

## **Intra-uterine rickets / by J.W. Ballantyne.**

### **Contributors**

Ballantyne, J. W. 1861-1923.  
Royal College of Physicians of Edinburgh

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# INTRA-UTERINE RICKETS.

BY

J. W. BALLANTYNE, M.D., F.R.C.P.E.,

BUCHANAN SCHOLAR, 1883; SIMPSON-GUNNING PRIZEMAN, 1889; ASSISTANT TO  
THE PROFESSOR OF MIDWIFERY, UNIVERSITY OF EDINBURGH; PHYSICIAN  
FOR DISEASES OF CHILDREN, COWGATE DISPENSARY, EDINBURGH.

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## INTRA-UTERINE RICKETS.

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SCHWARZ has shown (*Jahrb. für Kinderheilk.*, Bd. xxvii., Hft. 4) that slight rachitic changes are far from uncommon in new-born infants whose mothers have been placed under bad hygienic conditions during pregnancy, for out of 500 infants born at the Second Vienna Obstetric Clinic 80·6 per cent. showed the typical rachitic change in the skull, in the ribs, or in both the skull and the ribs. The observations of Kassowitz give results in accordance with the above statement. The example of intra-uterine rickets which I venture to bring before the notice of this Society shows, however, much more advanced and serious rachitic changes than are found in the above-mentioned cases of slight rachitis. In this case the rachitic process has advanced to a stage at which I do not believe it ever arrives in extra-uterine life, and so great is the resulting deformity that the child has an almost monstrous appearance. The characters presented by this infant are also different from those seen in the cases of so-called foetal rickets or foetal cretinism.

For permission to dissect the foetus, which I shall now proceed to describe, I am indebted to Sir William Turner, to whom the specimen was sent. Unfortunately, no note accompanied the specimen, and I have been unable to discover even the name of the sender, therefore no clinical history of the mother or her confinement is available. This is a circumstance much to be regretted, for reasons which are self-evident.

Before making a dissection of the foetus, I asked Mr Cathie to make two water-colour sketches of the specimen. These drawings represent in a very faithful manner the peculiar and characteristic features which the specimen showed. The limbs are curiously contorted, and nodular swellings mark the position of the shoulder, elbow, wrist, hip, knee, and ankle joints. In the position of the coccyx is a tail-like projection. The fingers and toes are long, and are widely separated from each other. The head appears to be large in comparison with the body, the upper jaw is somewhat prominent, and the occipital region is flattened. There is on the face a peculiar senile look, quite foreign to the expression of the healthy new-born infant. The umbilical cord is seen to be attached



to the abdomen, and shows no signs of having been tied. The attitude in which the foetus lies is characteristic, and is most probably approximately that which it occupied in utero. The head is flexed upon the sternum, the arms are folded upon the chest, and the legs are flexed and curiously interlocked. The thorax is expanded at its base, and is narrow from side to side anteriorly. These are the appearances shown in the first drawing (Fig. 1); the second (Fig. 2) shows the peculiar deformities of the legs and the curious appearance of the external genitals and perineum. The swollen knee and ankle joints are very evident, as is also the projection in the neighbourhood of the coccyx. A penis is present, but the scrotum is quite collapsed, and does not appear as if it contained testicles. A median raphe stretches from the root of the penis to the anus, and the anal aperture is situated immediately in front of the coccygeal projection.

Such were the outstanding features which this specimen presented to the eye; the following additional characters became evident on closer examination. There was immobility of the limbs at the various joints, and the right thigh was found on palpation to be fractured. So firmly fixed were the joints that an attempt to move the arm at the shoulder resulted in the separation of the shaft of the humerus from the head of the bone. It was also found that the vertebral column was rigidly fixed in a position of flexion. The lower end of the sternum was tilted sharply forwards, and through the skin the extremely contorted form of the scapulæ could be distinctly felt. The total length of the foetus was 47 ctms. ( $18\frac{1}{2}$  inches), and the length of the head and trunk from the vertex to the tip of the coccygeal projection was 35.6 ctms. (14 inches). The circumference of the body at the level of the ensiform cartilage was 23 ctms., and at the level of the umbilicus 21.7 ctms.

