American Journal of ORTHODONTICS

Volume 59, *Number* 2, **February, 1971**

ORIGINAL ARTICLES

A study of roentgenocephalometric bony landmarks

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Most roentgenocephalometric landmarks have been adapted from previously defined and accepted craniometric points on the assumption that they conform to their definition. Studies regarding the reliability of roentgenocephalometric landmarks have been directed mainly to the error of the method, which has been differentiated by (1) differences between two films of the same subject, (2) observed differences in locating the points, and (3) variations in measuring the distance between two marked points.[1] Further, the effect of different techniques in point determination[11] and the relative reproducibility of points, planes, and lines[13] have been investigated. The correct interpretation of the bony structures detectable in roentgenocephalograms has been studied by Yen,[12] who made a series of radiographs of a single dry skull after successive applications of a radiopaque paste.

However, difficulties in the proper determination of landmarks still are encountered frequently. These problems are related, among other things, to the individual variations in the structure of the skeleton and to overshadowing by soft-tissue structures. It is usually assumed that the cephalometric landmarks are comparable among individuals and do not change their relative locations during growth.

Three main factors motivated the undertaking of this study: (1) No reports could be found which tested whether the commonly used roentgenocephalometric

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This study was supported in part by United States Public Health Service Research Grant DE-02272.

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Table I

From 2 to 6 years	16 (0)
From 7 to 12 years	18 (2)
From 13 to 16 years	15 (6)
Young adults	4 (1)
Adults	11 (2)

The sixty-four skulls studied are subdivided into five age groups, estimated on the basis of development of the dentition. Most cases exhibited an Angle Class I occlusion. No Class III malocclusions were present. The number of Class II cases in each group is shown in parentheses.

landmarks do, indeed, conform to the accepted definitions; (2) little attention had been given to individual variations in skeletal structure which can affect the determination of landmarks; and (3) the relative constancy of cephalometric reference points during growth had not been investigated.

A study of the three aspects indicated above was carried out, not only to contribute to the understanding of the information obtainable from roentgenocephalograms for diagnostic purposes but also to improve the interpretation of observations of cross-sectional and longitudinal roentgenocephalometric investigations.

Material and methods

By the nature of its purposes, the study had to be conducted primarily on material that allowed a careful inspection of the relationship between the objects radiographed and their images on the roentgenograms. This condition can be met only when dry skulls are investigated. To arrive at the goals outlined above, the sample had to be of ample size and represent different developmental stages.

In all, sixty-four skulls, mainly of Asiatic Indian origin, were studied (Table I). Lateral roentgenocephalograms, standardized according to Broadbent,[3] were collected. Subsequently, the pertinent bony structures were studied on the skulls by visual inspection and, if relevant, by the taking of linear measurements. Some outlines were recorded by means of a contour gauge. The observations were then compared with the images on the radiographs.

The lateral roentgenocephalograms of sixty living persons, representing different developmental stages, were analyzed to determine whether the information obtained from the skull material could be applied to living subjects.

Findings

The findings will be presented separately for each landmark. A limitation was set regarding the number of points discussed, with preference given to those of major importance and those for which meaningful remarks could be made. Differences between the developmental stages are mentioned only when they could be detected systematically.

Sella. This reference point is usually described as "the midpoint of the sella turcica determined by inspection." Hunter[8] likes to call it a "space mark" instead of a landmark. As such, it lacks a craniometric definition.

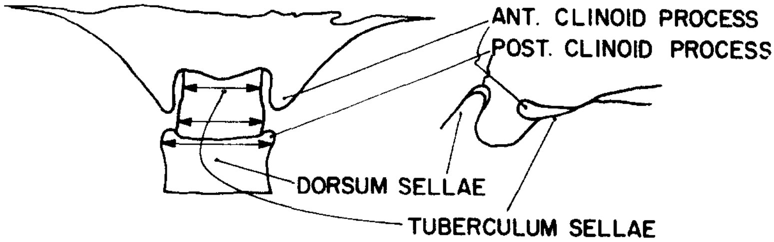


Fig. 1. Sella turcica with its surrounding structures.

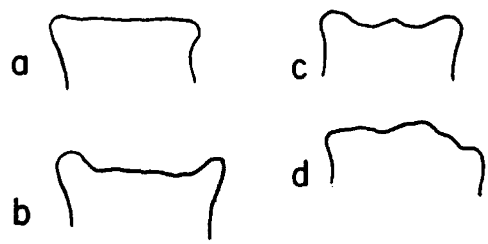


Fig. 2. Variations in the morphology in transverse direction of the dorsum sellae.

The relative stability of point S has been constantly assumed during its use.[9] However, some authors do not agree with this.

