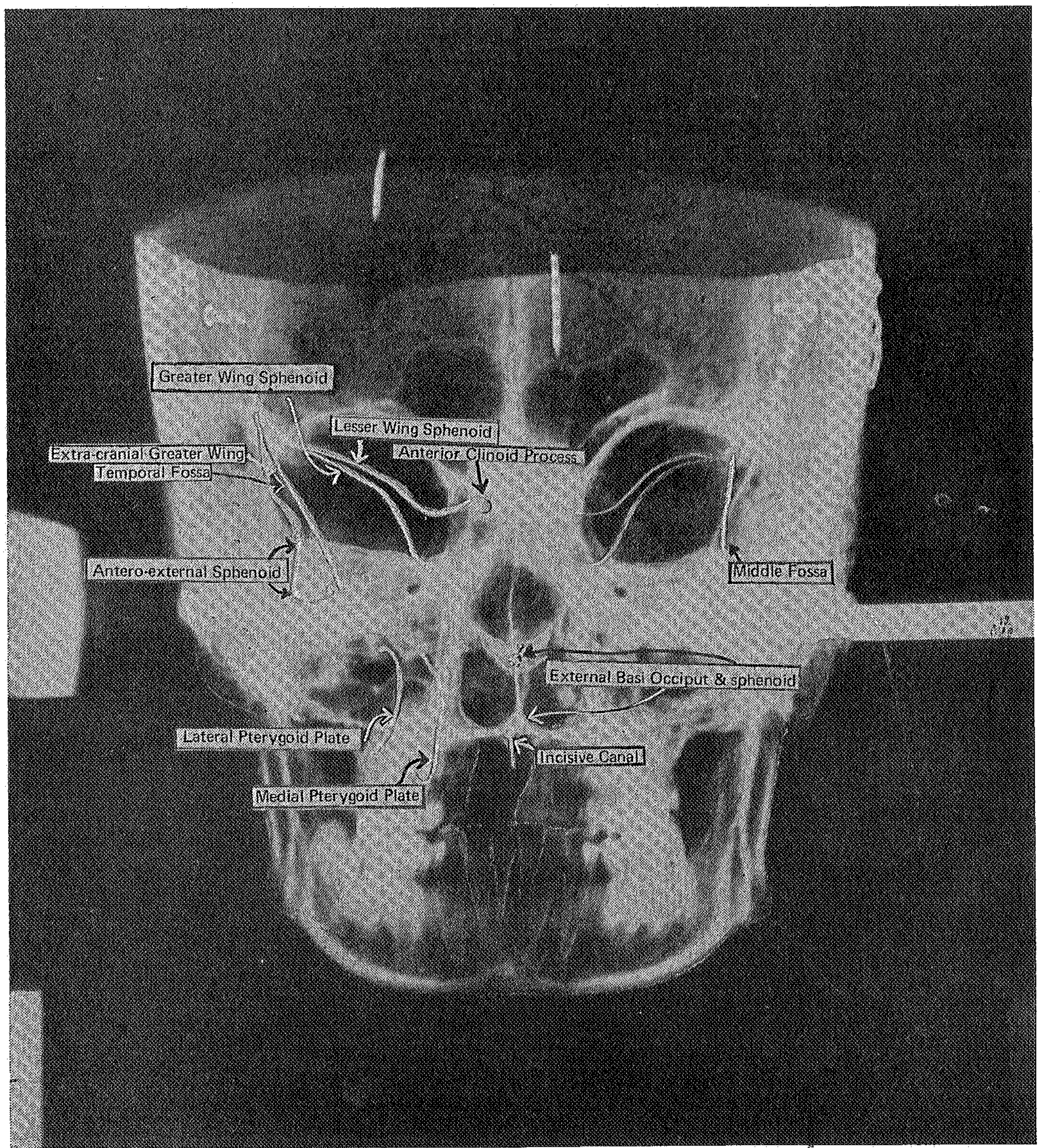

Fig. 9: Antero-posterior cephalometric radiograph illustrating wire positions.

the greater wings of the sphenoid are shown in the antero-posterior radiograph in Fig. 9.

(5) Basion.

The wire as illustrated in Figs. 1 and 2 beginning in the spheno-ethmoidal suture and traversing through the hypophyseal fossa and over the dorsum sella, continues over the cranial surface of the clivus, passing across the spheno-occipital synchondrosis and thence down to the cephalometric point "basion" (Figs. 1, 2 and 3).