The head measurements were as follow:—

Diameter occipito-mentalis, . . . . .	= 11.5 ctms.
Diameter occipito-frontalis, . . . . .	= 10.2 „
Diameter suboccipito-bregmatica, . . . . .	= 8.9 „
Diameter biparietalis, . . . . .	= 8.9 „
Diameter bitemporalis, . . . . .	= 7.7 „

The anterior fontanelle measured 5.1 ctms. in an antero-posterior, and 3.8 ctms. in a transverse direction. These measurements show that the head, far from being hydrocephalic, is rather below the average size as compared with the heads of healthy new-born infants of the same length as this foetus. The anterior fontanelle is, however, much larger than is normal, and the sutures are wider than they are in healthy infants. The parietal eminences and the occipital protuberance were well marked, and the whole head had, as viewed from above, a somewhat polygonal outline.

The thorax had an antero-posterior diameter of 5.1 ctms. superiorly, of 7.6 ctms. inferiorly, and of 6.4 ctms. at the level of the middle of the sternum. The transverse diameter of the chest at





FIG 1

FIG 2

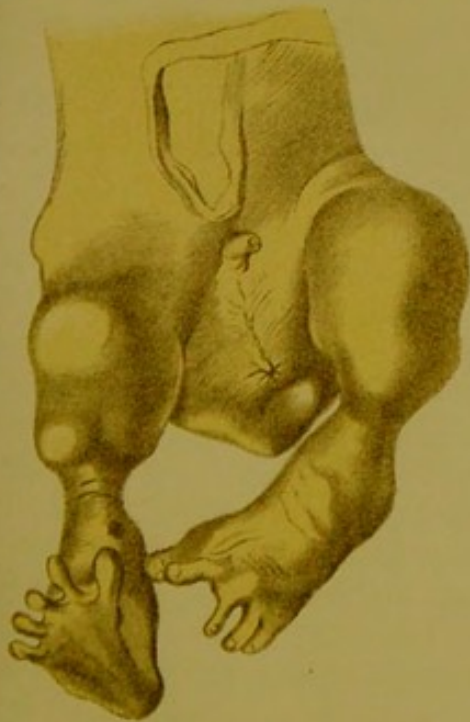


FIG 3







the level of the fifth rib was 5·1 ctms. The swollen condition of the anterior ends of the ribs could be felt through the skin.

The measurements of the limbs were as follow :—

Circumference of the arm above the elbow,	=	6·0	ctms.
Circumference of the arm at the elbow, .	=	8·7	„
Circumference of the arm below the elbow,	=	6·0	„
Circumference of the leg below the knee,	=	5·1	„
Circumference of the leg at the knee, .	=	11·0	„

The circumference of the leg at the knee was, therefore, more than twice that below the knee; and in the case of the arm the circumference at the elbow was half as great again as the measurement below or above that joint. These figures demonstrate very clearly the enormously swollen condition of the joints of the limbs.

The abdomen of the foetus was opened, and there was found in the peritoneal cavity a small quantity of serous fluid; but there was no glueing together of the intestines or other sign of inflammation. The testicles, which had not descended into the scrotum, were found lying, one on each side, in front of the psoas muscle a little above the plane of the pelvic brim. The liver, spleen, and kidneys had a normal appearance, and the stomach was empty and collapsed. In the thorax the lungs were found in an unexpanded condition lying posteriorly to the heart, and in the latter organ the foramen ovale was patent, as was also the ductus arteriosus. It may, therefore, be concluded that respiration was never established. Subcutaneous adipose tissue was found all over the body, but it was present in smaller amount than in a healthy full-time infant. The absence of the testicles from the scrotum served to explain the peculiar appearance of the perineal region.

I shall now describe with some fulness the appearances presented by the bones in this foetus, for it was in the skeleton that the most remarkable characters were visible.