All skulls were analyzed with respect to the morphologic characteristics of sella turcica and its surrounding structures as far as they may influence the image on the lateral roentgenocephalograms. The morphology and orientation of the superior border of the dorsum sellae, including both posterior clinoidal processes, was recorded and its width measured (Fig. 1). The same was done for the posterior and inferior surfaces of the hypophyseal fossa, the tuberculum sellae, and the relationship of the latter to the anterior clinoidal processes. Further, the midsagittal outline from the spheno-occipital synchondrosis to the spheno-ethmoidal junction was determined twice by means of the contour gauge and recorded on tracing paper. The average outline of the two tracings was later used to distinguish the image of the midline structures from the parasagittal ones on the roentgenogram.

In twenty-one cases the superior border of the dorsum sellae formed a plane. In sixteen the posterior clinoidal processes were superior to the median structure; in eleven instances they were more inferior (Fig. 2). In sixteen skulls the relevant area was damaged and could not be studied. The images in the radiographs varied accordingly (Fig. 3). In the first case, only one contour of the superior border of the dorsum sellae and the posterior clinoidal fossa was visible (Figs. 2, *a* and 3, *a*). In the second case, two or three outlines were found (Figs. 2, *b* and 3, *b*, *c*, and *d*); in the latter, usually only one corresponding broad demarcation was noticeable.

Comparison with the configuration obtained with the contour gauge revealed that the midline structure in general was detectable as the heaviest radiopaque structure. This confirms its relatively large transverse width, which ranged from

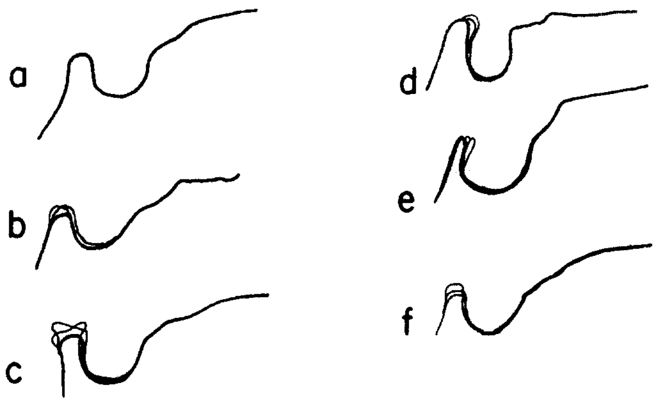


Fig. 3. Variations in the projections seen on the lateral roentgenocephalograms in the sella region.

12 to 22 mm. In cases of two or three equally heavy lines, the most inferior line usually represented the midline region.

The posterior internal wall of the hypophyseal fossa was projected in almost all cases with two or three lines. This corresponded to the concave formation of the structure, reflecting the convex shape of the pituitary gland. The most posterior image nearly always represented the midsaggital region. The floor of the fossa in the transverse direction was formed by a light concave or sometimes flat surface, with a width ranging from 9 to 14 mm., resulting in one frequently broad and clear outline in the radiographs. In a limited number of cases more lines were visible. The transverse contour of the tuberculum sellae was flat in almost all cases and ranged from 7 to 12 mm. in width. The image on the cephalogram was frequently somewhat obscured by the projections of the anterior clinoidal processes, which extended 1 to 5 mm. superiorly in all but two cases. However, the image of the tuberculum sellae could always be distinguished from these structures on the basis that it is more radiopaque and forms a continuous line with the floor of the fossa. The subsequent anterior structure presenting the planum sphenoidale is one of the most clearly defined structures in the skull and does not need to be discussed here. The superior surface of the ethmoid bone could not be distinguished adequately in the majority of cases.

In summary, it can be remarked that the midsaggital contour of the hypophyseal fossa and its surrounding structures in general can be detected accurately on lateral roentgenograms. It is usually formed by the most radiopaque continuing outline which, in the region of the posterior internal wall and the superior border of the dorsum sellae, frequently divides into two or three lines, of which the most dorsal and inferior one has to be given preference. When the floor of the fossa is projected with more than one line, the most inferior one has to be taken as the midsagittal image.

