OF
A PECULIARITY
IN THE
CONFORMATION
OF
THE SKELETON IN RICKETS.

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It is my object to direct the attention of the Society to a peculiarity in the form of the skeleton, when distorted by rickets, which I have not found noticed in the works that treat of this disease.

The appearance to which I allude is distinct from the incurvation of the bones, and is to be seen, only by examining the relative proportions which the different parts of the skeleton bear to one another. As this examination demonstrates that rickets, besides producing softening and distortion of the bones, has the effect of interrupting their growth:—as it leads to the observation of a remarkable character in the pelvis, which has an important relation to the practice of midwifery, but which has hitherto been overlooked

by pathologists ;—and as it tends to make the diagnosis respecting the form of the pelvis, in the various kinds of distortion, simple and complete, I have thought that the subject deserved the consideration of the members of the Society.

Of the Distortion which is produced by Rickets.

If we consult the various works which treat of distortion, we shall find that considerable confusion exists as to the nature of the deformity which is caused by rickets. It is necessary, therefore, to define what is the exact kind of distortion which is meant, when we speak of a skeleton being affected by this disease.

It is conceived by a numerous class of writers, that rickets is a disease which may commence at all periods of life, and that it is the common source of the varieties of deformity included under the term lateral distortion of the spine. Hence it has been concluded that the spinal curvature, which begins at the age of twelve or fourteen, and which is distinguished for its remarkable frequency in females, is the effect of this disorder of the osseous system.

Several objections might be urged against this theory :—but it may be sufficient to observe ; first, that the authors who support it, have made a remarkable, and, at the same time, a fatal omission,—they have dwelt at much length upon the appearances

of the distortion, (as if these alone could establish an identity with the disease,) and have neglected to prove that the concomitant symptoms, denoting the derangement of the system, had a correspondence with those which occur in rickets. It is known that this disease is a formidable and, too frequently, a fatal disorder during childhood; and produces a train of the most distressing and strongly marked symptoms:—yet it would appear, that when rickets occurs about the age of puberty, it is unattended with constitutional disturbance of any kind. But, if the disease really does prevail, is it not fair to surmise, that as the bones at a later age, are both larger and more solid than during infancy, the softening of their textures should be accompanied with an aggravation of all the symptoms? 2nd. It is another example of the carelessness with which this subject has been treated, that although rickets is acknowledged to be a specific disorder, which embraces all the bones of the skeleton, the authors who have maintained this theory (among whom we have to include the names of Petit, Portal, Pouteau, Mont-faulcon, and others of equal celebrity,) have confined their observations to its effects upon the vertebral column and the thorax. For example, in the treatise of Portal, entitled, “*Sur le Rachitisme*,” we do not find more than a simple passing remark, introduced incidentally, upon the condition of the pelvis in this disease. Indeed, the only author, of those who espouse this view, that has warned us of the dangers to which the pelvis must necessarily be exposed, as

well as the bones of the spine and chest, in these cases was Mr. Wilson, and such was his impression of the degree of softness to which the bones were reduced by the abstraction of the phosphate of lime from their textures, that he conceived that the simple application of instruments for supporting the spine, might be productive of the worst kind of deformity of the pelvis. This change in the figure of these solid bones he believed might be effected, "even after the pelvis was fully and well formed,"—and speaking of the frequency of lateral curvature in females, and urging with earnestness that these artificial supports should be removed, he adds, "by this timely attention, the lives of many mothers and children may be saved, in cases where either mother or child, or perhaps both, must otherwise have perished."*

My brother, the late Mr. John Shaw, being desirous of determining whether a disease of the osseous system, attended with so much danger to the pelvis, was to be considered the cause of that kind of deformity to which females were most especially subject, directed his attention to this question in his work upon Distortions of the Spine. With the view of illustrating this point, he examined an extensive series of morbid specimens of the spine, and from contemplating these, he was enabled to demonstrate this fact;—that the spinal column may be incurvated in a lateral direction, and may present a distortion

* Lectures on the Bones, delivered before the Royal College of Surgeons, p. 175. 1820.

of the same appearance, in two conditions of the system, which are altogether distinct from each other. In one class of these specimens he observed that there was lateral curvature of the spine, combined with distortion of the ribs—but this constituted the whole extent of the deformity,—in none of the other bones of the skeleton, however weak or exposed to pressure they might be, was there any trace of distortion to be discovered. In the other series of preparations, on the contrary, not only was there lateral distortion of the spine and ribs, such as was presented in the former specimens, but combined with this there was an universal deformity of the whole skeleton, including the cylindrical and solid, as well as the most delicate and pliant bones. It accordingly appeared that in the first of these series of preparations it was only a limited portion of the skeleton that was affected; while in the latter, every individual bone was deformed; and it was inferred that a cause which was peculiar to the vertebral column and to the ribs, or of a local nature, gave rise to the former kind; while a general specific disease occasioned the other.

Hence it was shewn on the authority of morbid anatomy, that the mere distortion of the spinal column could not be considered sufficient to indicate a general affection of the osseous system, such as rickets. It was proved, on the contrary, that this part might become deformed, even to the most remarkable extent, without any of the more solid bones

losing their natural shapes. Mr. Wilson, in describing the liability of the pelvis to be deformed, pointed to the vertebral column alone as affording indications of the existence of rickets, and neglected to speak of the condition of the bones of the extremities;—Mr. Shaw, on the other hand, was led to conclude that “in whatever state of distortion the spine and ribs may be, the bones of the pelvis will not be found distorted unless there be at the same time marks of rickets in some of the long and solid bones.” As it is familiar to every person that neither the bones of the upper, nor those of the lower, extremities, become incurvated when the distortion commences near the age of puberty, it follows that a cause, totally different from rickets, gives rise to it, and that the pelvis incurs no danger of being implicated in this kind of deformity.

