THE HEAD OF THE INFANT AT BIRTH.

PART I.

BY

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Part I.

From the point of view of the obstetrician, the most important part of the infant's body is the head. The great importance of this region of the child's body is due, in the first place, to the circumstance that in the great majority of confinements (95 per cent.) the child comes through the maternal passages head first; in the second place, for the reason that the head is the largest and most solid part of the body of the infant; and in the third place, from the fact that any abnormality in the size, form, position, or ossification of the head will immediately introduce the elements of delay and danger into the process of parturition. It is not, therefore, surprising that much has been written concerning the head of the infant, and the question may reasonably be asked whether there yet remains anything new to be said on the subject. I hope to be able to show in the following communication that there are still some questions with regard to the anatomy of the infant's head which may profitably be investigated by the obstetrician and by the anatomist.

The head consists of two parts, which differ from one another in size and in obstetric importance. These parts are the cranium and the face. In the infant the cranium is relatively much larger than the face, and this disproportion is due to the small degree of development of the latter region. The relatively small size of the face is very evident when the head is seen in sagittal section. The face also is of less importance to the obstetrician than is the cranium; for whilst the most common presentation is that of the cranial vertex, one of the rarest presentations is that of the face. The consideration of the cranium will, therefore, be taken first; and it will be necessary here briefly to recapitulate, for the sake of completeness, certain anatomical details concerning the cranium which are well known.

The cranium is made up of eight bones, two pairs and four single, which are in the infant loosely held together by membrane, and which are capable of a large amount of displacement upon each other. The cranium is clearly divided into two parts—the vault and the base. The vault is constituted by the two halves of the frontal bone, by the two parietal bones, and by that portion of the occipital bone which lies above the foramen magnum; at the sides also the squamous part of each temporal bone completes the framework of this part of the head. The base of the cranium is composed of the basi-occiput of the sphenoid, the ethmoid, and of the petrous part of the temporal bones. The bones which make up the vault differ from those that form the base, in being thinner and more loosely joined together; thus when pressure is brought to bear upon the vault the bones are displaced, and a change in the form of the head is the result; on the other hand, pressure does not affect to any appreciable degree the base of the cranium. In this anatomical fact is found the rationale of operations, such as basilysis, which not only diminish the size of the compressible vault, but also that of the incompressible base.

The bones of the cranium are joined together by sutures; and those which lie within the sphere of touch during labour are the sagittal, the frontal, the coronal, and the lambdoidal. To the obstetrician the sagittal suture is a most important landmark. This suture connects together the upper margins of the two parietal bones, and derives its name from its resemblance to an arrow (sagitta); but it must be borne in mind that the resemblance to an arrow is manifest only when the anterior fontanelle is considered as the head of the arrow. It is a matter of regret that all writers do not adopt the same definition of the sagittal suture. It is usually defined as terminating in front of the anterior fontanelle, and behind at the posterior fontanelle; but some authors include the fontanelles, and others, as Tarnier and Chantreuil (vol. i. p. 411), consider the frontal suture as forming the anterior portion of the sagittal, for they state that "la suture sagittale, grande suture, ou suture antéro-postérieure, s'étend de la racine du nez à l'angle supérieur de l'occipital." It is better, however, to define this suture, as does the majority of writers, as that which exists between the upper margins of the parietal bones and which is bounded in front by the coronal and behind by the lambdoidal suture. At the commencement of labour, when the vertex presents, the sagittal suture is found lying in one or other of the two diagonal diameters of the true pelvis, and the movement of internal rotation brings this suture into the antero-posterior diameter of the pelvis. The frontal, coronal, and lambdoidal sutures call for no special notice here. It is thus seen that in the head of the infant the bones of the vault are not immovably fixed to each other, as they are in the adult, but are loosely attached by a membrane composed of periosteum and dura mater, and can be moved to some extent upon one another. This constitutes one of the factors in head-moulding during labour.

The presence of fontanelles, or "openings in the head," is one of the most important characters of the infant's cranium. These membranous spaces are six in number, two being placed in the middle line of the vault, and four being situated laterally. Their general characters are well known, but it is not so generally recognised that their size varies considerably even in normal heads. I have measured the anterior fontanelle in a large number of cases, and have found its average length to be 2·7 ctms., and its average transverse diameter to be 2 ctms. In one case, where the ossification of the head was well advanced, both the antero-posterior diameter and the transverse measured 1·5 ctms.; whilst in a case where the bones of the head were widely separated, without there being any hydrocephalus, the anterior fontanelle measured 3 ctms. both antero-posteriorly and transversely. The variation in size of the anterior fontanelle must influence, to a very considerable extent, the degree of head moulding. With regard to the posterior or occipital fontanelle, it should be noted that if the ossification of the head be at all far advanced, there is at this spot no distinct membranous space, the tip of the supra-occiput fitting in between the parietal bones. In many cases, however, there exists a space which is then triangular in shape, and is always much smaller than the anterior fontanelle. I have found the average antero-posterior measurement of the fontanelle to be 8 mms., whilst the base of the triangular space had a length of from 7 mms. to 1 ctm. In one or two cases I have seen the space entirely filled up by a Wormian bone of triangular form. The posterior fontanelle supplies an important landmark in the study and description of the mechanism of normal labour; for it is always within the reach of the examiner's finger, and its relation to the girdle of contact of the soft parts can always be ascertained during labour. Thus the so-called movement of flexion may be defined and described as that movement by which the posterior fontanelle leaves the side of the area within the girdle of contact of the canals, and comes to lie nearer to the centre of that area. This is to be preferred to any definition founded upon the relation of the chin of the infant to the sternum, for these parts are out of the reach of the fingers of the obstetrician, and we are not warranted in basing definitions upon their relations. In the same way internal rotation may be defined as a movement which brings the posterior fontanelle and sagittal suture from a diagonal diameter of the area within the girdle of contact into the antero-posterior diameter of that area, the fontanelle lying anteriorly. The relations of the girdle of contact of the soft parts and the area of the head within it can always be felt, and if it were necessary seen, by the accoucheur. It is more easy to feel the posterior fontanelle moving from the side of the area within the girdle to its centre than to note its dipping or descent.