Basion illustrates the anterior limit of foramen magnum and thereby designates the antero inferior extent of the occipital bone. Designation of Basion allows the cephalometric assessment of cranial base angle as it designates cephalometrically the end of the posterior cranial base although this is not true anatomically for it ignores much of the occipital bone. Precise location of the point basion on the cephalometric radiograph is facilitated when it it recognised that:—

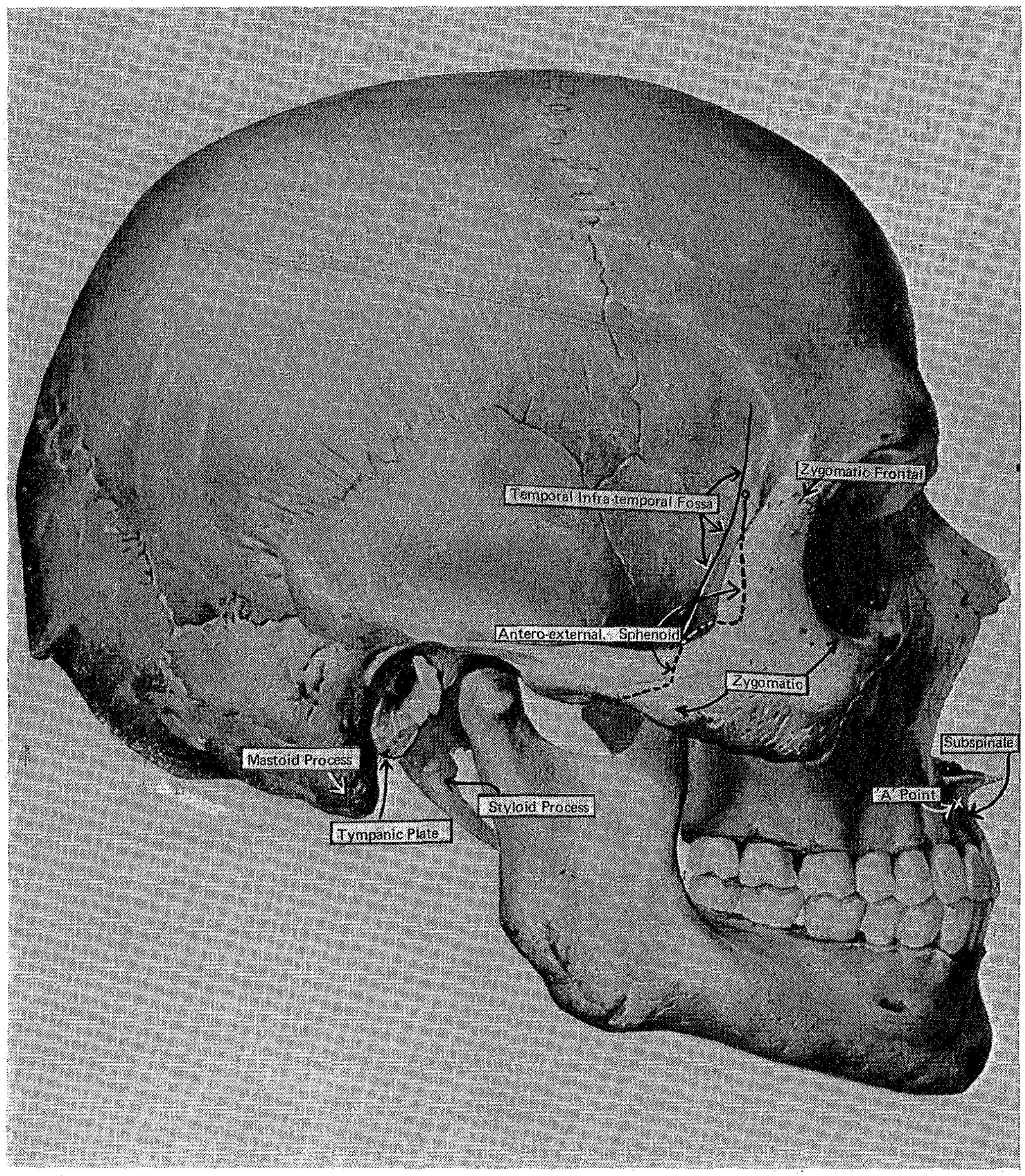

Fig. 10: Lateral view skull illustrating wires in temporal fossa and antero external margin of sphenoid.