Subsequent to the publication of the work on distortion by Mr. Shaw, several writers of eminence have given their support to the former theory respecting rickets. But they have neglected to controvert, or even to state the arguments which are opposed to this view; hence we need only consider their opinions on this subject very briefly. The first among these authors is Richerand, who in his work entitled “*Sur le Progrès recens de la Chirurgie*,” has, it may be said, brought us back to the very notions which flourished in the time of Glisson, the first writer upon this disease. He has, however,

ventured further than most of those who have preceded him; for he has made these two remarkable statements respecting rickets,—first, that it prevails with greater frequency about the age of puberty, than at any other period of life; and secondly, that it depends for its origin upon the establishment of the catamenial discharge in young females, and, hence, is exclusively found in that sex. Notwithstanding this alleged prevalence of the complaint in women, he neglects, however, to refer once to the condition of the pelvis*. Capuron, an authority upon the subject of midwifery, while speaking of distortion, also supports the opinion that rickets attacks the osseous system at all periods of life. Pravaz, although he owns that this disease is more commonly met with in childhood, explains the origin of the lateral curvature which is so frequent in girls, on the supposition that it is produced by rickets. Marjolin classifies distortion of the spine and of the pelvis, as occurring with equal frequency, and, as it would appear, proceeding from the same disease in every case. Velpeau, while discussing the uses of the pelvi-

* The only observation which this author makes respecting the pelvis would imply that it was at first deformed, but afterwards was restored to its natural shape by the treatment which he recommends, “la colonne vertebrale participe à cet effet general: les os, dont le tissu se dilate, s’épanouit et s’incruste en même temps de phosphate de chaux, element de leur solidité, deviennent capable de supporter le poids du corps. Les os qui forment l’enciente du bassin et de la poitrine, se redressent à mesure que s’effacent les inclinaisons vicieuses de la colonne.”

meter, in cases where difficulty of labour is apprehended from deformity of the pelvis, concludes that a disease to which he gives the name osteo-malaxie, but which he does not define or distinguish from rickets, although it may be said to produce the very same changes in the bones, is the source of the spinal distortion so common in young girls*.

As the objection, however, applies generally to these authors, that they neglect altogether to meet the arguments which are opposed to their views and rely solely upon their unsupported assertions, we may be allowed to adhere to the definition of rickets, as it was laid down by Mr. John Shaw. Accordingly it is proposed, in the following observations, to consider those skeletons only as true specimens of the effects of this disease, in which the distortion is exhibited throughout all the osseous system together:—in the skull, the cylindrical bones of the extremities, and the large bones of the pelvis, as well as in the spinal column and the thorax.

* The following extract may show the confusion which prevails upon this subject, in some of the treatises upon midwifery. “En disant qu’il suffit qu’une jeune personne ait été nouée ou *rachitique*, qu’elle ait une deviation de la colonne vertebrale, pour lui defendre le mariage, cet auteur (Puzos) d’ailleurs si sage, est assurément allé trop loin : et l’humanité d’accord avec le justice, devaient appeler de son jugement. Combien de femmes contrefaites mettent au monde avec la plus grande facilité, des enfans volumineux et robustes.”—Velpéau, *Traité Elem. de l’art des Accouch.*—l. 53.

Of the relative Proportions in the Ricketty Skeleton compared with those in the natural Adult Skeleton.

In examining a skeleton deformed by rickets, our attention is apt to be exclusively directed to the distortion of its several bones. But if we abstract from our minds, or make allowance for these incurvations or irregularities, and look only to the relative dimensions of the skeleton, we shall perceive that it has a configuration different from what belongs to the natural skeleton. The human figure, at maturity, is characterized by the lower extremities having a remarkable length, as well as breadth and solidity; while the superior parts are comparatively small and light in their structure. The figure of the ricketty skeleton, on the other hand, is distinguished by the head, the thorax, and the arms being preponderating and large, while the pelvis and lower extremities are in a relative degree, diminutive and short. This peculiarity I found more strongly marked in some deformed skeletons than in others, but in order to illustrate that it is a general character belonging to rickets, I took the measurements of eight specimens, and compared the average numbers resulting from these, with the corresponding measurements of the natural skeleton. As these deformed skeletons, together with six additional specimens of distorted pelvis, were obtained from female

subjects, they were contrasted with the standard proportions peculiar to the female sex.

By examining the Table (No. 1.) at the end of the paper, it will be observed, in the first place, that all the bones of the skeleton deformed by rickets, are deficient to a certain degree in their size. But if we direct our attention to the upper and to the lower divisions of the frame, it will be discovered that this diminution is much more considerable in the latter than in the former—that is, in the pelvis and the bones of the leg, than in the skull, the spine, the thorax, or the bones of the upper extremity. For example, in the deformed skeletons, the average length of the spinal column, when measured along its curvatures, was twenty-two and five-eighths inches, while in the natural skeleton it was twenty-three and a half; making a difference only of seven-eighths of an inch: again, the length of the arms was twenty-four inches and a half, while in the natural skeleton it was twenty-seven inches, making a difference of two inches and a half. But in examining the lower division, the average length of the legs, measured from the larger trochanter to the heel was twenty-four inches and a half in the deformed skeletons, while in the natural skeleton, it was thirty-five inches; or the difference amounted to ten inches and a half. By combining these measurements of the spine and of the bones of the arm, and contrasting them with those of the leg, it will be found that the former parts scarcely lose one-fifteenth of their natural

length, while the latter lose somewhat more than a third. If we examine, in the next place, the dimensions of the head, and compare them with those of the pelvis, the same contrast will be observed. The diminution of the skull is scarcely to be perceived; while that of the pelvis is most remarkable in its extent. Thus, the average length of the os innominatum, measured from the spine of the ilium to the ischium, was, in the fourteen rickety pelves, six inches and five-sevenths, while in the natural pelvis, it was eight inches and a half:—the space across the ilium, from the anterior to the posterior spinous process, was five inches and three-eighths, while in the natural one it was seven inches and a quarter:—the greatest breadth from one spine of the ilium to the other, was nine inches and five-sevenths, while in the natural pelvis it was eleven and a quarter;—lastly, the space from the pubes to the sacrum was two inches and four-sevenths, while in the natural pelvis it was four and a half. By adding these measurements together, it will be found that in the rickety pelves, the average number of the whole is six and a small fraction, while in the natural female pelvis it is almost eight; or, in other words, the general deficiency of the deformed bones amounts to very nearly a quarter of their natural size.