The four lateral fontanelles, although not of great clinical significance, are not to be neglected as factors in head moulding.

I have frequently found the antero-lateral fontanelles to measure 1 ctm. antero-posteriorly, whilst the postero-lateral fontanelles may measure nearly as much. Supplementary fontanelles may exist in the cranium of the infant in various positions. I have noted them several times in connexion with the sagittal suture, and they may also lie near to the sutures, or, more rarely, they may be found at different points in the bones at a distance from any suture.

In connexion with the sutures and fontanelles of the infant's head, may be considered the fibro-cartilaginous hinge of the occiput. Budin, in his work upon the head of the infant (*De la tête du fœtus au point de vue de l'obstétrique*, 1876), lays special stress upon the existence of this hinge (" charnière cartilagineuse et fibreuse"), and points out its special importance as a factor in head moulding. It is formed by a band of tissue partly cartilaginous, partly fibrous, which extends from the posterior end of the foramen magnum outwards on each side to the postero-lateral fontanelle. Budin points out that near the middle line it is composed of cartilage, that, namely, which intervenes between the supra-occiput and the posterior border of the ex-occipital; more externally fibrous tissue intervenes between these two bones; and further out still there is another piece of cartilage at the point where the occipital bone comes into contact with the temporal and parietal of the same side. According to this observer, the inner cartilaginous plate measures from 5 to 6 mms. antero-posteriorly and 10 mms. transversely, whilst the fibrous portion of the hinge measures 9 mms. antero-posteriorly, and 10 mms. transversely. I have examined several infants' skulls, and have found that rarely does this hinge exist in the condition described by Budin. Most frequently I have found the inner plate of cartilage ossified more or less completely, whilst the fibrous portion does not measure so much antero-posteriorly as Budin states. In infants, however, which have not reached the full term of nine months, the hinge exists in its entire extent. It has been stated that if the occipital bone, or rather that part of it which lies behind this hinge, be separated from its attachments along the line of the lambdoidal suture, it can then be flexed and extended upon this hinge to a great degree. In dried skulls I have found that a small amount of movement of the occiput backwards and forwards is thus rendered possible; but even in fresh heads I have not been able to make the occiput execute the extensive movements which have been described. In seven months' infants I found the range of movement to be much greater. Still, the amount of movement thus permitted even in the full-time child will be sufficient to explain the depression of the occipital bone under the parietals which is found after prolonged labours. The existence of this hinge also serves to explain the large amount of antero-posterior shortening of the fœtal head, which Dr Milne Murray found he was able to obtain by applying considerable pressure to the frontal and occipital bones (*Edin. Obstet. Trans.*, vol. xiii. p. 206). At the same time, it must be borne in mind that the parietal bones are raised, and that in addition to the depression of the occiput there is this rising of the parietal bones, with consequent increase in the vertical diameters of the cranium. This cartilaginous hinge, it may be pointed out, has an interest also when looked at from the developmental standpoint, for it marks posteriorly the line which separates the bones of the cranial vault from those of the base. The bones of the vault are developed from the membranous capsules surrounding the encephalon, which in its turn is derived from the second ring of the protovertebral mass; whilst the bones of the base are developed from the first ring of this protovertebral mass, and pass through an intermediate cartilaginous stage before becoming ossified. The supra-occiput is thus divided developmentally from the basilar and ex-occipital portions of the bone.

The vault of the cranium has been, for descriptive purposes, divided into several regions; but some difference of opinion has long existed as to the exact signification of the terms used by obstetric writers to designate these regions. The regions are the sinciput, the occiput, and the vertex. The subject of the nomenclature of the cranial regions was one of the questions considered by the Uniformity in Obstetrical Nomenclature Committee at the International Medical Congress in Washington in 1887. It is to be regretted that the definitions then agreed upon have not been more generally adopted in the various text-books on midwifery published during the last three years; for we find that even in the *American System of Obstetrics*, published in 1888, the term vertex is held to be synonymous with the posterior fontanelle and the small area around it. The following are the definitions recommended by the committee for the regions of the cranial vault:—

Occiput—the portion of the head lying behind the posterior fontanelle.

Sinciput—the portion of the head lying in front of the bregma or anterior fontanelle.

Vertex—the portion of the head lying between the fontanelles and extending laterally to the parietal protuberances.

It will be observed that the vertex thus defined is a region and not a point, and whilst this definition is the most useful clinically, it would have been more strictly accurate to have defined the vertex as the point at which a line joining the two parietal eminences crosses the sagittal suture.

It will be noted that all the landmarks of the cranium which are of practical interest to the obstetrician are grouped either in or immediately around the vertex. The sutures, the fontanelles, and the parietal and occipital eminences, constitute the important landmarks of the head of the infant.