Nasion. Nasion is defined anthropologically as the intersection of the internasal suture with the nasofrontal suture.[10] The first suture cannot be seen in a lateral roentgenogram, and the definition is accordingly modified as the most

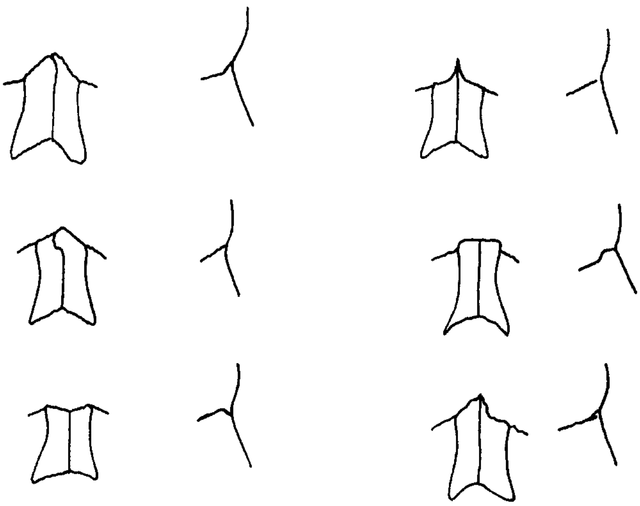


Fig. 4. Variations in the structures related with nasion.

anterior point of the nasofrontal suture seen from norma lateralis.[9] In the majority of the skulls (forty-six out of sixty-four), the intersection of the internasal suture with the nasofrontal suture deviated from the midsagittal plane, mostly because of an asymmetry in the nasal bones. The craniometric and cephalometric definitions did not coincide in many cases.

All frontonasal sutures studied had one feature in common, namely, they ran obliquely upward and forward. However, some variation was noticed in the direction and composition of the most anterior part. In eighteen cases this part continued along the same line; in thirteen skulls it deviated from its posterior part; and in the remaining cases the most anterior part was either less superior-anterior oriented (n = 18), more or less horizontal (n = 7), or even inferiorly inclined (n = 3) (Fig. 4). In sixteen instances additional accessory bones were found in the nasofrontal suture area.

A noticeable asymmetry in the anterior height of the suture was seen in thirty-two skulls, whereas in twenty-nine cases the parasagittal structure in a horizontal direction deviated markedly. Furthermore, the width of the suture varied considerably. In twenty-three instances a notch was found, for which several factors appeared to be responsible (Fig. 5).

The variations described above and illustrated in Figs. 4 and 5 are detectable in the skull; however, frequently they do not show up as such in the radiographs. Usually they result in a relative broadening of the pertinent image at nasion and in a loss of clearness. The factors that can contribute to this phenomenon are many and usually cannot be distinguished on the head film. This explains, to some extent, why it is frequently difficult to determine nasion accurately.

Particularly in cross-sectional studies, it is of interest to eliminate nonessential factors which can lead to a deviation in the landmark determination. The findings on the skull material substantiated a previously made suggestion[11] that, in cases of a marked notching at the anterior side of the suture, nasion prefer-

Fig. 5

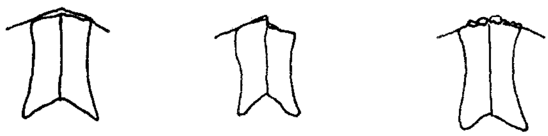


Fig. 6

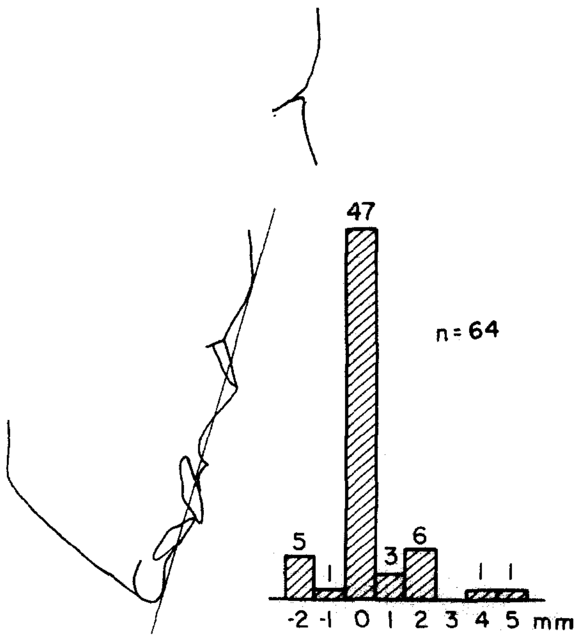


Fig. 5. Variations leading to "notching" of nasion on the lateral roentgenocephalograms.

Fig. 6. For cases in which nasion is not visible on the roentgenocephalograms, Hunter[8] suggested determining this landmark by taking the most posterior point on the curve. In forty-seven out of sixty-four cases this approach proved to be correct. In the remaining cases only small deviations were seen, as a rule. (- = Nasion more inferior than the most posterior point in the curve.)

ably has to be placed more anteriorly and at the general curve of the frontonasal contour.