(1) The overlying shadows of the occipital condyles come inferiorly and usually extend anteriorly (Fig. 2) just beyond the point basion. The position of point basion is sometimes wrongfully located too far inferiorly and anteriorly, i.e. it is mistaken for the anterior limit of the occipital condyle, so much so that some authors (Cobden 1955 and Knott 1969) use this anterior margin of occipital condyle in place of basion. The condyles are bilateral and extend posteriorly approximately to mid foramen magnum and the tracing of right and left condyles facilitates the accurate recording of basion. In under exposed radiographs the condyles and the outline of the body of the atlas together with the odontoid process of the axis dominate the area and may overshadow basion.

(2) The tympanic plates, the mastoid process and the styloid processes anatomically are positioned (Fig. 10) where they may mask the point basion on the lateral radiograph. However if correctly exposed, the cephalometric radiograph rarely shows the fragile tympanic plate and the mastoid air cells make the mastoid process very radiolucent where it overlies basion. It is only in under-exposed radiographs, where the tympanic plates and the mastoid process become visible and mask the identification of basion. However an anatomical understanding of their respective shapes and positions (Fig. 10) usually allows precise identification of basion.

(3) Accurate identification of basion is dependent on the ear rods not masking the area hence the ear plug surrounds should be contoured as small as possible. The plug positioning is also important and should be placed so they coincide with the radiological image of the external

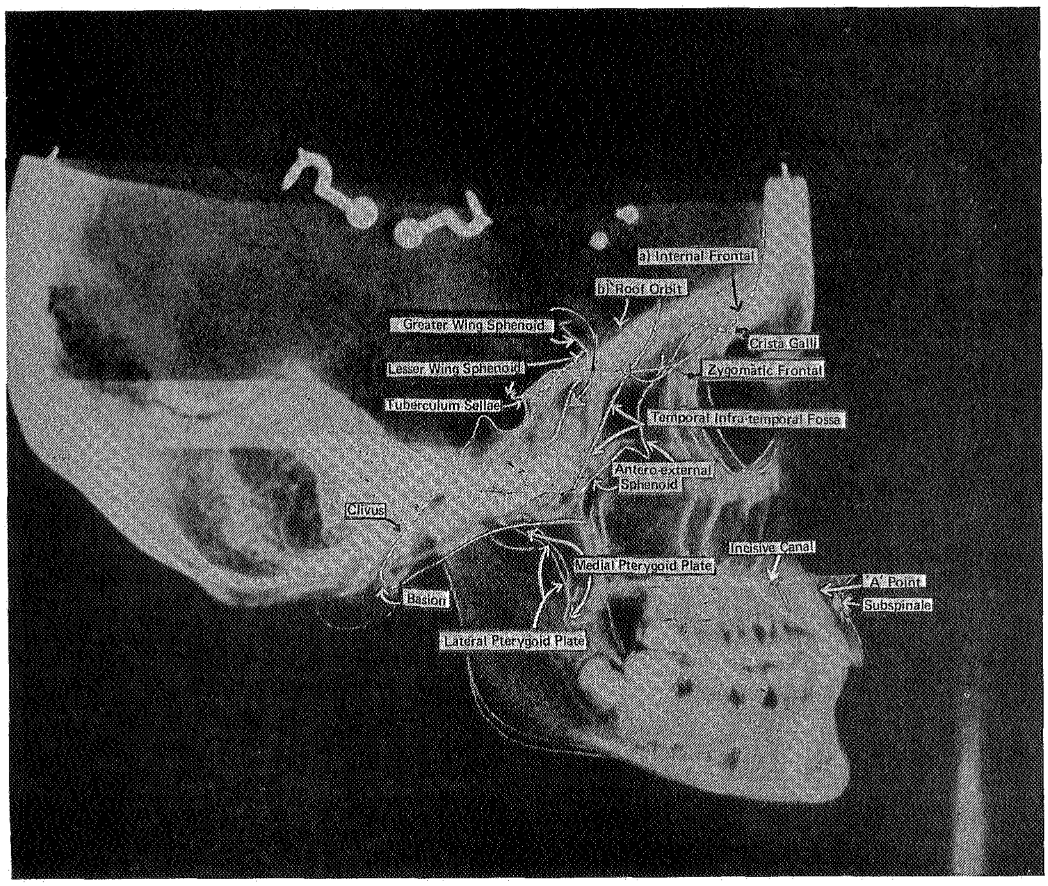

Fig. 11: Lateral skull radiograph illustrating combined wire positions.

auditory meatus. This necessitates placing the ear rod slightly posterior and superior to the soft tissue outline of external auditory meatus and then encouraging the subject to extend the neck as the ear rod is inserted.

