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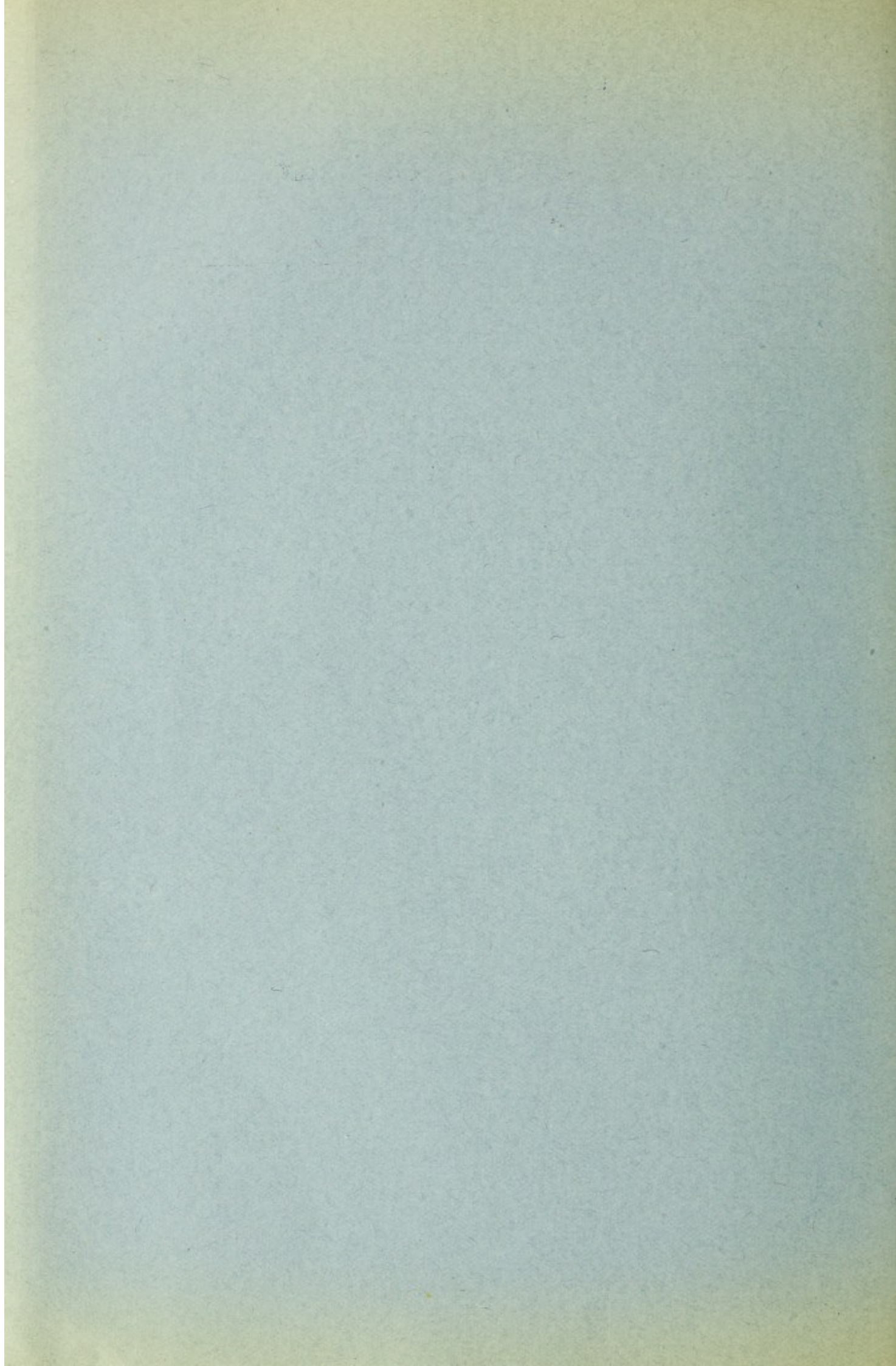
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FREQUENCY, ETIOLOGY AND PRACTICAL SIGNIFICANCE OF CONTRACTIONS OF THE PELVIC OUTLET

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WHILE it is a matter of general knowledge that pronounced contraction of the pelvic outlet is to be expected in certain cases of osteomalacia, spondylolistheses, and more particularly in lumbar and lumbo-sacral kyphosis my attention had not been directed to the possibility of its existence in women who presented no external deformity and in whom the usual pelvic measurements were normal, until I had learned it by several disagreeable personal experiences.

Thus, it happened several years ago that within the course of a few months, I attended two primiparæ, in whom preliminary examination showed that the usual pelvic measurements were normal, and that the foetal head was deeply engaged. Accordingly, I stated that there was no mechanical obstacle to the birth of the child and predicted a favorable outcome, and was greatly chagrined at the time of labor to find my prognosis incorrect. In each instance, labor progressed normally until the head became visible at the vulva, when all advance ceased, notwithstanding the fact that the pains continued strong. After waiting somewhat more than an hour, and thinking that the delay was due to a rigid perineum, I applied low forceps in each case, with the expectation that a few slight tractions would effect delivery, but to my great surprise the operation proved very difficult and was completed only after most strenuous effort, one child dying from a fractured skull, while the other was born at the expense of a deep perineal tear.