The form of the head of the infant now may be considered. The normal size and form of the head before the commencement of labour is not yet clearly ascertained. This is due to the fact that from the passage of the head through the pelvis changes occur in its form, and these changes have not yet been fully worked out; hence, until the details of the measurements of heads of infants which have been removed by the Cæsarean section have been noted in a large number of cases, the exact form of the infant's head immediately before labour sets in cannot be definitely stated. Further, needless confusion and difficulty have been introduced into the study of this subject from the fact that different observers have taken different points on the head as their landmarks in measuring the various diameters. The latter difficulty may now be overcome by the universal adoption by obstetric writers of the definitions of the various diameters laid down at the Washington Congress. These definitions have been adopted in the present communication, and it may be well briefly to restate them at this point. There are three antero-posterior diameters:—

(*a.*) From the tip of the occipital bone to the lower margin of the chin = diameter occipito-mentalis, O.M.

(*b.*) From the occipital protuberance to the root of the nose = diameter occipito-frontalis, O.F.

(*c.*) From the point of union of the neck and the occiput to the centre of the anterior fontanelle = diameter sub-occipital bregmatica, s.O.B.

The definitions of the occipito-mental and occipito-frontal diameters given above agree with those found in the majority of text-books; but with regard to the sub-occipito-bregmatic diameter, some writers have placed its anterior starting-point at the posterior end of the bregma, others at the anterior end of the bregma, and still others at its centre. The definition as given by these last authors is, as will be seen, the one adopted by the congress. In addition to the three diameters above mentioned, Budin describes a fourth antero-posterior diameter, which he terms the supra-occipito-mental or maximum diameter. According to this observer the occipito-mental diameter, although generally supposed to be the longest, is not really so, and this observation is perfectly correct if the definition of the occipito-mental as given by the congress is accepted. Budin states that the maximum antero-posterior diameter is one which extends from the chin to the sagittal suture, terminating at a point in the suture which lies between the tip of the occiput and the anterior fontanelle, and varies in different cases. This observation I have confirmed in many instances. Thus, in one case the O.M. measured 10·5 ctms., whilst the maximum measured 11 ctms.; and in this instance the starting-point of the maximum diameter posteriorly lay nearly midway between the posterior fontanelle and the posterior end of the anterior fontanelle. In another case the O.M. measured 12·5 ctms., and the maximum measured 14·5 ctms.; whilst even in the normal or antepartum head the maximum diameter exceeds the occipito-mental by from 5 mms. to 1 ctm. The maximum diameter of Budin, which it may be noted corresponds to the occipito-mental as defined by Schroeder, is important as being the longest diameter of the head, and the only diameter which is always increased during the progress of the head through the pelvis in normal labour.

With regard to the transverse diameters of the head, comparatively little confusion exists. Two are usually defined :—

(*a.*) Between the two parietal protuberances = diameter Bi-Parietalis, Bi-P.

(*b.*) Between the two lower extremities of the coronal suture = diameter bi-temporalis, Bi-T.

A bi-mastoid diameter is sometimes measured.

The vertical diameters of the head are somewhat vaguely defined, thus the fronto-mental passes from the highest point of the forehead to the chin, and the cervico- or laryngo-bregmatic passes from the middle of the anterior fontanelle to the upper and anterior part of the neck in the neighbourhood of the larynx.

In relation to each antero-posterior diameter of the head there is a corresponding circumference, and the circumference corresponding to the maximum diameter is the greatest, whilst that corresponding to the suboccipito-bregmatic diameter is the minimum circumference.

The diameter of the head being clearly defined, we are in a position to study the form of the head—first, before labour; secondly, during labour; thirdly, immediately after labour; and, fourthly, five or six days after parturition. It is impossible that such terms as ovoid, wedge-shaped, and the like, can convey an adequate idea of the form of the head, and it is necessary that the form be expressed in the terms of the three measurements represented by the antero-posterior, transverse, and vertical diameters.

Form of the Head before Birth—the Normal Head.—Budin points out that what are called in the text-books the normal measurements of the infant's head are not truly normal, for the form of the head has been modified by the pressure to which it has been subjected during its passage through the pelvis. This statement is true not only in cases of head presentation, but also in those in which the pelvic extremity of the infant comes first, and in those labours which from the large size of the mother's pelvis, or the small size of the child's head, are very rapidly accomplished. How, then, is the normal form and size of the infant's head at term to be ascertained? Budin employs two methods—first, the measurement of the heads of children which have been removed by the Cæsarean section before labour sets in; and, secondly, the measurement of the heads of children five or six days old, at the time when, as Budin believes, the effects of labour will have passed off. To the information obtained from these two sources, we can now add that obtained from the measurement of the head of the infant in utero in cases where frozen sections have been made of the mother's body, when death has occurred before labour has set in. In a case reported by Budin, the mother died of pulmonary hæmorrhage, and the child was removed by Cæsarean section. Labour had not commenced. The following were the measurements of the head of the infant:—Maximum = 12·9 ctms.; O.M. = 12·4 ctms.; O.F. = 11·8 ctms.; s.O.B. = 10·3 ctms.; Bi-P. = 10 ctms.; Bi-T. = 8·7 ctms. The maximum circumference was 37·6 ctms., and the minimum 33·5 ctms. The total length of the child was 51 ctms. I have not had the opportunity of measuring the head of a full-time child removed by Cæsarean section; but in a case where the mother died of pneumonia between the seventh and eighth months of her pregnancy, I was able to measure the infant's head. Labour had not commenced in this case, and the measurements were—maximum = 10·5 ctms.; O.M. = 10 ctms.; O.F. = 8·9 ctms.; s.O.B. = 7·5 ctms.; Bi-P. = 5·9 ctms.; Bi-T. = 5·1 ctms. The total length of the child was 30 ctms. In one of Freeland Barbour's cases, where frozen sections were made of the pregnant woman, the measurements of the head in utero were—O.M. = 12·7 ctms.; O.F. = 10·4 ctms.; s.O.B. = 10·8 ctms. In this case the patient died before labour set in, but the head of the child was in the pelvic cavity. In addition to these three cases where measurements were made of the head unmoulded by labour, there may be mentioned one out of many cases in which the head was measured six days after the confinement. The measurements in this case were as follows—maximum = 13 ctms.; O.M. = 12·5 ctms.; O.F. = 11·3 ctms.; s.O.B. = 10 ctms.; Bi-P. = 9·7 ctms.; Bi-T. = 8·3 ctms. The circumference in the O.M. plane was 35·5 ctms., and in the s.O.B. plane 29·2 ctms. The total length of the child was 48·1 ctms. In one case in which labour was precipitate the measurements of the head very closely resembled those given above. From a study of the figures thus obtained, an idea of the normal form and size of the head before the onset of labour may be obtained. The measurements may be placed in tabular form for the sake of comparison:—