When the image of the anterior part of the suture is not distinguishable, there is some question as to the advisability of continuing the more posterior outline. For cases in which the suture cannot be seen on the radiograph, Hunter[8] suggested taking the most posterior point on the curve as nasion. This suggestion is strongly supported by our findings. In the majority of the cases studied, nasion coincided with the most posterior point on the curve (Fig. 6).

Subspinale or point A. Subspinale is defined anthropologically as "the deepest midline point on the premaxilla between the anterior nasal spine and prosthion." Downs[5] incorporated it in his analysis and named it point A. Björk[1] defined it as "the deepest point on the contour of the alveolar projection between the spinal point and prosthion."

The observations on our material did not confirm these definitions or the ones presented by others.[9] On the lateral head films of all sixty-four skulls, the anterior outline between anterior nasal spine and prosthion was caused by para-

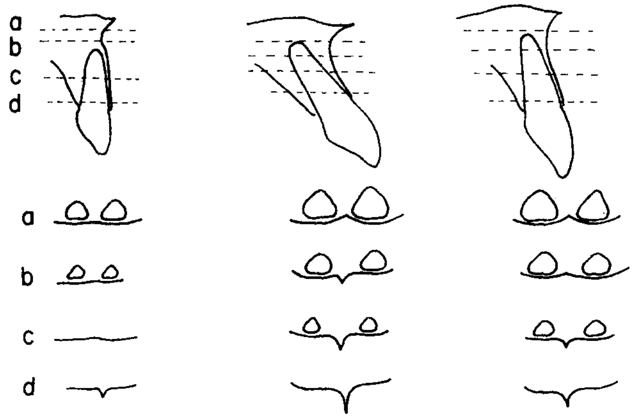


Fig. 7

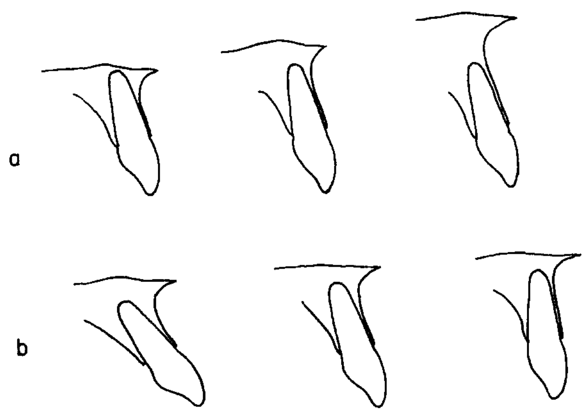


Fig. 8

Fig. 7. Variations in the morphology of the anterior maxillary region.

Fig. 8. The location of point A in regard to the distance from prosthion to anterior nasal spine **(a)** and the inclination of the incisors **(b)**.

sagittal structures in the inferior region and by midline structures superiorly. Invariably, the outline of the alveolar bone from one or both central incisors composed the inferior part whereas the midline structure was more dorsal and thus not visible on the radiograph. It usually showed up slightly superior to the onset of the anterior nasal spine. In the deciduous dentition, the point of crossing over (where the midline structure takes over and from thereon goes superiorly, forming the most anterior image on the radiograph) was located at the level of the apices of the central incisors or slightly superior to it. In the latter case, it was usually associated with a slight notch (Fig. 7). Further, the midline structures in the deciduous dentitions were frequently close to the same plane as the alveolar outline of the central incisors, in contrast to the situation when the permanent incisors are involved.

The replacement of deciduous teeth by permanent ones is associated with a renewal and reconstruction of the alveolar bone. The more anteriorly placed and labially inclined permanent incisor crowns have more protruding accompanying alveolar structures, as could be detected and recorded with the contour gauge. Further, the crossing-over point was in almost all cases located inferiorly to the

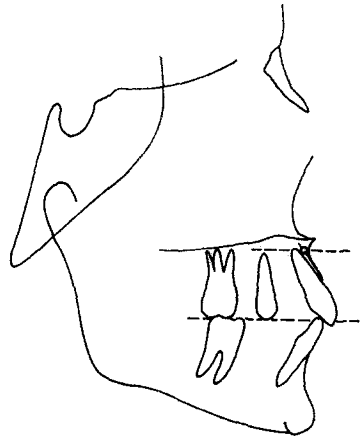


Fig. 9. Point L is located on the anterior surface of the labial lamella(e) covering the central incisor(s) at the region of the completely formed root, where its more or less straight anterior outline changes over to the rounding of the apex. In this the functional occlusal plane is used as reference line. For the location of point L in other developmental stages, see Fig. 10.

apex. This was associated with the considerably more protruding anterior nasal spine and its lower onset in the older age groups (Fig. 7). The impression was gained that a more inferior and consequently usually more anterior location of the crossing-over point, the point usually indicated as point A, was further associated with a more labial inclination of the incisors. The reverse is true for the relative height of the distance from anterior nasal spine to prosthion. The larger this distance was, the more point A seemed to be located superiorly and dorsally (Fig. 8).