On seeking an explanation for the dystocia I found that the pubic arch was greatly narrowed and the distance between the ischial tuberosities reduced to between 7 and 7.5 cm. With this experience in mind, I began to measure the pelvic outlet in all of my patients, and

soon found that it was contracted much more frequently than is generally believed.

In this paper I desire to report the results of the mensuration of the outlet in 1,200 consecutive patients in the obstetrical department of the Johns Hopkins Hospital, most of whom I measured personally, and afterwards to consider the obstetrical significance, etiology, diagnosis and treatment of funnel shaped pelves.

History. Although Deventer, de la Motte, Smellie and other early writers mentioned isolated cases of outlet contraction, it was not until the latter part of the eighteenth century that Baudelocque and Mme. Boursier du Coudray gave anything like an accurate description of funnel shaped pelves. The former described a specimen in which the distance between the tubera ischii measured $7\frac{1}{2}$ cm., and the latter in her *Abrégé* gave two colored figures, one illustrating dystocia resulting from a too narrow pubic arch, and the other from too close approach of the tip of the sacrum to the lower margin of the symphysis pubis. Moreover, she also mentioned a Cæsarean section performed upon a woman, in whom the tubera ischii were only 4.5 cm. apart, but unfortunately the history was not sufficiently precise to enable one to determine whether she had to do with an osteomalacic or a typical funnel pelvis.

From that time onward isolated cases were described, but it was not until the appearance of Busch's text-book and Kilian's "*Geburtslehre*" in 1838 and 1839, respectively, that the abnormality in question was considered under a special heading. In several reports concerning the activity of the Berlin clinic from 1829 to 1847, Busch gave notes of 35 labors occurring in funnel shaped pelves and stated that dystocia frequently occurred, and was more likely to be pronounced when the condition

of the pelvis had escaped recognition, as it frequently happened when the head had become arrested at the vulva, that the obstetrician applied low forceps in the expectation of an easy delivery, but was chagrined to find that it required the expenditure of an unusual amount of force, and frequently could be terminated only after craniotomy.

Following this Ritgen, Hugenberger, Scharlau, Dedolph and others described similar cases, but their work suffered from the fact that they were uncertain of the etiology of the condition and did not possess satisfactory methods of mensuration. In 1867 Schroeder, and a little later, Spiegelburg, enunciated their views, to which reference will be made under the appropriate headings.

In 1870, Breisky described an instrumental method of measuring the distance between the tubera ischii, as well as that between the tip of the sacrum and the lower margin of the symphysis pubis. The latter method has stood the test of time, and is in general use at the present. Nine years later, Frankenhäuser made an important contribution to the subject, and described the technique of determining the length of the transverse diameter of the pelvic outlet, which was been employed in my series of cases.

The description of these methods, which made more or less accurate mensuration possible, led to renewed interest in the study of funnel pelves, as was manifested by the casuistical and statistical contributions of Fischel, Fleischmann, Roth and Mansbach, from the clinics of Breisky, Schauta, Frankenhäuser and Ahlfeld, respectively. According to these authors the distance between the ischial tuberosities was reduced to 9 cm. or less about once in every 100 cases of labor.

Schauta devoted a section to the subject in Müller's *Handbuch der Geburtshilfe*, and, after reviewing the existing knowledge concerning it, stated that abnormalities of the outlet were present in 5.9 per cent of 2,070 contracted pelves, which he had observed in Prag. Walther's monograph which appeared in 1894, while adding nothing essentially new to the subject, was of considerable interest in that it contained an analysis of the course of labor in 117 cases of funnel pelves collected

from the literature, which he compared with his own experience in 7 cases observed in a series of 750 labors in Giessen.

In 1896 Klien made a most important contribution, and after stating that abnormalities of the outlet were present in 24 per cent of 439 consecutive patients which he studied, clearly demonstrated that the extent of obstruction at the time of labor did not depend entirely upon the degree of shortening of either the transverse or antero-posterior diameters, but was more frequently dependent upon the space available between a line joining the tubera ischii and the tip of the sacrum, which he designated as the posterior sagittal diameter of the outlet. He also devised an ingenious instrument for its mensuration, and formulated certain limits, below which spontaneous labor could not occur. As will appear later, I am unable to agree with all of his conclusions; but at the same time I feel very strongly that the general principles which he enunciated are undoubtedly correct and are destined to revolutionize our ideas as to the prognostic significance of funnel pelves. Unfortunately his teachings have not as yet received the recognition they deserve, as the authors of most standard text-books dismiss the subject with a few words, and, like Tarnier and Budin, merely state that funnel pelves occur but rarely and possess only slight obstetrical significance.