	Budin's Case, full-time Infant, Cæsarean Section.	Barbour's Case, full-time Infant, in Frozen Section.	Ballantyne's Case, 7½ months' Infant, removed post-mortem.	Ballantyne's Case, 6 days' old Infant.
Max.	12·9 ctms.		10·5 ctms.	13·0 ctms.
O.M.	12·4 „	12·7 ctms.	10·0 „	12·5 „
O.F.	11·8 „	10·4 „	8·9 „	11·5 „
s.O.B.	10·3 „	10·8 „	7·5 „	10·3 „
Bi-P.	10·0 „		5·9 „	9·7 „
Bi-T.	8·7 „		5·1 „	8·3 „

A glance at the accompanying drawings (Figs. 1, 2, and 6) will give an idea of how closely the head in Budin's case resembles the heads in my two cases, both as regards form, and as regards relative length of the diameters. The maximum diameter in Budin's case was 5 mms. longer than the O.M., 1·1 ctms. longer than the O.F., and 2·6 ctms. longer than the s.O.B.; in the case of the seven and a half months' fœtus, whose head I measured, the maximum exceeded the O.M. by 5 mms., the O.F. by 1·6 ctms., and the s.O.B. by 3 ctms.; and in the case of the full-time infant, six days old, the maximum exceeded the O.M. by 5 mms., the O.F. by 1·7 ctms., and the s.O.B. by 3 ctms. In regard to the transverse diameters, the Bi-P., in Budin's case (Fig. 4), exceeded the Bi-T. by 1·3 ctms.; in the seven and a half months' infant the Bi-P. measured 8 mms. more than the Bi-T.; whilst in the six days old infant the Bi-P. measured 1·4 ctms. more than the Bi-T. In the case of the seven and a half months' infant it will be observed that both the absolute and relative lengths of the two transverse diameters differ considerably from those seen in the full-time child; but this difference is to be accounted for by the relatively small development of the head of the fœtus in a transverse direction, along with the small size of the parietal eminences. From Budin's researches and those of Labat (*La tête du fœtus au point du vue obstétrical*, Labat, 1881), it is probable that, in the normal unmoulded head, the bi-parietal diameter is a little more than 1 ctm. greater than the bi-temporal diameter. Whilst we may regard the head, in the three cases given above, as showing the normal unmoulded form, we may also provisionally state that the diameters of the normal head of an infant of from 48 to 51 ctms. (19 to 20 inches) in length are as follows:—

Maximum,	13	ctms.	$5\frac{1}{8}$	inches.	
Occipito-Mental,	12·5	,,	$4\frac{7}{8}$	,,	(nearly 5 inches).
Occipito-Frontal,	11·5	,,	$4\frac{1}{2}$	,,	
Sub-Occipito-Bregmatic,	10·3	,,	$4\frac{1}{16}$	,,	(about 4 inches).
Bi-Parietal,	10·0	,,	$3\frac{15}{16}$	,,	(about 4 inches).
Bi-Temporal,	8·7	,,	$3\frac{7}{16}$	,,	(about $3\frac{1}{2}$ inches).

In Barbour's case it is to be noted that whilst the occipito-mental agrees closely with that diameter in the other cases, the occipito-frontal is less, and the sub-occipito-bregmatic greater than in the other cases.

Form of the Head during Labour—The Moulding Head.

It is well known that the head becomes moulded during its passage through the pelvis. This moulding is, in the first place, due to the fact that the expulsive powers are propelling the head through canals or passages which offer considerable resistance even in normal cases, but it is also due to certain inherent characteristics of the head, for there exist in the head certain sutures and fontanelles which permit the bones to glide one upon the other; there is, secondly, incomplete ossification of the bones themselves; and there is, thirdly, the presence of the cartilaginous hinge of the occiput. Our ideas of the form of the head and of the length of its diameters during labour have hitherto been derived from an examination of the head immediately after labour, and from clinical examination by touch during the progress. From these two methods, which are neither of them free from fallacy (for the immediate elastic recoil of the head after its expulsion from the canals must be considerable, and the obstetrician's conclusions derived from the sense of touch may not be accurate)—from these two methods it has been affirmed, that during labour the frontal bone is somewhat depressed under the margins of the parietal bones, the tip of the occiput is also depressed below the parietals, and the parietal bone, which lies anteriorly in the pelvis, slightly overrides that which lies next the sacrum. In a recent contribution (*Reports of Laboratory of Royal College of Physicians, Edinburgh*, vol. ii.) Barbour and Webster give a drawing of a very interesting frozen section of a woman who died at the end of the second stage of labour, and in this section the vertical elongation and lateral deformity of the moulding infant's head are well displayed.