Point A is one of the most important points in many diagnostic cephalometric analyses. With this in mind, the total material was studied again with the primary purpose of searching for a more adequate and reliable registration point that could represent the anterior outline of the maxillary apical base. From the previous findings, it became clear that the anterior nasal spine, and particularly its onset, played an overruling and unjustified role in the determination of point A. It affected the vertical and anteroposterior location of point A and varied markedly in the extent to which the midline structure in that region protruded over the labial side of the alveolar wall.

Careful analysis of the cephalograms revealed that the labial plate of the alveolar wall covering the upper central incisors was clearly visible in all radiographs. The image of the lateral lamellae extended a few millimeters beyond a low-positioned crossing-over point and, in most cases, came up to the level of the apex.

This structure representing the labial lamella usually showed up more distinctly than the region representing the anterior midline area. The latter is frequently obscured in cephalograms of living persons by the projection of the soft tissues.

In comparing and analyzing the different approaches that could be followed in the determination of the anterior outline of the apical base, preference was

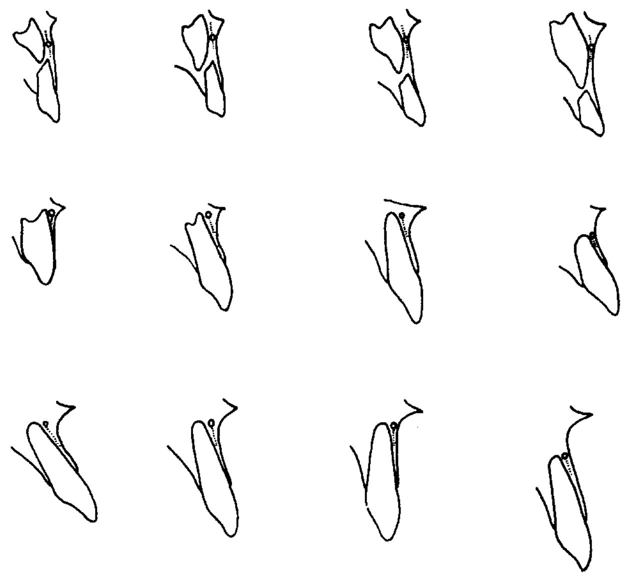


Fig. 10. Variations regarding the determination of point L in different developmental stages.

given to a point, called L, on the anterior surface of the image of the labial lamella at the region of the apex (Fig. 9). Point L is independent of the midline structure and is, by definition, located at the apical base region.

When the permanent incisors before eruption are positioned with their crowns at the apical base region, the definition of point L has to be adapted to this situation. When the permanent incisors are erupted and their roots are not fully formed, point L is located at the root end. Point L stays as such in more or less the same vertical position when the root develops further and the tooth continues to erupt (Fig. 10).

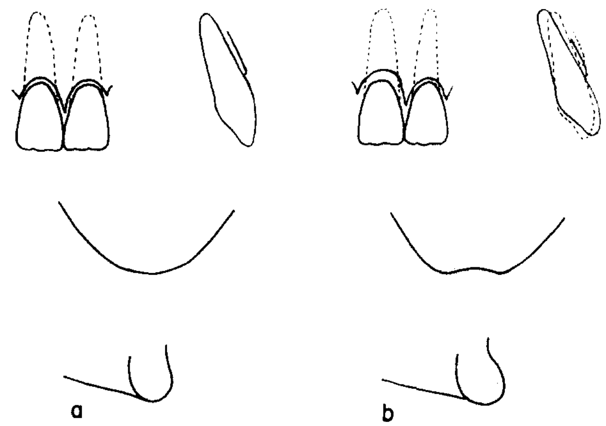
Prosthion. Prosthion is defined anthropologically as the most anterior and inferior midline point between the upper central incisors.[10] Krogman and Sassouni[9] described it as the "most anterior point of the alveolar portion of the premaxillary bone, usually between the upper central incisors." Björk[1] used as a definition the "transition point between the crown of the most prominent medial maxillary incisor and the alveolar projection," and in 1954 Björk and Palling[2] described it as the "lowest and foremost projecting point of the maxillary alveolar process."

Prosthion, as seen on the cephalograms, was not situated in the midline in any of the skulls studied. In all cases, the alveolar bone at the labial margin of the tooth was situated more anteriorly than the corresponding midline structures (Fig. 11). In nineteen cases, the most anterior alveolar border on one side was higher than that on the other side. In twelve cases the one side protruded more than the other. Both forms of asymmetry resulted frequently in double images for those cases. Prosthion, according to the anthropologic definition, was systematically covered in the cephalograms by the central incisors.