Since my attention has been directed to this subject, I have not failed to observe with interest the forms of those individuals, distorted from rickets, whom we have numerous opportunities of meeting in the

streets. It is generally remarked that these persons are diminutive in height; but it is not so commonly noticed how much this shortness of stature results from the smallness of the lower extremities—which is independent altogether of the incurvations of the bones. If we refer to Table 1, and look along the lines which contain the measurements of the bones of the leg and those of the arm, it will be seen that there are only two examples, in which the length of the leg exceeds that of the arm even to a trifling degree, yet in the natural figure, the leg measured from the hip-joint to the heel, is seven inches longer than the arm.

Of the Changes which the Human Figure undergoes in its development: in illustration of the Peculiarity in the Proportions of the Ricketty Skeleton.

If we proceed, in the next place, to consider what may be the cause of this particular form in rickets, we must direct our attention first to the course of the development of the bones. Hitherto, we have compared the proportions of the ricketty skeleton with those which are peculiar to the full grown adult; but it will be seen that in order to discover a correspondence with the natural figure, we must contrast them with the skeleton previous to its arriving at maturity. During the process of growth, the human figure undergoes a remarkable change in its proportions; and that we may fully comprehend the

extent of this revolution, it is necessary that we attend to the two grand objects for which it is accomplished:—viz., First, the configuration of the foetus, while it remains inclosed within the womb, must bear a relation to the act of parturition.—Secondly, the form of the adult must be accommodated to his maintaining the erect position of his body. It will be seen, that the conformation which is admirably adapted for the first of these objects is altogether inconsistent with the latter.

If we examine a human embryo at the earliest period, we shall perceive that, even then, there are provisions in its form for its future safe delivery. In natural labour, the head descends first, and it is to obtain the position of the head next the orifice of the womb, that the peculiar figure of the foetus, as contrasted with that of the adult, is impressed upon it thus early. The head at the commencement of the growth, has such a remarkable development that it forms one third or even more, of the entire bulk of the body. The umbilical cord, by which the embryo is suspended from the fundus of the uterus, is short and thick, and it is attached to the extremity of the trunk directly opposite to the head: hence, it follows, that as the whole germ floats in the liquor amnii, the head will gravitate towards the cervix, and be directed over the opening, through which it is destined to pass in the act of delivery.

In observing the form of the foetus, it is interesting

to notice how slowly both the extremities become developed. These continue to be remarkably small, and resembling short appendages, rather than perfect limbs, for a considerable time. Now, it would appear, that the design was to delay the growth of these parts until the head of the fœtus had become safely lodged over the canal which leads to the os uteri. If the limbs had possessed, at the first, the same relative length which belongs to them at adolescence, it is obvious that while suspended in the liquor amnii, they would have hung down towards the cervix, and in all probability have become impacted between the head and the orifice of the womb. This is an accident which occasionally happens, notwithstanding the provisions for guarding against it; and the accoucheur knows how serious are the dangers, which attend a presentation either of the hand or of the foot in delivery*.

But the circumstance which principally distinguishes

* It is a favourite theory that the configuration of the fœtus, at the different epochs of its growth, represents by "analogy," the gradations in the animal kingdom, and in illustrating this principle the progressive development of the extremities is much referred to. For example, when the embryo is without extremities, the human being is said to resemble a molluscous animal; when the upper extremities alone are developed, he is likened to the cetacei or by some to the whale; when the inferior extremities present themselves, but are yet smaller than the superior, a resemblance is discovered to the walrus, &c. But it has not been considered, how important these modifications of the shape are to the peculiar gestation and act of parturition in the human subject.

the form of the *foetus* from that of the adult, is the extraordinary smallness of the pelvis and of the legs, when compared with the size of the head, and of the trunk. Portal has conjectured that this was a provision for assisting the delivery of the child when the breech presented in labour;—that the pelvis dilated the os uteri like a wedge, thus permitting the head to pass with facility*. Haller, Bichat, and other physiologists have conceived, that this conformation was only an effect of the peculiar circulation of the blood in the *foetus*. The umbilical arteries, they alleged, conveyed away the stream of blood from the pelvis and lower extremities to the placenta, and thus, by an imperfection or a mere accident, as we must presume, these parts remained diminutive while the rest of the body increased in size. But such an explanation cannot be admitted, 1st. Because the current of blood, thus supposed to be diverted from its course, is not intended for nourishing the limbs, which is evinced by its passing to the placenta, the function of which part is essential to the life of the *foetus*. 2nd. It is a law of the economy, exhibited in numerous organs of the body, that the distribution of the blood, has a reference to the necessities which demand its supply, and is not influenced by the mere mechanical arrangement of the vessels;—thus when the uterus, the *mammæ*, and other organs become evolved or active in their functions, the blood-vessels enlarge in a corresponding measure; and when these parts subside, the arteries become

* Anat. Med. Tom. I. p. 18.

diminished at the same time. In varicose aneurism of the arm, where the blood is truly diverted from its course, being conveyed back to the heart by the communication formed between the main artery and the vein, the arm does not shrink or lose its nourishment; but the humeral artery becomes increased in size, and transmits a larger supply of blood. 3rd. It is not to be granted that because the lower extremities are found diminutive in size, the circulation of blood in them is therefore more languid; or, it may be asked, how we shall account for the points of ossification in the bones of the foot exhibiting a more rapid growth at the period of birth than those in the corresponding bones of the hand. If we examine these small bones in a quadruped newly dropped, such as in the young colt, where the circulation of the blood is the same as in the human subject, but where there is a provision for a more early use of the legs, we shall not find the same contrast between the anterior and posterior extremities. Neither shall we find that the configuration of the whole body at birth is analogous to that of the human foetus; for, although the umbilical arteries have a similar distribution as those in man, the lower extremities in the foetal horse bear the same proportionate size to the rest of the frame, or are even larger than at the period of mature growth.