The measurements of the head in this case were as follows:—

Maximum,	16	ctms.	6	inches	(approx.)
Occipito-Mental,	13	„	5	„	„
Occipito-Frontal,	10	„	4	„	„
Sub-Occipito-Bregmatic,	10·8	„	4¼	„	„
Bi-Parietal,	8·8	„	3½	„	„
Bi-Temporal,	8·7	„	3½	„	„

Form of the Head immediately after Labour.—Countless observations have been made upon the form and diameters of the infant's head immediately after labour. The moulding which has occurred during labour is present, but, no doubt, in a less marked degree, after parturition is completed. If the diameters be compared with those of the normal unmoulded head, it is seen that the O.M., the O.F., and the s.O.B. are diminished whilst the maximum diameter is increased. In one of Budin's cases in which the head lay in the O.L.A. position, the measurements were—Max. = 13·9 ctms.; O.M. = 11·8 ctms.; O.F. = 11 ctms.; and the s.O.B. = 8·6 ctms. The average measurements which I have found so closely agree with those as to be practically identical. There is, therefore, a compression of the head in the sub-occipito-bregmatic plane, and a compensatory enlargement in the plane of the maximum diameter. In addition, there is present in many cases what is known as the parietal deformity. This transverse deformity has been specially studied by Fankhauser (*Die Schadelform nach Hinterhauptslage*, Bern, 1872), Labat, and others. The parietal bone which lies posteriorly *quâ* the pelvis, the left parietal therefore, in O.L.A. cases, is depressed at the sagittal suture below the contiguous margin of its fellow. In other words, the bone which lies anteriorly is at a lower level *quâ* the pelvis than that which is in relation with the posterior wall of the pelvis. Further, the parietal eminence, which lies anteriorly, is carried backwards *quâ* the head, and the whole of this side of the head is flattened. Barbour's specimen, to which reference has already been made, shows that this parietal deformity is produced during labour, and that it may be unaccompanied by any overlapping of the parietal bones. The cause of its production is probably to be found in the existence of a triangular deficiency in the anterior pelvic wall, and in the presence of firm resisting structures posteriorly.

In occipito-dextra-posterior cases the moulding of the head and consequent change in form is more marked than in occipito-læva-anterior cases, and this is more especially the case in the labours where the head has not rotated well. In one case in which I made frozen sections of the infant, the peculiar moulding of the head is well seen (Fig. 5). The tip of the occiput is depressed below the margins of the parietal bones at the posterior fontanelle, and there is also great parietal distortion, for the right parietal bone, which lay posteriorly *quâ* the pelvis, is depressed below that which lay anteriorly, and the sagittal suture is displaced to the left of the middle line of the infant's body. In one of Budin's cases the head lay in the O.D.P. position, and the following were the head measurements as compared with those in my own case:—

	Budin's Case.	My own.
Maximum,	15·6 ctms.	14·5 ctms.
O.M. diameter,	13·9 „	12·8 „
O.F. „	10·8 „	11·5 „
s.O.B. „	9·4 „	10·2 „

The figures show that in Budin's case the elongation of the maximum diameter and the shortening of the O.F. and s.O.B. diameters have been greater than in my case, and this fact is also shown in the drawings (Figs. 5 and 6).

Budin, in his work already quoted, gives drawings and measurements of the head in pelvic cases, in face cases, and in others; but I have had no opportunity of studying the heads from such cases, either in the living infant or by means of frozen sections, and shall therefore omit any reference to them.

Form of the Head a few Days after Labour.—From elaborate statistics, Budin shows that during the days that follow birth, all the diameters of the head increase with the exception of the maximum diameter, which diminishes in length. After the first week of life, however, the maximum diameter also begins to increase in length. The increase in the diameters is due to the enlargement of the sutures and fontanelles, which in turn is due to the fact that the bones of the cranial vault no longer override one another, but lie in the same plane. In a typical case (Fig. 6) I found the head diameters at birth and six days afterwards to be as follow:—

	At Birth.	Six Days after Birth.
Maximum,	13·5 ctms.	13·0 ctms.
O.M.	12·3 „	12·5 „
O.F.	10·4 „	11·3 „
s.O.B.	8·3 „	10·3 „
Bi-P.	8·0 „	9·7 „
Bi-T.	7·0 „	8·3 „

From the above table it will be seen that there is six days after birth a great increase, varying from 1 ctm. to nearly 2 ctms. in the length of the occipito-frontal, sub-occipito-bregmatic, bi-parietal, and bi-temporal diameters. The occipito-mental shows a trifling increase, whilst the maximum shows a decrease of 5 mms. There is, therefore, six days after labour, a return to the conditions of the head which existed before labour began, with the exception that the sub-occipito-bregmatic diameter does not quite regain its former length.

Such are the changes which occur in the form and diameters of the infant's head during and after birth; there remains for consideration the wedge-shape of the head.