On the basis of our findings, consideration of prosthion as a bilateral cephalometric landmark is suggested. In cases of double images, the midpoint of the two

Fig. 11

Fig. 12



a b

Fig. 11. The morphology pertinent to prosthion. The midline point is not seen in lateral radiographs. Instead, the most anterior and inferior points of the bony lamellae covering the upper central incisors are used in roentgenocephalometry.

Fig. 12. The general pattern in chin morphology at an early age **(a)** and in the adult stage **(b)**.

or the one most anterior will be preferred, depending partly on whether only the most protruding central incisors will be used in the evaluation of the cephalogram.

For roentgenocephalometric purposes, prosthion can best be defined as the most anterior and inferior point of the bony lamella covering the upper central incisor; it is bilateral. This is in accordance with Björk and Palling.[2]

Infradentale. Infradentale is the point in the mandible corresponding to prosthion in the upper jaw. The remarks made regarding prosthion in the previous section can be applied to infradentale and will not be repeated here, including comments on the definitions as well as observations on the skulls and their relationships to cephalograms. For roentgenocephalometric purposes, infradentale can be defined as the most anterior and superior point of the bony lamella covering the lower central incisor. It is by nature a bilateral landmark, as is prosthion.

Supramentale or point B. For this point, the craniometric and roentgenocephalometric definitions coincide with the most posterior point in the concavity between infradentale and pogonion. This turned out to be the case for all skulls studied if the anthropologic definition of infradentale was used. Supramentale was systematically located in the median plane and was clearly visible on the radiographs.

One aspect to be considered is the relation in which the term *most posterior* should be interpreted. If this is done in relation to a tangent drawn from point N, the result is usually a more superior and anterior determination than when the occlusal plane or the mandibular plane is used for reference. Further, point B varied considerably in its vertical relation to the apex of the central incisors. In most cases a determination in relation to the mandibular border placed the point more in the region of the apices.

Pogonion. In craniometric and roentgenocephalometric definitions, pogonion is described as the most prominent or anterior point of the bony chin determined by inspection and seen from norma lateralis.[9] No deviations from this definition were found in the material studied. However, the remarks made for point B may be applied here with respect to the plane of reference used in the determination of pogonion.

Menton. As defined by Martin and Saller,[10] menton is the most inferior midline point on the lower margin of the mandible, in the median sagittal plane, roughly where the anterior curvature becomes confluent with the base. In roentgenographic cephalometry menton is located at the lowermost point on the symphyseal shadow as seen from norma lateralis.[9] The analysis of the skull material revealed that in all specimens from the youngest developmental stage the lowermost point is located in the midsagittal plane or is formed by a table that extends to the lateral plane. In the material representing the young adult and adult stages, structures at the level of the lateral incisors were more inferior than those at the midline in fourteen out of fifteen cases (Fig. 12). In the two remaining developmental stages, the changes taking place with age were evident.

What is seen and determined on the roentgenogram as menton may be a midline or a bilateral structure, depending on the developmental stage of the subject and the individual variation. Furthermore, if the point is used in the evaluation of longitudinal data, it may not represent the same structure in earlier and later stages. It is likely that the morphologic change with growth is different for males than it is for females.[14]

The roentgenographic cephalometric definition of menton may be adapted to these findings and formulated as the one or two lowest points of the anterior part of the mandible, as seen in norma lateralis.

Gnathion. As a roentgenocephalometric description of gnathion, we will use that of Brodie,[4] who said: "It is located by taking the midpoint between the most anterior and inferior points on the bony chin."

The same phenomenon as described for menton was found in the location of gnathion. However, there were fewer cases in which the lateral structures protruded and determined the image on the radiograph instead of that of the midline. The more the lateral structures dominate in menton, the greater the change, which is also true for gnathion. In the older material, the contour of the bony chin deviated from that of the younger specimens. The changes in longitudinal material recorded in the roentgenocephalometric determination of menton and gnathion are expressions of an over-all change in structure of the anterior and inferior border of the mandible with growth. It is suggested that another roentgenocephalometric definition of gnathion should be adopted which would be more in accordance with our findings, as is done above for menton.

Gonion. Gonion was studied primarily to detect asymmetries between the left and right sides and to determine their effect on the radiographic picture.

The dry mandibles showed little noticeable asymmetry in the region of the jaw angle. Evidence was found in only fifteen cases and consisted of minor local exostoses and anterior or posterior notchings. The interpretation of the images on the roentgenograms did not present a problem.