*The Cranium.*—Whilst all the fontanelles of the head, as well as the coronal, sagittal, frontal, and lambdoidal sutures were wider than normal, yet the ossification of the cranial bones was irregular rather than defective; and indeed the bones of the base of the cranium and of the face showed a more advanced stage of ossification than they do in the healthy infant at birth. The parietal bosses were large and prominent, but the margins of the parietal bones were thin, flexible, and comb-like. The occipital bone was curiously deformed. It had the shape of a hook, the occipitals being bent at a sharp angle upon the supra-occiput, and the basi-occiput being acutely flexed upon the exoccipital portions of the bone. The margins of the supra-occiput were thin and flexible, and this part of the bone was flat, a fact which explained the flattened appearance of the back of the head already described. There was no trace of cartilage between the supra-occiput and the



exoccipitals, and the ossification of the basi- and ex-occipitals was far advanced. Whilst the ossification of the supra-occiput was therefore somewhat defective, the ossific process was far advanced in the basi- and ex-occipital parts of the bones,—the parts, it will be remembered, which pass through a pre-cartilaginous stage before becoming bone. The frontal bone in the neighbourhood of its two eminences was ossified, but the two halves of the bone were separated by an inter-frontal suture, much wider than normal. The orbital plates of the frontal bone were thin and fragile. All the parts of the sphenoid were joined by osseous union, there being no cartilage between the basi- and pre-sphenoid portions of the bone. The rostrum of the sphenoid was of unusually large size, being nearly 2 ctns. in length, and was articulated in the usual way with the vomer. The temporal bones, with the exception of the squamous portions, were well ossified, and the tympanic ossicles and annulus tympanicus were as well developed as they are in the new-born healthy infant. The ethmoid bone was normal in appearance. It was found that the two halves of the lower maxilla were well ossified, the condyles being even a little larger than they normally are at birth. The lower jaw contained the usual number of dental germs, and this fact is specially worthy of note, for it is well known from clinical observation that when rickets comes on during infancy there is marked retardation in the eruption of the teeth, and great irregularity in the mode of their appearance. The superior maxillæ, which also contained the usual dental germs, projected forwards in the middle line, and this projection I believe to have been caused by the unusually large size of the rostrum of the sphenoid. This peculiarity of the sphenoidal rostrum may serve to explain the beak shape of the upper jaw described by Fleischman as common in post-natal rachitis. The malars and the other facial bones were well developed and fully ossified.

*The Vertebral Column and Pelvis.*—The spine, in this case, was curved, and fixedly curved both laterally and antero-posteriorly. There was a convexity to the left side in the cervical and upper dorsal regions, a convexity to the right in the middle dorsal. The lower dorsal portion of the spine was straight, and there was a convexity to the left in the lumbar region. There was also a general anterior concavity of the whole spine. Such fixed curvatures of the spine are entirely absent in the healthy new-born infant. The sacrum had a marked promontory and was well ossified. The coccyx was entirely cartilaginous, and was of enormous size, a fact which fully accounted for the tail-like projection. It consisted of the usual number of segments (four). The pelvic brim was contracted in its antero-posterior diameter, for the transverse diameter at the brim exceeded the antero-posterior by 5 mms. The iliac fossæ were slightly deeper than in the normal fœtus, and the crests of the ilia and the anterior iliac spines were thick and rounded. The ossification of the iliac bones was not so far advanced as it usually



is at birth, whilst that of the ischial and pubic bones was much retarded. The pelvis, therefore, presented characters quite different from those seen in the normal foetal pelvis in which the antero-posterior diameter at the brim is equal to or greater than the transverse, and in which the iliac fossæ are very shallow. The pelvis, also, does not show all the characteristic features of a typical adult rachitic pelvis, although in some of its characters the resemblance is strong. The anterior wall of the pelvis has an appearance as if it had been compressed and driven backwards by the enormously large upper extremities of the femora.

*The Clavicles and Scapulæ.*—The clavicles were relatively long when compared with the rest of the bones. Their inner ends were enlarged, and the upper surface of the bones showed a marked concavity. The right clavicle was slightly longer than the left. It measured 3 ctms.; the left measured 2·8 ctms. The chin of the foetus appeared to rest upon the upper concave surfaces of the clavicles. Both scapulæ were remarkably contorted. The infra- and supra-spinous fossæ were very deep, and the normal sub-scapular fossa was replaced by a convexity, upon which, however, was a small concavity corresponding in position to the region of the spine on the external aspect of the bones. The vertebral border of each scapula had a marked S-shape, and the lower angle was twisted forwards. The spine of the scapula had a distinct projection directed downwards about midway between its two extremities. The glenoid cavity was not well ossified.