The head at birth has nearly always a wedge-shape as viewed from behind, from above, and from the side; but the wedge-shape, as seen from the side, is very important, as upon its existence depends, to a great extent, Lahs' theory of flexion (*Die Theorie der Geburt*, Lahs, 1877; *Head Flexion in Labour*, A. R. Simpson, 1879). Lahs pointed out that the head, as viewed from the side, has an asymmetrical wedge-shape, the occipital end of the wedge being steeper, and the anterior, or sincipital end, being more gently sloping, and upon this fact he founded his theory of the causation of head flexion in labour. The theory is now well known, and may be briefly stated as follows:—"That end of the cephalic ovoid will be guided foremost, the tangent of whose surface in the girdle of contact meets the perpendicular of that zone at the smallest angle." A reference to the drawings of the unmoulded head will show that the asymmetrical wedge-shape does exist before labour begins, whilst Braune's plate showing the head at the beginning of the second stage of labour, and Barbour's recent plate, showing the head nearly at the end of the second stage, demonstrate that the wedge-shape is greatly increased during labour. Again, drawings of the head made immediately after labour show the marked wedge-shape which, however, lessens in a few days, the head resuming very nearly its unmoulded form. It would seem, therefore, that the head has a primitive wedge-shape, and whilst this may be, and in all probability is, at least one factor in the causation of flexion, it is also evident that flexion increases and emphasizes the wedge-shape as labour goes on. The formation of the caput succedaneum still further increases the wedge-shape of the head. It seems clear also that the wedge-shape of the normal head is closely related to the primitive conical shape of the bones of the cranial vault. Cleland, in his *Memoir on the Form of the Human Skull,* points out the fact that, before birth, the two halves of the frontal bone, the two parietal bones, and the supra-occiput, "each present a prominent eminence from which the bone radiates in nearly straight lines." After birth a rounding of these eminences occurs. "Each roof bone is at first conical, and afterwards more nearly approaches a spherical curve." Any deviation from the normal form of the roof bones will, therefore, interfere with the mechanism of labour, if Lahs' explanation be the true one, and this may be an additional reason why premature ossification of the head causes so much difficulty in labour.

Proportionate Size of Vault and Base of Cranium.—In a recent memoir ("Form of the Human Skull," Cleland, *Memoirs and Memoranda of Anatomy,* vol. i. pp. 13–26, 1889) Cleland makes the following statement:—"The arch elongates more rapidly than the base in fœtal life, until at birth, or soon afterwards, the arch, as measured from the root of the nose round to the back of the foramen magnum, has reached its highest proportionate length, as compared with a straight line uniting the same points, namely, —a proportion slightly exceeding 3 to 1." I have measured the cranial vault and base in a number of full time children, and have obtained the following results:—

		Vault.	Base.
Case	I.	22·2 ctms.	8·0 ctms.
"	II.	23·0 "	8·0 "
"	III.	24·5 "	7·5 "
"	IV.	26·0 "	8·5 "
"	V.	21·0 "	7·5 "
"	VI.	23·0 "	8·4 "
"	VII.	19·0 "	6·0 "
"	VIII.	23·0 "	7·5 "
"	IX.	20·5 "	6·8 "
"	X.	21·0 "	8·0 "

These measurements were made upon full-time children with no obvious deformity of the cranium, and the result is that the vault was on an average nearly three times the length of the base. The exact proportion was 2·93 times, or 223·2 ctms. to 76·2 ctms. in the ten cases. I also measured the vault and base in fœtal skulls, in cases where labour had expelled the fœtus before the seventh month, with the following results:—

		Vault.	Base.
Case	I.	17·0 ctms.	5·5 ctms.
"	II.	17·5 "	5·7 "
"	III.	9·5 "	3·0 "

The vault in these cases was therefore almost exactly three times the length of the base, for on taking the average the relation is seen to be as 3·09 to 1 (vaults 44·0 ctms., bases 14·2 ctms.) In two children I ascertained the relation of vault to base; thus, in the case of a child of six the vault measured 34 ctms. and the base 12 ctms., whilst in a child of thirteen years of age the proportion was 38 ctms. to 13 ctms. In these cases the vault was 2·88 times longer than the base. In the adult Cleland finds that in Scotch skulls the proportion is as 2·72 to 1. It will be seen that with regard to the measurement of the arch and its relation to that of the base at birth, the figures in my cases do not quite give the relative proportion of a little over 3 to 1 which Cleland finds to be the rule. The probability is that Cleland measured heads of children a few days old, in which the compressing effects of labour had passed off, whilst I measured the skulls of still-born children at the time when the bones were overlapping. Cleland, in the case of five skulls of new-born children, finds the proportion of arch to base to be 3·06 to 1; my measurements made upon ten skulls gave a proportion of 2·93 to 1. It is not, therefore, altogether certain that the arch bears a greater proportion to the base at the time of birth than at any time either before or after birth; it is most probable that during the last three months of intra-uterine life and the first ten years of extra-uterine the arch of the cranium bears to the base the proportion of 3 (or nearly 3) to 1. After ten years of age the proportion sinks to 2·7 or 2·8 to 1.

The Orbito-Nasal Angle.—Cleland, in his paper read before the Royal Society (*Philosophical Transactions of the Royal Society*, vol. clx. pp. 117–174), gives measurements of the orbito-nasal angle in the fœtus, in the infant at the time of birth, in children, and in adults. He states that "in infants at birth it has attained a greater size than it has either before or afterwards, but as childhood advances it becomes rather smaller than the adult average." The angle is that at which the front of the upper jaw lies in relation to the floor of the anterior fossa of the cranium. It is measured by drawing a line from the optic foramen to the fronto-nasal suture, and another from the suture to the tip of the nasal spine of the maxilla; the contained angle is the orbito-nasal. In a recent contribution to the subject Cleland draws the line to the *base* of the nasal spine; but I have, in my observations, drawn it to the tip in order to compare the results with those which Cleland has published. The method I employed was as follows: A thin strip of Britannia metal was taken, one end of which was placed in the optic foramen. The metal was then bent downwards at the level of the fronto-nasal suture until its lower end came in line with the tip of the nasal spine. The angle thus obtained was traced upon paper. The sides were then produced, and the angle formed was read off by means of a protractor. In fœtal skulls (from four to eight months) Cleland found the average angle to be one of 88°. This average he arrived at from the measure-