There is an important object attained, in the act of parturition, by the diminutive size of the pelvis in the human foetus, which has been overlooked in offering these explanations. In the human subject, the

axis of the pelvis, along which the infant has to be propelled, is nearly perpendicular instead of being horizontal as in other mammiferous animals. From this it follows that to ensure the safety both of the parent and of the offspring, the process of delivery must be slow and laborious*. Since the foetus, therefore, in passing through the narrow canal of the mother's pelvis occupies a considerable time in its descent, it is necessary that the umbilical cord should be protected from compression; otherwise the supply of blood from the placenta, will be interrupted, and the life of the infant be destroyed before it can respire. Now it seems to be with the view of giving perfect security to the vessels of the cord, that the pelvis is restrained in its growth and is narrow and elongated in its form. As the head of the child, in the natural labour, descends first, no danger is incurred, however long this part may be delayed in its passage, because the circulation within the uterus continues free all the while. The head, therefore, descends slowly; and as it advances, it opens and dilates the orifice of the womb and the os externum, thus providing for the easy and rapid delivery of the rest of the body. But if it had happened that after the head was delivered, together with the abdomen and the first turns of the umbilical cord, a new source of difficulty was occasioned by the size

* It may be asked—Does not the remarkable peculiarity of gestation in the kangaroo derive some explanation from considering the erect position in which this animal carries itself, while running or springing on its hinder extremities and tail?

of the hips of the infant—for example, by their being of the same relative magnitude as in the adult, it is obvious that the blood-vessels of the cord, being impacted betwixt the hips of the fœtus and the brim of the pelvis, could not have escaped being fatally compressed. Happily, the pelvis of the infant, being small, it descends rapidly through the dilated passage of the cervix and vagina, and there is not time for the circulation in the umbilical vessels to be impeded. In breech presentations the order of the natural delivery is reversed; the smaller part is propelled before the larger, the cord, therefore, is exposed to compression during all the time that the head is descending; and it is this circumstance which gives rise to the principal alarm in these cases.

It thus appears that the capacious head and diminutive pelvis of the fœtus are provisions for its safe delivery from the womb. But the same configuration, it is obvious, would be incompatible with the privilege enjoyed by man of carrying his body erect. Accordingly, before the child can leave the nurse's arms, or before the human form is completed, there is a remarkable change in the proportions of the figure:—the pelvis and the legs, which form the base on which the trunk is sustained, become the larger and preponderating parts, while the head, upper extremities, and thorax are comparatively light. As an example of the extent of this alteration, the centre of gravity in the fœtus, immediately before birth, is situated as high up as the *scrobiculus cordis*, while in the adult,

according to Borelli, it is between the two hip-joints. With the view of obtaining a more accurate conception of the change which thus takes place in the relative proportions, the following measurements of the skeleton were made, in the infant newly born, and in the adult. The entire length of the child, measured for this purpose, was eighteen inches and a quarter; the dimensions of the adult were found by measuring four individuals, whose mean height was five feet eight inches. In the infant the length from the apex of the head to the highest part of the spine of the ilium, was two inches greater than the length from the same point of the ilium to the heel; that is, the length of the superior division exceeded that of the inferior by one-ninth of the entire height. In the adult, the upper division was *less* than the lower by sixteen inches; or, in other words, it was one-fourth of the whole height shorter than the inferior division. Upon comparing the size of the head with that of the pelvis a similar variation was observed: the circumference of the head in the newly born child was twice that of the pelvis; whereas in the adult it was less by nearly a half. Lastly, on contrasting the length of the arms and of the legs, it was found that in the child, the former, when measured from the acromion process to the tip of the middle finger, were exactly of the same length as the latter, measured from the greater trochanter to the heel; but in the adult the arms were twelve inches shorter than the lower extremities. In illustration of the same fact we may observe that the humerus in the fœtus,

near the sixth month, is equal, both in size and weight, to the femur; but at adolescence the femur is fully three times the weight of the humerus.

From these calculations we may perceive what a remarkable accession to its growth the inferior division of the body acquires in contrast with the superior division. We are authorized therefore to conclude that the lower extremities, including under that term the pelvis and the bones of the leg, advance with a greater activity between birth and manhood, than the head, thorax, spinal column, or upper extremities: and that it is owing to this difference in the rapidity of the development of the several parts of the frame that the human figure becomes changed, as we have observed, in its proportions.

Of the influence which Rickets has in retarding the growth and changing the proportions of the Skeleton.

If we revert now to the peculiarity of the conformation which characterizes the skeleton affected with rickets, we shall perceive that although it differs from the adult skeleton, it bears an obvious resemblance to that of the child:—the bones may be larger, they may have the firmness and strength which belong to the mature subject, the marks of the sutures and epiphyses may be obliterated; but the superior division of the frame preponderates over the lower as it does in infancy. Reflecting upon this

similarity, it is naturally suggested that the cause of the remarkable form of the rickety skeleton must be a defect in the process of growth occasioned by the prevalence of that disease in the osseous system. If the interruption, which we are supposing, takes place while the change of the configuration just described is in the course of being accomplished, it is evident that the skeleton will retain in adolescence the peculiarities that belong to its primitive form. It might appear, at first sight, as if the peculiarity were owing to the defect of growth falling more exclusively upon the lower division of the frame than upon the upper, inasmuch as the bones of the pelvis and of the legs suffer a greater loss in their dimensions than the other parts. But this difference is to be accounted for by the process of development being more active in the lower extremities than in the superior division, as has just been shown; which makes the stoppage of the growth more strikingly exhibited in them.