*The Sternum and the Ribs.*—The manubrium sterni was very large, and the first three portions of the meso-sternum were well ossified. The ensiform cartilage was large, and its tip was turned forwards. There was a well-marked concavity on the anterior aspect of the sternum, with a corresponding convexity on its posterior surface. It may here be remarked that the heart showed a distinct furrow on its anterior aspect, marking the sharp bend which the sternum showed. A similar condition of the heart was observed by Bland Sutton in cases of rickets in monkeys (*Introduction to General Pathology*, p. 56), and the same author pointed out that marked thinning of the right ventricular wall resulted from the pressure to which it was subjected by the sharply-flexed sternum. In this case the thinning was not well marked, although the depression upon the anterior aspect of the heart was very evident. The ribs, which were rather slender at their vertebral ends, had distinct swellings at their sternal ends. The swelling on the anterior end of a rib was hollowed out into a little circular cavity from which a thin costal cartilage passed to the sternum. In the first three ribs the angle was very sharp, the 4th, 5th, and 6th ribs had no marked angle, whilst the lower ribs had an angle not nearly so well defined as those of the upper three ribs. These characters of the ribs were seen to correspond to the convexity and



concavity of the scapula. The lower margins of the middle ribs were very thin, and were distinctly notched. The anterior ends of the two upper ribs on each side were directed upwards. In the case of the other ribs they were directed downwards. The intercostal spaces were practically non-existent.

*The Long Bones of the Limbs.*—The long bones had this peculiarity in common, that whilst their ends were enormously large, the intervening shaft was small, short, straight, and nearly quite cylindrical. In the case of the femur there was a trace of the *linea aspera*, but in the case of the other long bones the shafts were quite smooth. The ends of the long bones were composed principally of cartilage greatly hypertrophied, and of softer consistence than is normal in the new-born infant; but at the line where the cartilage stopped and the bone began there was also a great thickening of the bone, so that the large ends of the bones were partly osseous, although principally cartilaginous. There was immobility of the joints and a certain amount of dislocation, especially in the case of the hip, shoulder, and ankle, and both the immobility and dislocation were apparently due to the enormous size of the opposing cartilaginous surfaces. Some of the characters of the individual long bones may be given here. The shaft of the humerus was straight, cylindrical, and short. The two extremities were greatly enlarged. The upper was somewhat round in form; the lower was broader transversely than antero-posteriorly. There were no ossific centres in the epiphyses. Taking the length of the humerus in the normal infant as 6 ctms., it was seen that in this case the bone was shorter than normal. The left humerus measured 4 ctms. in length, the right 3·9 ctms. The upper end of each humerus had a circumference of 7 ctms., whilst the circumference of the shaft was only 2·1 ctms. The radius and ulna were of equal length, each measuring 3·2 ctms., but the radius extended beyond the ulna below, and the ulna passed beyond the radius at the elbow-joint above. The interosseous space was 6 mm. in width. The lower end of the ulna had a marked concavity inwards. The lower end of the radius had a circumference of 3·4 ctms.; the upper end had one of 2·6 ctms., whilst the shaft measured only 1·3 ctms. in circumference. The upper end of the ulna had a circumference of 3·6 ctms., the lower end one of 3·3 ctms., whilst the shaft had one of only 1·4 ctms.