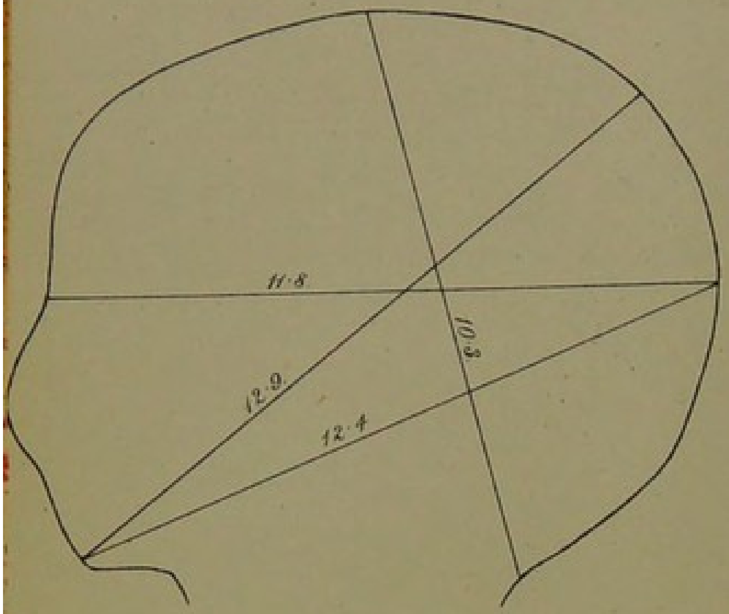

Fig. 1.

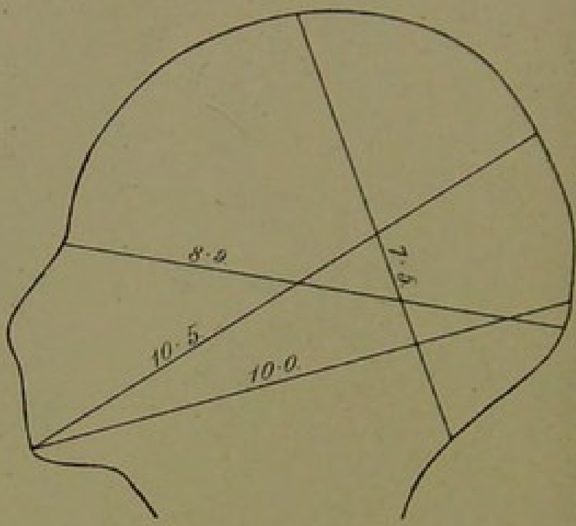

Fig. 2.

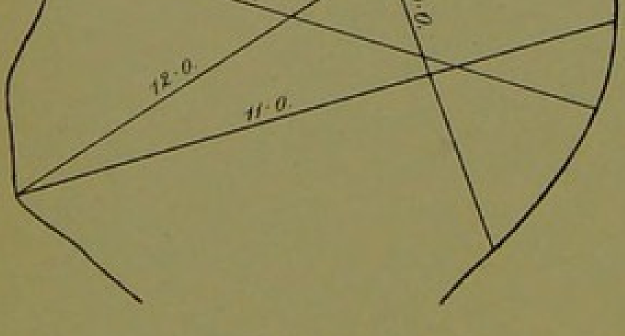

Fig. 3.

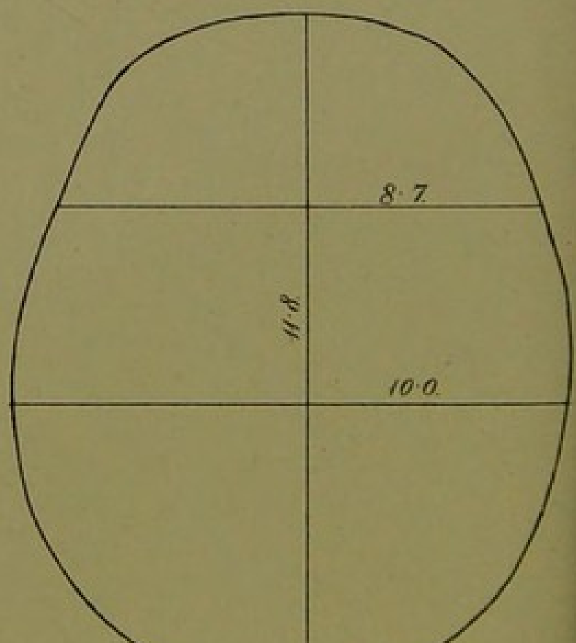

Fig. 4.

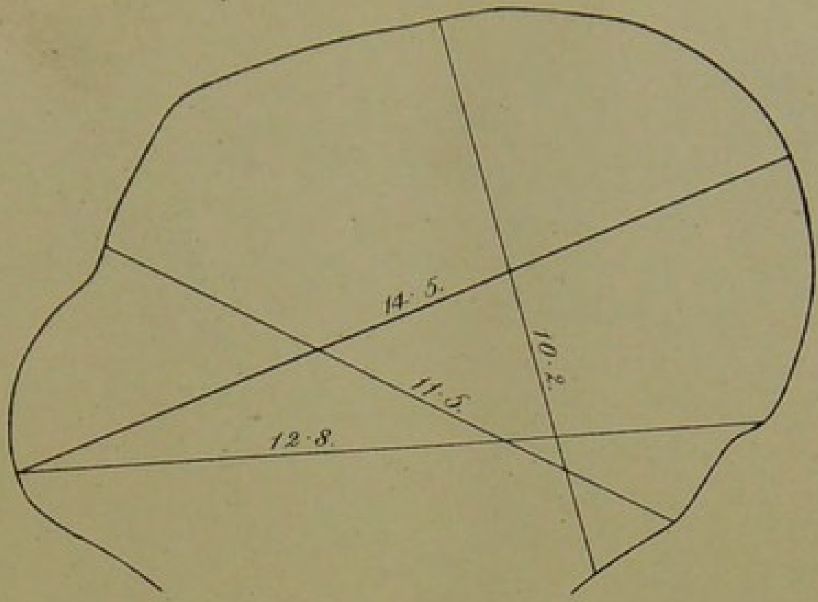

Fig. 5.