Perhaps the most accurate method to locate the point basion on the lateral skull radiograph is to trace both occipital condyles in position. Then trace the clivus as it runs down from the dorsum sellae, disappears behind the very dense superimposed petrous temporal bone and then emerges just behind the occipital condyle. Trace the body of the occipital bone as it finishes at the anterior margin of foramen magnum (basion) and returns up the external or basilar surface of the occipital bone. Where the outline of the clivus and basilar surface of occipital bone meet is basion.

(6) External Basi-Occiput and Basi-Sphenoid.

The external surface of occipital and sphenoid, anterior to basion, is illustrated by the wire in Figs. 2 and 3. The wire lies first on the basilar part of the occipital bone then crosses the spheno-occipital synchondrosis and the body of the sphenoid to finally finish (illustrated by bent pin in Figs. 2 and 3) where the rostrum of sphenoid is roofed over by the alae of the vomer. This fine canal between the posterior extent of the vomer and the anterior extent of the sphenoid is surprisingly well defined and its identification gives a helpful hint as to the depth, and hence the morphology, of the body of the sphenoid bone as well as illustrating the posterior extent of the vomer. It should be noted in the radiograph (Fig. 3) that this extra cranial aspect of the body of sphenoid overlies first the neck of the condyle then crosses the sigmoid or mandibular notch, cuts across the outlines of the beginnings of the pterygoid plates and finishes under the vomer at the approximate antero-posterior position of the outline of the well defined tear-drop shaped pterygo-maxillary fissure. These relative antero-posterior relations on the radiograph of the junction of the body of the sphenoid and the alae of the vomer, the outline of the commencement of the pterygoid plates and the pterygo maxillary fissure should be particularly noted.

The position of the wire coincident with basi-occiput and basi-sphenoid should be noted in Fig. 9 on the antero-posterior radiograph and particularly the alae of the vomer overlying the basi-sphenoid is well illustrated lateral to the bent pin.

(7) Posterior Limit of Foramen Magnum.

Difficulties sometimes arise in identifying the posterior limit of the foramen magnum. This can be alleviated by tracing the internal occipital protruberance on the cranial surface of the skull (Figs. 1 and 2) and then the external surface of the occipital bone running inferiorly from the external occipital protruberance and projecting them until they meet. The mid-sagittal extent of foramen magnum will frequently be found positioned more superiorly (Fig. 3) than suspected from the outlines of foramen magnum, however this slight "V" in the posterior margin of the foramen is well illustrated anatomically in a posterior basilar view of the area.

(8) Temporal and Infra-Temporal Fossa.

The temporal and infra-temporal fossae are only readily recognised on the antero-posterior radiograph (Fig. 9) because it is only on the antero-posterior radiograph that the x-rays cut the cortical bone at right angles, which would produce a distinct radiological image. Its identification is not relevant to the cephalometric analyses of cranial base structures but is included for completeness and to invalidate the labelling by Enlow (Fig. 128) as the greater wing of the sphenoid. The "B" in Enlow's Fig. 128 is positioned on the antero-posterior tracing extracranially and is the curved edge of the depths of the temporal and infra temporal fossae and although formed by the extracranial surface of the greater wing of the sphenoid it includes also the frontal bone. The coincident wire position is illustrated anatomically in Fig. 10 and it should be noted that although the radiographs were taken initially with wires positioned intracranially and extracranially the intracranial wires were deleted for illustration purposes. The intracranial surface rarely produces a definite regular shadow on cephalometric radiographs as can be seen on the opposite (right) side of the radiograph without wires but the outline of the extracranial temporal fossa is quite definite. Notice on the right and left sides the wires coincident with middle fossa floor but it should be noted that the anatomical positions coincident with the "middle fossa" wires would not cast a shadow on the antero-posterior radiograph as the x-rays pass parallel to the position of these wires and therefore the underlying structures. Further posteriorly where the middle fossa floor is provided by the dense petrous temporal bone as it runs medially and almost horizontally this outline is shown running from lateral to medial as the floor of the fossa.

(9) Antero External Limit of Sphenoid Bone.

The wire coincident with the anterior extent of greater wing of sphenoid externally is shown in Fig. 10 outlining first the zygomatico-sphenoid suture then it runs inferiorly outlining the margin of the inferior orbital fissure and then running along the infra-temporal crest to finish at the junction of sphenoid with the squamous temporal. As illustrated the configuration is irregular and this outline usually is indistinct on lateral cephalometric radiographs but may be observed at the infratemporal crest which shows up posterior to the superior outline of the pear-shaped pterygo maxillary fissure (Fig. 11).