The femur on both sides had a slight concavity inwards of its shaft. There was a distinct projection on the inner surface of the upper end corresponding in position to the trochanter minor, but the trochanter major was lost in the general cartilaginous mass. The head of the femur was no larger than a pea, but was ossified. The femur measured 4·5 ctms. in length, the circumference at the upper end was 7·2 ctms., at the lower end 8·0 ctms., and at the middle of the shaft 2·1 ctms. The tibia was 3·3 ctms. in length, and its shaft had a circumference of 2·1 ctms. The shaft was thicker



than that of the fibula, which measured only 1 ctm. in circumference. The tibia was displaced forwards on to the dorsum of the foot. The fibula was situated in a plane posterior to that of the tibia, and more markedly so than in the case of the normal infant. It had a curvature convex to the front and internally, and concave posteriorly and externally. There was a large elliptical interosseous space 9 mms. in breadth. The length of the fibula was 3.1 ctms., and it reached to a level a little below that of the tibia. The patella was large and cartilaginous.

*The Hand and Foot.*—There was no point of ossification in the carpus, but the shafts of the metacarpal bones were large and well ossified, as were also the first and second but not the terminal phalanges of the digits. The bones of the tarsus were cartilaginous, except the os calcis, which had a large ossific centre. The feet were distinctly clubbed (*talipes varus*). All the metatarsal bones were ossified. The first and second phalanges of all the toes were ossified; the terminal phalanges were cartilaginous. The hallux, like the pollex, had both its phalanges osseous.

Such were the characters of the component parts of the skeleton, and it may be stated in addition that at the time when the fœtus came into Sir William Turner's possession there was a transverse fracture of the right femur in the upper third of its shaft. This fracture may have been intra-uterine; but I am more inclined to believe that it was produced at the time of birth or subsequently, for the long bones were very fragile, and during the process of dissection I myself accidentally fractured the other femur and the right humerus. In the case of the last-mentioned bones, however, what really occurred was a separation of the diaphysis from the epiphysis along the line where cartilage and bone met; whilst in the case of the right femur there was a true fracture of the bone itself. Each of the long bones presented on section very similar characters. The medullary canal was large and was surrounded by friable spongy osseous tissue. Near the epiphyses there was a thick layer of hard bone, and the epiphysial extremities of the bone were composed of soft cartilage of an almost gelatinous consistence. The microscopic examination of the tissues and organs of this fœtus was not satisfactory, the specimen not being fresh when I made the dissection, but the swollen ends of the long bones and the whole of the coccyx seemed to be made up of large masses of cartilage cells with little or no intercellular matrix and no deposit of lime salts. The absence of the placenta and membranes of this fœtus is a circumstance much to be regretted, as is also the want of any clinical history of the case. The incompleteness of the case is a great misfortune, nevertheless there are several interesting questions suggested by this specimen, to some of which I may now briefly advert.

Spiegelberg (*Lehrb. der Geburt*, 1875, p. 356) and other writers recognise two varieties of intra-uterine rachitis—*fœtal* rickets and



*congenital* rickets. Winkler (*Arch. f. Gyn.*, Bd. ii. p. 101) describes two varieties also, but gives to them the names of *micromelic* rickets and *annular* rickets.

*Fœtal Rickets.*—The class of cases to which the name of fœtal rachitis is given includes the cases of so-called micromelic rickets, and is also allied, in a way which is at present somewhat obscure, with the conditions known as fœtal cretinism and achondroplasy (Parrot). Fœtal rickets is a disease which it is supposed comes on during the earlier months of intra-uterine life, and in which it is believed the rachitic process is fully evolved *in utero*, with the result that at birth the infant is really a cured rachitic. The stage in which the bones are soft is, it is stated, past, and at the time of birth the bones are found hard and eburnated, and the peculiar deformities fixed. An infant with fœtal rickets presents the following characters so constant as to lead Tarnier and Budin (*Traité de l'art des accouchements*, ii. p. 356) to make the statement that all the fœtuses seem to have been stereotyped from the same model (*v.* Fig. 3). The head is large and is often hydrocephalic, but hydrocephalus is not an invariable concomitant condition, neither is the large size of the head always due to the presence of fluid in the ventricles (Depaul, *Arch. de Tocologie*, 1877, pp. 641–50). The thorax has the form of a cone with a wide base, the tip of the ensiform cartilage projects forwards, and the margins of the false ribs are turned outwards. The large size of the abdomen is characteristic, and there may or may not be a concomitant ascites. The small, stunted appearance of the limbs contrasts very markedly with that of the large head and prominent abdomen. Adipose tissue under the skin is very plentiful all over the body, and in the case of the extremities the large quantity of the subcutaneous fat and the lax condition of the skin have thrown the integument into transverse folds, which mask, to a great extent, the normal flexures of the articulations. The fœtus looks as if it had on garments too large for it. The shafts of the long bones are composed of hard, compact osseous tissue, are thick, very short, and are bent in abnormal directions. The extremities of the bones are somewhat swollen. There is no actively proliferating zone of cartilage at the junction area between shaft and epiphysis in the case of the long bones, and it is on account of this fact that Parrot has proposed to give to the disease the name of achondroplasy. Fœtal rickets does not, as a rule, show fractures of the bones. The deformity of the pelvis varies much in amount, it may even be absent entirely, but usually there is some flattening from before backwards. The term micromelic rachitis was suggested by the fact that the limbs are so small. Some authors, however, as Lauro (*Archivio di Patol. Inf.*, 1887), believe that whilst most of the cases described as micromelic rachitis are really cases of true rickets, some of them are due to processes quite distinct from rachitis,—to the interposi-