The distorted skeleton, marked No. 3 in Table 1., was found to be of the same height, when measured along the course of its curvatures, as a girl whose age was eleven years and a half; they were both fifty-one inches and a half in height. But the following contrast was observed in their relative dimensions. In the girl, the length from the apex of the head to the spine of the ilium was eleven inches and a half less than from the ilium to the heel; but in the rickety skeleton the superior division was only five inches and a half less than the inferior. The

arms of the girl were nine inches shorter than the extent from the ilium to the heel ; but in the rickety skeleton the difference was only three inches and a half. It thus appears, that if we desire to make a comparison between the natural skeleton and that of this deformed person, we must take the skeleton of a child still less advanced than this ; that is to say, about three or four years of age.

If we reflect upon the nature of the morbid action in rickets, it will not appear improbable that it should be accompanied with a disturbance of the growth. Although the osseous system is principally affected in this disease, yet we have abundant proofs in the marasmus and constitutional disorder, (which is so general as to extend its influence even to the intellect, causing, most commonly, a remarkable precocity in the mental faculties,) that every function of the body is deranged. With regard to the bones, it is a mistake to suppose that it is the deficiency in the secretion of phosphate of lime which alone marks the disturbance in them. In addition to the process of softening, there is a disorganization of the minute textures of the bones, which equally demands our attention. This morbid appearance is exhibited upon making the section of a rickety bone that has been removed during the active stage of the complaint ; and it is described by various pathological writers.—Thus we find it stated by Bichat, while explaining the effects of this disease, “ that the solid structure, forming the walls of a long bone, entirely

disappears; the whole interior presents a homogeneous appearance, and is composed of cellular texture throughout." * In the bones of the skull the derangement of the minute textures is commonly exhibited in a very remarkable manner,—some parts of the calvarium being increased to an extraordinary degree in thickness, while other parts are reduced to the thinness of paper, and the divisions of the tables are lost †. It may be argued that since there are such extensive changes in the deposit of the material composing the osseous structures generally, it is a proof that the laws which regulate the formation of the internal substance of the bones are disturbed in rickets; and if such be allowed, it is natural to conclude that the course of development, by which these individual bones increase, at different and appropriate rates according as they are in the upper or lower divisions of the frame, is also deranged.

* Bichat quoted by Mr. Stanley. See the Transactions of this Society, Vol. VII. p. 406.

† Sir Charles Bell has in his possession a skull affected with rickets, in which the parietal bones are seven-eighths of an inch in thickness at their central parts. He had also the skeleton of a child seven years of age, in which the parietal bones measured five-eighths of an inch. In both these specimens the calvarium was remarkably thin in the situation of the sutures and fontanelles. Hunauld exhibited to the Academy of Sciences the skull of a child between three and four years of age, in which the bones of the skull-cap were, in some places, seven or eight lines in thickness; and when squeezed with the fingers, blood and serum oozed from the interstices of the bone.

*Of the relative Proportions in Dwarfs and in tall
Individuals.*

The examples of dwarfs and of persons whose height surpasses the common standard, serve to illustrate our subject. They shew how much the relative proportions of the body may be varied according as the growth is either retarded or accelerated. In the dwarf, where the development is a slow and imperfect process, the superior half of the body retains, at maturity, the same preponderance over the lower, which naturally belongs to it at birth. An interesting example of this is to be seen in the skeleton of the dwarf, Crachami, preserved in the Museum of the College of Surgeons. Although this individual lived to the age of nine years and a half, the skeleton exhibits the very same relative proportions which belong to the infant at the age of two or three months; indeed, if it were not for the advanced condition of the teeth, the closing together of the sutures, and the general firmness of the bones, we should not be able to distinguish it from a skeleton of that early period. In the same Museum there are the portraits of five other remarkable dwarfs, among which is that of the Polish dwarf Boroawloski; and in him the peculiarity which is here described is very distinctly presented. It can at once be observed, that although his features, and the court dress with which he is equipped, bespeak a person of mature years, the size of his head, the length and capaciousness of his body, the narrowness of his hips,

and the disproportionate shortness of his legs, betray the original configuration of the child. It accordingly appears that the proportions of the dwarf correspond with those of the individual affected with rickets; for in both the lower division of the body fails to acquire that superiority of bulk over the upper division which naturally belongs to the figure in adolescence.

But as the interruption to the process of growth causes the adult to retain the peculiarities of the child's figure, so it may be shown that the acceleration of the process makes the tall individual become a true caricature of the mature form. The lower extremities being endowed with a superior activity of development, they expand and elongate in the tall person, under the increased impulse given to the whole growth, with a rapidity that soon destroys the proportions of the body. Thence it is a general remark, that persons distinguished for their unusual height, have their lower limbs disproportionately long, in comparison with the size of their trunk. To illustrate this, I took the measurements of a gentleman whose height was six feet four inches and a half, and contrasted them with the measurements of an individual, of the proper proportions, whose height was five feet eight inches. It was found; in the first place, that the length from the apex of the head to the spine of the ilium, was only half an inch greater in the tall person than in the other; but below the same point of the ilium the tall individual measured as much as eight inches more than the other. 2dly,

The circumference of the head was only one inch and a quarter greater in the tall individual than in the person of common proportions; but in the pelvis the difference amounted to seven inches. 3dly, The length of the arms in the tall person was less than that from the spine of the ilium to the heel by sixteen inches; while in the other individual the difference was only eleven inches and three quarters. This shortness of the arms, contrasted with the length of the legs, would have caused, it is obvious, a remarkable deformity of the figure, if the vertebral column had not also been peculiarly short: but the spine, being comparatively defective in height, allowed the arms to hang down to their usual extent in this gentleman, and thus the difference in the relative length of the upper and lower limbs was not easily noticed; yet it is to be observed that the increase in the length of the arms was only equal to the half of what it was in the lower extremities. 4thly, The difference between the length of the upper and of the lower divisions amounted, in the tall individual, to one-third of his entire height; while it was only one-quarter in the person of common proportions*.