Condylion. Condylion is defined by Björk and Palling[2] as the top of the condyle head and by Enlow and associates[6] as the most posterior-superior point on the mandibular condyle. The total structure was difficult to determine on the radiographs, partly because of an overlapping of some Plexiglas parts on the cephalostat. All separate mandibles were analyzed regarding the variation in condylar structure. Over-all asymmetry was found in twenty-four cases. The top of the condyle was situated markedly more to the lateral on one side than on the other in twenty-six mandibles. A large individual variation in condylar structure was noticed. These findings may partly explain why there is so much difficulty in locating the point condylion in many lateral roentgenocephalograms.

PTM. The pterygomaxillary (PTM) fissure is a typical roentgenocephalometric landmark. It is defined by Hunter[8] as a "bilateral, upside-down, teardrop-shaped area of radiolucency, the anterior surfaces of which are taken as the posterior surfaces of the maxilla. The point itself is usually taken at the most anterior, inferior confluence of the curvatures." Krogman and Sassouni[9] described it as the projected contour of the fissure and indicated that the anterior wall represents closely the retromolar tuberosity of the maxilla whereas the posterior wall represents the anterior curve of the pterygoid process.

In a number of skulls studied, the inferior part of the posterior image was formed by the palatine bone, rather than by the maxilla. In many cases, particularly the ones representing the earlier stages, the pterygoidal plates and fossae were medial to the maxillary tuberosities, and no direct contact existed. In the older stages there was closer transversal proximity, as a rule. The impression was gained that this was related to the dorsal inward tapering of the upper alveolar arch which usually accompanies the presence of the third molars.

In the cases in which an upper molar still had to erupt, usually the bone surrounding the developing tooth locally protruded through the over-all dorsal outline of the retromaxillary tuberosity. This, together with the presence of the relevant tooth, frequently obscured the parts essential in the determination of PTM.

PTM may be recorded quite well in the roentgenocephalograms of younger persons with no locally overlapping molars. In older persons, however, the direct contact between the different structures, the density of that area, and the unifying calcification can make an acceptable determination of PTM rather difficult. Also, the coronoid process of the mandible was frequently projected in the region of PTM, and its image was obscured to some extent in all cases studied.

It was considered to be of interest to record the anteroposterior relationship between PTM, the dorsal outline of the maxillary tuberositas, and the position of the posterior nasal spine (Fig. 13). All three relationships were spread around zero as the largest value. The ranges were from 6 to 8 mm. On the average, the three structures coincided. Large variations existed, however, making the application of the average recorded values to individual cases of limited value.

General discussion

For practical reasons, most of the interpretation of the findings has been done in conjunction with their presentation. This discussion will be limited mainly to some more general aspects.

The study described here has been carried out mainly on Asiatic Indian

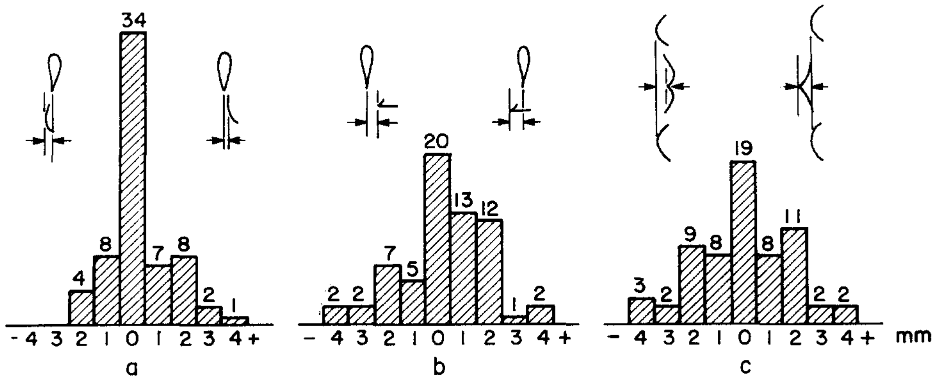


Fig. 13. Histograms of the anteroposterior relationship recorded perpendicularly to the Frankfort horizontal on sixty-four skulls between PTM and the dorsal outline of the maxillary tuberositas (PTM ant. = -) (**a**), PTM and the posterior nasal spine (PTM ant. = +) (**b**), and the posterior nasal spine and the dorsal outline of the maxillary tuberositas (PNS ant. = -) (**c**).

skulls. In the interpretation of the findings, it must be realized that some differences exist between the craniofacial skeletons of different ethnic groups.

The visibility of bony landmarks is more clear on radiographs of dry skulls than on those of living persons. In the latter the other tissues of the head frequently obscure the bony structures. This is particularly true for areas with limited transverse bony dimensions, such as the anterior nasal spine and its midline crest, which are of importance in the determination of point A.