tion, namely, of periosteum between the epiphysial cartilages and the diaphysis, or to defective cartilage formation. In this relation it must necessarily be remembered that deformities in the skeleton of the foetus may be due to conditions other than the rachitic. Barlow (Keating's *Cyclopædia of the Diseases of Children*, vol. ii. p. 253) is of opinion that the cases of foetal rickets which have been described are more properly to be regarded as examples of foetal cretinism. He further notes that in a case described by himself there was the curious tribasilar synostosis first described in Virchow's *Pathological Archives*, vol. c. p. 256. This condition consists in the premature union of the basi-occipital, basi-sphenoid, and præ-sphenoid, with the result that there is formed at the base of the cranium one short continuous bone—the os tribasilare. This peculiar state of premature osseous union of the bones of the base of the cranium is not in itself sufficient evidence to show that the cases of foetal rickets are not true rachitis, for in the case which I have just described, and which, as I shall now show, seems to form a connecting link between foetal rickets and congenital rickets, there is also this early union of the præ-sphenoid, basi-sphenoid, and basi-occipital. The condition, also, of the thyroid cannot be adduced as evidence for the statement that foetal rickets is really foetal cretinism, for the reason that in these cases the thyroid is often quite normal. Infants affected with foetal rickets are usually still-born. Infants with foetal rickets present a very considerable superficial resemblance to those rare monstrosities known as phocomely, in which the segments of the limbs are very small and entirely cartilaginous.

It will be seen at once that the specimen which I have described to-night presents features which are, with only one or two exceptions, quite different from the characters seen in cases of foetal rickets. The general appearance of the limbs is quite different, and the changes in the separate bones are also quite distinct in this case as compared with the conditions found in the foetal rachitic foetuses. There is, however, one feature in common, namely, the prematurely ossified condition of the bones of the base of the cranium. In the case I have described the præ- and basi-sphenoid are firmly joined by osseous union, whilst the basi-sphenoid and the basi-occiput, although not firmly united by bone, yet show no intervening plate of cartilage such as is present in the healthy infant at birth. There is, therefore, a marked resemblance between the condition of the bones at the base of the cranium in this specimen and the premature tribasilar synostosis described by Virchow, Barlow, and others in cases of foetal rachitis or foetal cretinism. In this one character, therefore, there is a resemblance between this case and the described cases of foetal rachitis; but in its other features the case resembles the second variety of intra-uterine rickets—the congenital form, or, to use Winkler's nomenclature, the annular variety.