* It is a general remark respecting tall persons, that their extraordinary height is unnoticed while they are sitting at a table, and that it is only when they rise from their chair that a feeling of surprise is excited. Those who reside in London have the opportunity of observing the effects of this law, in the soldiers of the life guards: and no one can pass these fine looking men, especially when they are in undress, without entertaining some speculations about the remarkable shortness of their waists, shown by the diminutive size of their jackets, as contrasted with the prolonged dimensions of their lower extremities.

Of the influence possessed by Rickets in arresting the Growth of the Pelvis.

The questions which we have been engaged in considering, have led us to observe a remarkable character in the pelvis when deformed by rickets, which has not been noticed by writers upon midwifery, but which appears, nevertheless, essential for comprehending the true condition of this circle of bones in such cases. It will be found that these authors, while treating of the effects of this disease upon the pelvis, confine their observations to the deformity of the bones, and to the encroachment produced upon the cavities by that cause; and that they attribute all the dangers met with in parturition to the irregularities only of the form of the canal. But after contemplating the imperfect course of development in the body when affected by this disease, and observing, in particular, the extensive change which ought naturally to be effected in the size of the pelvis in the female during that process, we are prepared to comprehend how two distinct causes are in operation to diminish the capacity of the brim and of the outlet: viz. first, there is the softening of the bones, arising from the want of phosphate of lime, and giving rise to deformity; and, secondly, there is the defective growth and consequent imperfect expansion of the cavities of the pelvis as compared with the development of the other parts of the body. This diminution of the size of the bones, it was formerly shewn, amounted to nearly a quarter of the natural dimensions. We may conceive, therefore, the influence which the stop-

page of the growth, independently of the deformity of the bones, must have in obstructing the course of delivery; and we might even suppose that the narrowness of the canal, resulting from this cause alone, even if the pelvis retained its natural shape, would lead to the most serious results. It may, at all events, be perceived how imperfect the calculations must be, whether made with the pelvimeter or by any other means, with the view of ascertaining the dimensions of the ricketty pelvis, when the natural and full sized bones of the healthy subject are taken as the standard of comparison. In the pelvis deformed by rickets, it is not only those diameters, which are contracted by the thrusting inwards of the bones, that are smaller than usual, which would be the case if the distortion were merely effected by the yielding of the bones,—but all the diameters are less than natural. In squeezing a hoop, in proportion as one diameter is diminished, the other is elongated: and so it is in the diameters of the pelvis distorted by mollities ossium: but this is never the case in rickets.

If we refer to the Table No. 1., it will be perceived that a correspondence may be traced in the diminution of the bones of the pelvis and those of the leg; that is, in proportion as the bones of the leg are shorter than natural, the pelvis is in a corresponding measure smaller in all its dimensions. Hence it may be suggested as a means of estimating the extent to which the pelvis is diminished below its natural size, to observe the proportions which the length of the legs bears to the rest of the frame. This correspondence

in the deficiency of growth between these two parts, is what we might naturally expect, since in the healthy development they expand and elongate with a similar activity. It may corroborate the same view, that whenever one of the lower extremities is "wasted," or more properly, is arrested in its growth, owing to fever or derangement of the health during childhood, not only are the femur, the tibia, and fibula, and the bones of the foot diminished in size, but the os innominatum of the same side is likewise affected in a similar degree. In one of the skeletons, of which the measurements are given in the Table, there was this partial wasting of one of the lower extremities combined with the general deformity of the bones; viz., the left leg was two inches shorter than the right, and the muscles also were proportionately smaller. Now it was observed, on examining the left os innominatum, that the defect in its growth corresponded with the diminution of the leg. Here, then, it might be said, that both the right and the left lower extremities were examples of the law referred to; for as there was a general stoppage of the growth, neither of the limbs possessed its true proportions; yet each of the ossa innominata bore a relation in its size to the corresponding extremity. An analogous effect is observed when the arm is similarly affected; for the scapula and clavicle, which may be considered as corresponding to the os innominatum, are stopped in their development in the same proportion as the bones situated below the shoulder joint*.

* Sir Charles Bell has in his possession a preparation, which illustrates in a striking manner this general wasting of the

Is Rickets to be considered the Cause of the lateral Distortion of the Spine which commences at the age of Puberty?

I may be allowed, before concluding, to draw attention again to the theory which supposes that rickets is the cause of the common lateral curvature of the spine, which commences about the age of ten or twelve, and is a frequent complaint in young females. Now, it would appear that this opinion may be entirely overthrown if we attend only to the effects which rickets has upon the development of the body, as shown in the preceding observations. In the cases of distortion occurring subsequent to early childhood, we shall discover that even while the spinal column is increasing in its curvature, and while the ribs are becoming more and more twisted, and therefore, when it may be supposed that the disease, if it be rickets, is most active in its progress, the pelvis continues to expand and the limbs to elongate, just as in the natural process of growth. Hence the patient is commonly observed to gain in height, at the very time that the spinal column is losing some inches of its proper length. And an obvious distinction in the general proportions of the figure in

bones of the upper extremity. To confirm what is stated in regard to the os innominatum being affected in conjunction with the other bones of the extremity in wasting of the limb, I may refer to an interesting account of the dissection of a patient who had this kind of deformity, by Lobstein, who has added the different measurements of the two sides of the pelvis. See the "Report of the additions made to the Strasbourg Museum." 1822.

the two kinds of deformity, is the consequence of this difference of the growth. For example, in the person deformed by rickets, the trunk, when contrasted with the size of the limbs, appears to be considerably larger than natural, notwithstanding the curvatures in the course of the spine ; whereas, in the individual, who has the common lateral distortion, there is a shortness and squareness of the trunk ; and the lower extremities, besides being perfectly straight, appear to be of a disproportionate length to the rest of the body.