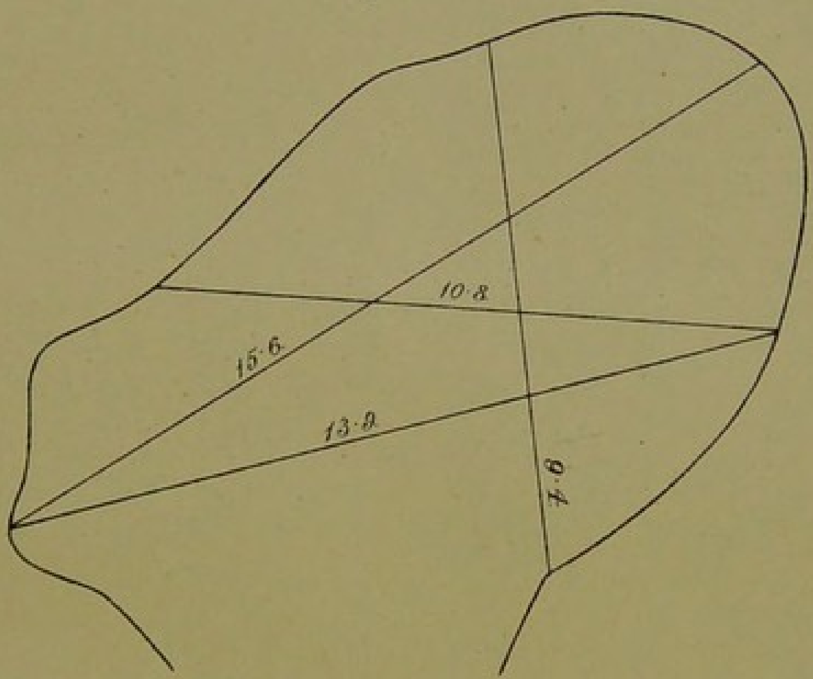

Fig. 6.

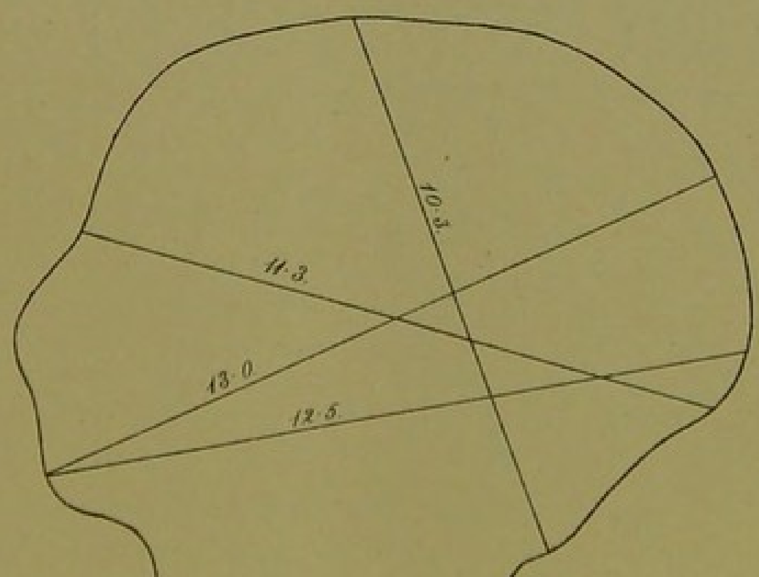

Fig 7.

ment of six skulls. I have only been able to measure three skulls.

	Age.	Orbito-nasal angle.
Case I.	5 months.	80°.
„ II.	5 „	77°.
„ III.	6 „	88°.

The average which was obtained was 81°·6, an average smaller than that found by Cleland. At the time of birth Cleland gives the angle in five skulls and gets an average of 98°. I have measured the angle in ten full-time skulls, and get the average measurement of 84°·8.

Cleland's cases. Orbito-nasal angle.		My own cases. Orbito-nasal angle.	
Case I.	102°.	Case I.	87°.
„ II.	94°.	„ II.	77°.
„ III.	103°.	„ III.	93°.
„ IV.	97°.	„ IV.	75°.
„ V.	96°.	„ V.	83°.
		„ VI.	87°.
		„ VII.	88°.
		„ VIII.	91°.
		„ IX.	89°.
		„ X.	78°.

It will be seen that there is a great discrepancy between the measurements in the two series of observations, in Cleland's the angle at birth being more than a right angle (98°), in mine the angle being less than a right angle (84°·8). At the same time, the results in both cases agree in giving the angle at birth as greater than that in skulls of four to eight months' fœtuses, but the difference is not so great in my cases as in Cleland's. In the latter it is 98° to 88°; in the former, 84°·8 to 81°·6. The conclusion which is reached is that there must be considerable variations with regard to the relation of the floor of the anterior cranial fossa to the front of the upper jaw in the infant at birth.

The relation of the soft parts of the head of the infant I must defer until a future occasion.

Description of Plates.

Fig. 1.—Sagittal section of "normal head" (Budin), half natural size.
Fig. 2.—Sagittal section of normal head of 7½ months' fœtus, half natural size.
Fig. 3.—Sagittal section of head immediately after normal easy labour.
Fig. 4.—Normal head as seen from above (Budin).
Fig. 5.—Sagittal section of head immediately after labour (O.D.P. position).
Fig. 6.—Sagittal section of head immediately after labour (O.D.P. position, Budin).
Fig. 7.—Sagittal section of head of infant 6 days old, half natural size.