*Congenital Rachitis.*—Under this designation Spiegelberg (*loc. cit.*) and Quisling (*Arch. f. Gyn.*, Bd. ix., Hft. 4 and 5) include those cases in which rachitic symptoms are present in the new-born infant either in an incipient form or else in a stage of full evolution. Many examples of the incipient form of congenital rickets are to be met with in practice, more especially on the Continent of Europe, as has been clearly demonstrated by the observations of Schwarz at Vienna, and of others at Christiania and Paris. In the incipient form the most common manifestations are the head changes known as craniotabes, consisting in enlarged fontanelles and soft and easily impressible cranial bones, and along with the skull changes there are usually associated the changes in the bones of the thorax known as breast rachitis or the rachitic rosary. In 37·6 per cent. of the new-born infants at the Second Vienna Obstetric Clinic Schwarz found the skull and breast changes in a more or less marked degree, whilst in 31 per cent. the ribs alone were diseased, and in 7·2 per cent. there existed only the cranial rachitic changes. It is much more uncommon to find in this incipient form of congenital rachitis the characteristic rickety changes in the limbs. I have met with a few cases of slight rickets in infants in dispensary practice in Edinburgh, and those whose experience has been larger than mine must have met with many such cases. Congenital rachitis in full process of evolution presents, in addition to the changes in the thorax and the craniotabes, marked enlargement of the ends of the long bones, a more deformed condition of the pelvis, and the presence of a varying number of fractures of the bones or of separations of epiphysis from diaphysis. In these cases the resulting deformity is much greater than in incipient rickets, or even in foetal rachitis. The rachitic process is in, or has only just passed through the soft stage, and therefore there is seen in such cases great deformity of all the bones of the skeleton, with the exception of those whose ossification begins very early in intra-uterine life, such as the clavicles, the maxillæ (inferior and superior), the malars, and the greater number of the vertebræ. This form of rickets has been called by Winkler annular, on account of the presence of furrows on the long bones. These furrows have been supposed to represent the sites of intra-uterine fractures which have united whilst the foetus was still in utero; but this explanation of the ridges and furrows on the bones has not been accepted by Charpentier and others, who look upon them as having been produced by defects in the process of calcification. An infant affected with congenital rachitis may live, and the rachitic process may be continued in extra-uterine life, but in the cases where the osseous lesions are very marked a separate existence comes to be impossible.

The specimen which has formed the subject of this communication is an example of far-advanced and well-marked congenital rachitis. It is a rare occurrence to find in a new-born infant such marked rachitic changes; and it is probable, as Barlow suggests,



that intra-uterine rickets runs an accelerated course as compared with post-natal rachitis. The changes at the ends of the long bones are very extensive, and the deformity of the chest walls, of the sternum, scapulæ, pelvis, coccyx, and base of the cranium, is greater than that usually described. The peculiar changes at the base of the cranium lead me to the conclusion that in this case there was in early foetal life true foetal rachitis, which, as it were, became cured and passed into the stage of hard, compact bone production; and that then the rachitic process attacked the long bones and the other parts of the skeleton, and had in them reached the stage of excessive soft cartilage formation when the infant was born. I look upon the case, therefore, as one forming a connecting link between the foetal and congenital forms of intra-uterine rickets. Spiegelberg, Lauro, and others, have shown that the histological characters of intra- and extra-uterine rickets are identical, and this case would seem to support the statement by showing the possibility of the existence in the same foetus of characters peculiar to both foetal and congenital rachitis. The deformities in this infant seem to owe their character very much to the attitude of the foetus in utero, and this is especially the case with the sternum, ribs, scapulæ, and pelvis. Whether the fracture of the right femur took place in utero at birth or after birth it is impossible, from the absence of any clinical history, to say, but the peculiar form of the occiput seems to have been due to intra-uterine fractures which have partially united. The numerous dislocations present in this case are no doubt due to the enormously large size of the opposed articular surfaces.

There are three leading theories as to the pathogenesis of rickets, — firstly, that advanced by Kassowitz, who regards rickets as due to a chronic inflammation beginning in the bone-forming tissues; secondly, that theory which regards deficiency in the supply of the mineral constituents as the cause; and, thirdly, the acid theory, which states that the normally calcified bones are deprived of their lime by some acid, as lactic, present in the circulation. It is not, however, within the scope of this paper to enter into the vexed question of etiology, and the same remark holds with regard to the subject of treatment, which must necessarily be maternal.

The description of the changes in the skeleton in this case formed part of the appendix to the M.D. thesis on "Some Anatomical and Pathological Conditions of the Fœtus and New-born Infant in their Relation to Obstetrics," handed in by me to the Edinburgh University last April.