When we consider the imperfect manner in which this theory has been advocated *, we cannot help surmising, notwithstanding our respect for the authors who have maintained it, that they have resorted to it more because there was a difficulty of explaining the origin and progress of the common lateral curvature without supposing some diseased action in the bones, than because there was a resemblance in the history or symptoms or pathological appearances to what are found in rickets. The same remark applies to the various, opposite, and inconsistent opinions, which are founded upon its being scrofulous inflammation that

* It is forgotten that the common lateral distortion of the spine prevails, nearly exclusively, in the families of the rich, whereas rickets is scarcely ever found except among the children of the poor, who are miserably fed, badly clothed, and live in the narrow streets of large cities in a confined and unhealthy atmosphere. Again, rickets attacks the children of both sexes with equal frequency ; which is different from what is observed in the common lateral curvature.

produces lateral distortion ; some authors conceiving, according to this supposition, that the morbid action extends along the whole vertebræ of the spine, missing the joints or ligamentous textures ; and others, on the contrary, supposing that the inflammation is confined to the intervertebral cartilages and ligaments avoiding the osseous textures. Notwithstanding its being imagined that such an extensive portion of the body is affected with active disease, no distinct symptoms are described as accompanying the complaint. Indeed, we know in practice, that it is not the condition of the spine which first attracts the notice of the friends of a patient who has the common lateral curvature ; but what occasions alarm is the displacement of the scapula, the prominence of one of the mammæ, or the bulging out of one of the hips ; and there is neither pain in the course of the spinal column nor the slightest feverishness to denote the presence of inflammation. The treatment, it is also to be remarked, recommended for this supposed scrofulous inflammation, is altogether inconsistent with what ought to be pursued, if such a morbid condition existed, being violent gymnastic exercises of various kinds, or powerful stretching of the spine, which would undoubtedly bring on caries of the bones, extensive suppuration, with paralysis of the limbs. But the worst effects which are to be dreaded from such theories is, that the pathology being incorrect, practitioners may be led to treat those cases of deformities, which really proceed from the disease here described, and which in some instances nearly resemble

lateral distortion in outward appearance, as well as in the want of pain and distinct symptoms, as if they had the same origin as the common lateral curvature and could bear the same severe measures *.

Before assuming that such formidable diseased actions gave rise to the common lateral distortion, it is remarkable that the authors have not attended more to the natural softness of texture and natural flexibility, both of the spine and the ribs, which are peculiar to the period of life when this deformity commences;—and which condition is characteristic more especially of the bones of young females. As there are, however, certain circumstances unconnected with disease, which tend to increase the natural weakness of these parts, and to render them still more liable to become distorted from slight causes, I may be permitted shortly to enumerate them. 1st. The restraints to which young girls, especially in the higher classes of society, are subject, owing to the system of their education, as they interfere with the natural exercise of the body, deprive the muscles of the spine of their strength; and tend also to make the bones and the ligaments more spongy and weak. 2nd. This debility of the muscular frame makes it irksome for the young patient to sit with the spine erect for any length of time; and accordingly, a disposition to lounge or to stoop is the consequence:—thus the weight of the body, instead of being sustained

* See Delpech "De l'Orthomorphie," Vol. II. p. 362, et passim.

perpendicularly upon the spinal column by the active exercise of the muscles, is allowed to hang, as it were, upon the ligaments which bind the processes of the vertebræ together, and these parts become unnaturally elongated. It is in this manner that the numerous joints of the spine, amounting to seventy-two, become relaxed, and are prepared to yield in whatever direction a particular habit may induce them.

3d. The spinal column represents a pillar of a very remarkable structure; it is not only flexible, and made to sustain a perpendicular weight, but it is supported upon a basis that is constantly shifting its level. The pelvis, on which the spine rests, is seldom for a moment placed horizontally. For example, the natural position of ease while standing, is to stand upon one leg; and accordingly the pelvis, in this posture, is necessarily elevated above its natural level on that side, and depressed below it in a corresponding degree on the other. The consequence of this inclination at the basis of the spine is that the lumbar vertebræ which are next to the pelvis, and which form together the most flexible part of the spine, are also raised unequally in one direction and fall obliquely aside on the other. Hence, in order to preserve the equilibrium, a curvature of the spine takes place in the lumbar vertebræ, while standing upon one leg.

4th. There being this curvature formed at the base, it follows that the weight of the body falls more upon the concave side of the spine than upon the convex. But it has not been observed what are all the consequences which result from this. If we attend

to the natural structure of the spine, it will be seen that whilst we lean the body to one side, the pressure is thrown, almost exclusively, upon the articulating processes of that side; these processes, delicate as they are, being the only bony structures which check the lateral movements of the trunk. Hence when a habit is acquired of inclining to one side, or of resting upon one hip, as in sitting, the sharp edges of these small points of bone receive the weight of the entire body. But as the articulating processes are remarkably soft, and are imperfectly formed at the age of puberty, it follows that they will become wasted by absorption when this position is long persisted in; and an inequality of the length of these two lateral props, on which the vertebræ rest posteriorly, will be the consequence, those of the concave side being shorter than those of the convex. 5th. In lateral curvature of the spine we have a distinct demonstration that the articulating processes give way more extensively than any of the other parts of the column. This is evinced by the rotation which the spine makes in its perpendicular axis, at the same time that it inclines laterally. The joints of the articulating processes being situated posteriorly as well as laterally, the spinal column cannot yield in their direction, without wheeling partially round; and it is owing to this rotation that the transverse processes, and the ribs, are directed obliquely forward upon the concave side and obliquely backwards upon the convex side of the curvatures, thus giving rise to a fulness or swelling on the one hand, and a depression or sinking inwards on the

other *. 6th. When a curvature is established in the lumbar vertebræ, it is easy to understand that a second one must follow higher up, produced by the natural efforts of the body to correct the inclination thus formed at the base of the column. With a view to preserve the equilibrium, which is disturbed, in consequence of this curve, whenever the pelvis assumes the horizontal position, one of the shoulders is elevated and the head turned aside, causing a bend to take place in the dorsal region of the spine, in an opposite direction to that situated in the lumbar. 7th. If it be admitted that in standing, we have a natural preference to use the right leg, as being the strongest and that with which the chief efforts are made in the powerful exertions of the limbs, we may comprehend