The situation at point A was found to be rather complex, and its location depended on a number of variables not essential for the representation of the anterior delineation of the maxillary apical base. Further, the chance for an accurate determination of point A is usually reduced by the projections of the overlying soft tissues, particularly when the cheeks appear in the same area.

Analysis of errors in the measurement of different roentgenocephalometric landmarks by means of double determinations reveals essential information on the reliability and reproducibility of the reference points as discussed in the introduction. However, it does not present information with regard to the possible differences in the point location among different persons as a result of variations in the morphology of the relevant structures; nor does it give information on alterations in the determination of the landmarks as a result of changes evoked by growth. The latter was found to be the case for menton and gnathion and certainly holds true for landmarks that are influenced by the changes in the dentition, as in point A and probably also, but to a lesser extent, point B. Some restrictions in this sense have to be made for PTM, since the relationship between the parts used in the determination of this landmark seem to change with growth.

An understanding of individual morphologic variations affecting the determination of certain landmarks is of primary importance for cross-sectional studies and in the analysis of the skeletal pattern for diagnostic purposes. Shortcomings in this respect showed up particularly for point A. This, together with the other aspects discussed before, initiated the search for a landmark that can be determined more accurately, is more constant in its location among different

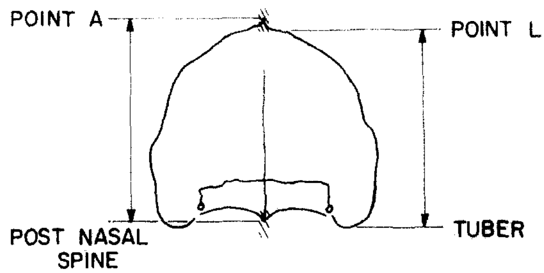


Fig. 14. The locations of point A and the posterior nasal spine vary in anteroposterior direction as a result of factors not of essence in the determination of the anteroposterior dimension of the maxilla. These shortcomings are greatly eliminated when point L and the dorsal boundaries of the maxillary tuberositas are used for this purpose.

persons, and represents more adequately the anterior outline of the apical base in the maxilla. It was found that the landmark introduced as point L met the requirements stated.

A word is in order regarding the location of point B as it depends on the reference line used for its determination. A tangent from N to the most posterior outline between infradentale and pogonion usually leads to a more anterior and superior location of point B than achieved when the occlusal or mandibular plane is used as a reference. The first approach has advantages for the evaluation of the facial profile. However, the determination of point B in relation to the mandibular plane and, by preference, to the occlusal plane relates it more to the directly relevant area. As such, it is more suited for the analysis of dental conditions. The same holds true for point A.[7] An advantage of point L is that its location is independent of the aspects mentioned here.

The findings at the dorsal region of the maxilla showed that the point determined as PTM cannot be considered a reliable and accurate indication of the position of the posterior nasal spine. Furthermore, the anteroposterior position of the latter varied also in its relation to the dorsal outline of the maxillary tuberositas.

It may seem meaningful to use midline structures for the determination of the maxillary length and to record it as the distance between PNS and ANS or point A. However, the shortcomings of the two last points are evident. The limitations have been indicated regarding PNS. For these considerations, it seems preferable to determine the anteroposterior length of the maxilla as the distance between PTM and point L, parallel to the functional occlusal plane. PTM offers a good presentation of the dorsal outline of the maxillary tuberositas, and point L offers a good presentation of the anterior maxillary apical base. Last, but not least, the maxilla is not primarily a midline structure but, rather, one that is arch shaped. It might as well be measured accordingly, and the more dorsal outlines of the maxillary tuberositas are, on this basis, also preferable over the midline point PNS (Fig. 14).

Summary

The validity of roentgenocephalometric landmark definitions, as well as the way their determination is affected by individual variation in skeletal morphology

and by changes associated with growth, has been tested by several studies of sixty-four human skulls and by an analysis of their radiographs. Furthermore, lateral head films of sixty living persons have been analyzed to check the findings obtained from the skeletal material. A number of landmarks deviated from the generally accepted definitions. This was true for prosthion, infradentale, and in a number of cases for menton and gnathion.

Individual local variations in skeletal structure played a role in the roentgenocephalometric location of sella, nasion, prosthion, infradentale, menton, gnathion, and especially point A. Several suggestions have been made for improving the standardization of the determination of some of these landmarks.

Because of the considerable shortcomings of point A, a new landmark, point L, has been suggested, tested, and found to be superior.

On the basis of theoretical considerations, as well as the findings in our material, it is proposed that the anteroposterior length of the maxilla be determined not by means of a midline structure but as the distance between point L and the dorsal outline of the maxillary tuberositas, for which PTM can be used as a substitute.

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