(10) The Inferior Margin of Orbit.

Difficulties sometimes arise with the identification of the inferior margin of the orbital cavity outline and particularly demarcation of orbitale on the lateral radiograph. When this occurs it is best to trace the posterior margin of the zygomatic bone as it descends (Fig. 10) from the zygomatic process of the frontal bone and the zygomatico frontal suture through the radiological outline of the superimposed maxillary sinus (Fig. 11) and then turns anteriorly at the ''malar or keyridge.'' Because these are lateral structures the right and left sides usually are not superimposed completely. To help identify the internal or orbital margins of this zygomatic bone notice how the anatomical width of this aspect of the bone (Fig. 10) varies from approximately 6 mm. at the zygomatico frontal suture to 20 mm. as the orbital margin descends to the infero lateral aspect of the orbit and then swings medially providing the inferior margin of the orbit. By commencing the tracing of the orbital outline (Fig. 11) at the zygomatico-frontal suture and following the outline of the zygomatic bone inferiorly it becomes easier to follow the margin inferiorly and medially to its deepest point, orbitale. Because of the lack of superimposition, frequently the left posterior margin of zygomatic bone is superimposed almost over the right internal margin of the orbit, but the left internal margin is thrown forward and clear.

It is desirable in these cases to trace both left and right sides to be sure of accurate identification.

(11) Pterygoid Plates.

The position of both the lateral and medial pterygoid plates are illustrated on the skull in Fig. 2 and on the radiograph in Fig. 11. It should be noted that in the adult skull the medial pterygoid plate commences further posteriorly and runs more inferiorly (down to the hamulus) than the lateral pterygoid plate but the relative sizes and extents of the medial and lateral pterygoid plates vary considerably in different skulls. The coincident wire illustrates the position of the plates as they begin approximately 1 - 2 mm. superior to the extracranial outline of the body of the sphenoid (the medial plate at approximately the antero-posterior level of the spheno-occipital synchondrosis) and the plates then run inferiorly and diagonally across the sigmoid or mandibular notch. Their identification is almost always possible on the lateral radiograph and greatly facilitates identification of the extracranial aspect of body of basi-sphenoid, (see 6) differentiating it from the slightly more superiorly placed glenoid fossa and from the beginnings of the zygomatic arch (Fig. 10).

(12) ''A'' Point.

The recognition of the anatomical position of ''A'' Point requires a clear understanding that if it is related to ''the deepest mid-line point on the premaxilla between anterior nasal spine and prosthion'' (Downs 1948), it represents a mid-line position and is dependent on the relative development of anterior nasal spine (a racial characteristic) and would be termed more precisely as ''subspinale.'' Cephalometric radiographs exposed correctly to show the cranial points previously described will show Down's point ''A'' (subspinale) (Fig. 11). This point will not correspond with the ''A'' point defined by Bjork and Palling (1954) ''the most posterior point on the outer contour of the maxillary **alveolar** process.'' The Bjork defined ''**alveolar** point'' will always be slightly lateral to the mid-line and is usually only recognisable in very under exposed radiographs as the dominant basal bone of subspinale lies considerably anterior to it (Fig. 11).

The discussions over movement of ''A'' point with treatment, (Donovan 1953 and Holdaway 1956), and its use as a clinical guide dictating treatment procedures (Williams 1965) will thus rest more suredly if this is realised, and particularly does this confusion apply in cases with anterior placement of incisor apices, e.g. Class II Division II type cases. The before treatment tracings in these cases would show usually the alveolar ''A'' point most anterior to subspinale, (due to the forward positioning of the incisor apices) and therefore ''A'' point would be traced initially whilst the after treatment tracings indicating palatal movement of apices, would be more likely to reveal the true basal point (subspinale).

(13) Incisive Canal.

A small pin is shown inserted in the left incisive canal (Fig. 2) and this is illustrated radiographically in Fig. 11. The regular outline of the canal relative to the nasal floor produces a well demarcated outline.

The outline of incisive canals will alter in radiographic appearance with age, sometimes in the child the erupting canines disguise them and sometimes in the adult because of the density of the cortical bone on the nasal floor the wide nasal contour is indistinct. The incisive canal outline is particularly suitable for an area of superimposition for tracings of the maxillary area to decide upon individual tooth movements during growth or due to treatment.

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