* This difference in the appearance of the two sides of the spine, has given rise to various speculations respecting "hypertrophy" and "atrophy" of the muscles of the back in spinal distortion. Dr. Quain, in his "Elements of Descriptive and Practical Anatomy," p. 363, has attempted to prove that the small muscles of the dorsal region of the spine, situated upon the convex side of the curvature, produce the inclination of the column at this part; that is, he conceives that these muscles, being affected with hypertrophy, can turn this highly inflexible part of the spine in the opposite direction from which they themselves act. But this is surely to be considered an oversight of that accomplished anatomist. Dr. Mason Good, founding upon the same opinion that an irregular contraction of the muscles gives rise to deformity, has included the common lateral curvature of the spine, in his new arrangement of diseases, among the spasmodic complaints;—where we find it classed by the side of hydrophobia, tetanus, priapismus, &c., and entitled by him "Entasia Rachybia." See the last edition of Dr. Good's "Study of Medicine."

how the curvature of the lumbar region of the spine is so frequently directed with its convexity on the left side of the body, and the curvature in the dorsal region, with its convexity on the right side. The former curve results from the pelvis being depressed on its left side, as a consequence of standing upon the right leg; this inclination of the pelvis throws the spine to the left side, making it bend to the right in order to correct the want of balance. As this curvature in the loins becomes habitual, but can only be maintained while the pelvis continues oblique, the incurvation of the dorsal region must necessarily be to the left side, or in a direction opposite to the former.

If it be admitted from the preceding observations, that rickets has no share in producing this variety of distortion which is so frequent in females, it is obvious to what an extent the number of cases must be abridged, in which the question as to the form of the pelvis becomes a source of anxiety during pregnancy. When the accoucheur meets with a true case of deformity of the spine from rickets—he will not, it is hoped, be deceived by the notion which at present too generally prevails, that it is a mere accidental circumstance, whether the pelvis in this complaint be included or not in the distortion. He will reflect, on the contrary, that if this disease has attacked the osseous system, two causes have been in operation to diminish the size of the pelvis, and having a more correct knowledge of the different sources of the dangers in such cases, he will be prepared to meet them with greater promptitude.

TABLE I.—FEMALE SKELETONS DEFORMED BY RICKETS.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	Average measure- ment of distorted skeletons.	Natural female skeletons.	Difference.
Skull—its circumference	19½	20	22	..	21	20	22	..	..	..	..	..	..	..	..	22½	21	22	1
Spine following the curvatures anteriorly	21¾	23½	21	20½	23½	23	23½	24	..	..	..	..	..	..	..	..	22½	23½	¾
From the acromion to the tip of the middle finger	22½	23½	25	..	25¾	25	24	..	..	..	..	..	..	..	24	26	24½	27	2½
Greatest breadth of the pelvis from one spine of the ilium to the other	10¼	9½	9½	10¼	11	10	10	10	10	10½	9½	9½	9½	8½	..	..	9½	11½	1½
From pubes to sacrum	1½	3	2½	2	2½	3¼	2½	2	3	3½	2½	2½	2½	2¼	..	..	2½	4½	1½
From highest part of the spine of the ilium to the lowest part of the ischium.	6¼	6	6¾	6½	7	7	7	6	7	7½	6½	7	6	..	..	..	6¾	8½	1½
From ant. sup. spinous process to post. sup. spinous process }	5	5¼	5½	5½	5¼	5½	5½	5½	5½	5½	5½	5½	5½	5	..	..	5½	7½	1½
From trochanter to the heel following the curves	22½	21	25	23½	25¾	25	28	..	..	..	..	..	..	22½	24	24½	24½	35	10½
Length of the femur	10	10½	12	10	12	14¼	13	..	..	..	..	..	..	..	..	..	11½	18	6¾
Round the knee	8½	9½	9	8½	8½	8½	8½	..	..	..	..	..	..	..	..	..	8¾	10½	1½

TABLE II.,
SHOWING
THE CHANGES IN THE RELATIVE PROPORTIONS OF THE
FIGURE DURING GROWTH.

Years.	Entire height in inches.	Above spine of the ilium.	Below spine of the ilium.	Arm, acrom. to tip of finger.	Circum. of the head.	Circum. of the hips.
Fœtus at 5th month }	9½	5½	4	3½	6½	3½
At birth.....	18½	10	8½	8½	13½	6½
2	28½	14½	14	11½	16½	11
3½	37	17	20	15	20½	19½
8	44½	19½	25	19	19½	18½
11½	51½	20	31½	22½	20½	24½
14	55½	20	35½	22½	21	26½
16	62½	22½	40	28½	21½	31
21	68	26	42	30½	22	35
—	72	25½	46½	33½	22½	39
—	76½	26½	50	34	23½	44

**SKELETONS OF THE GIANT AND DWARF PRESERVED
 IN THE COLLEGE OF SURGEONS.**

—	93	37	56	41	(Skull.) 23½	(Pelvis.) 37
9½	19½	9½	10½	8½	14	8½

RELATIVE WEIGHTS OF FŒTUS AND ADULT FEMALE.

	Total	Above spine of ilium.	Below spine of ilium.	One Upper extremity.
5 months....	3viiss	3xlvii7 ₁₀	3xli2 ₁₀	3iii8 ₁₅
Adult female	lbxxxvii. 3vii	lbxxxviii 3ss	lbxxxix 3viss	lbv 3v½