An equally important contribution was made by Breus and Kolisko, who, by demonstrating the frequent occurrence of lumbo-sacral assimilation and its effect upon the shape of the pelvis, have thrown light upon the etiology of certain varieties of funnel pelves, and rescued it from the vague and unsatisfactory condition it previously occupied. Their views have also found intelligent support at the hands of Bayer.

Classification. Schauta defined a funnel pelvis as one with a normal or only slightly contracted inlet, whose walls converge to such an extent as to lead to a marked narrowing of the outlet. In such cases he held that the contraction might involve either the transverse or antero-posterior diameter, or both diameters simultaneously; the first and last being the most usual varieties. He likewise classified funnel pelves as generally or partially con-

tracted, according as the narrowing of the outlet involved all diameters or was limited to a single one.

Klien, on the other hand, classified such pelves according to the length of the antero-posterior diameter of the outlet, and distinguished two main categories according as it is normal or absolutely too short. In the first group the transverse diameter may be only relatively shortened while the posterior sagittal is too short, or the transverse diameter may be absolutely too small. In the second group the shortened antero-posterior diameter may or may not be associated with lessened distances between the tubera ischii.

From my own experience neither classification is perfectly satisfactory for clinical purposes, and I shall therefore distinguish between three groups: namely, typical, generally contracted, and complicated funnel pelves. In the first type, the superior strait is essentially normal, while the inferior is contracted, the narrowing occurring in either the antero-posterior or transverse diameter, or in both simultaneously, as described by Schauta. In the generally contracted variety, the entire pelvis is smaller than normal, while the inferior strait is narrowed to a greater extent than is usual in typical justo-minor pelves. In the third group are included a small number of flat or rhachitic pelves, in which the outlet contraction is superadded to the typical deformity.

Breisky, Roth and Stocker designated as funnel shaped all pelves in which the distance between the tubera ischii is reduced to 9 cm. or less, while Walther and Klien placed the limit one half centimeter higher. In this article I have adopted 8 cm. as the dividing line for two reasons. In the first place, I have never observed serious dystocia resulting from outlet contractions when the transverse diameter exceeds that measurement; and in the second place, a higher limit, in my experience, would place so many pelves in the funnel shaped category as to make its incidence appear ridiculous.

Frequency. The statements concerning the incidence of funnel shaped pelves vary so greatly that it is difficult to draw accurate conclusions from a study of the literature upon the subject. Thus, Stocker, Klien and Franken-

häuser stated that the distance between the tubera ischii was reduced to 9.5 cm. or less in 25, 24 and 13 per cent of their patients, respectively; while Fischel, Fleischmann and Walther noted it in only about one per cent of their cases. A similar discrepancy likewise impairs the value of the statements made concerning the relative frequency of funnel as compared with the usual types of contracted pelves. Schmidt, Schauta, Roth and Busch stated that 2, 5.9, 17 and 17.9 per cent, respectively, of the contracted pelves which they studied were of the funnel variety, while A. Müller in a short note states that in his experience the latter occurs almost as frequently as all of the usual varieties combined.

For this reason, I feel that my results will be of interest, as they are based upon my personal mensuration of 1,200 outlets in a series of 1,444 consecutive women treated in the obstetrical department of the Johns Hopkins Hospital, (cases 2,042-3,486), 670 of whom were white and the balance black, so that the material is almost equally divided between the two races.

As indicated under the heading of classification, I have designated as contracted only those pelves in which the transverse diameter of the outlet is reduced to 8 cm. or less in length, or in which the distance between the lower margin of the symphysis and the tip of sacrum falls below 9 cm. Judged by these criteria 122 funnels pelves were observed in 1,200 women, an incidence of 10.17 per cent, and may be classified as follows:

83 Typical funnel pelves.....	6.92%
34 Generally contracted funnel pelves.....	2.83%
3 Generally contracted rhachitic funnel pelves.....	0.25%
2 Flat rhachitic funnel pelves.....	0.17%

In the entire series the distance between the tubera ischii was reduced to 8 cm. in 84 cases, to 7.5 cm. in 38 cases, to 7 cm. in 14 cases, and to 5.5 cm. in one case. The single instance in which the transverse diameter was reduced to 5.5 cm. was observed in a typical funnel pelvis; and in general it would appear that the degree of contraction is somewhat more pronounced in this than in the generally con-

tracted variety, as is shown by the following table:

Transverse of outlet	8 cm.	7.5 cm.	7 cm.	5.5 cm.	Total
Typical funnel pelvis . . .	50 (60.2%)	22 (26.8%)	10 (12%)	1 (1%)	83
Generally contracted funnel pelvis	24 (70.6%)	6 (17.7%)	4 (11.7%)	0 (0%)	34

Upon comparing the findings in the two races it is noted that the incidence of the typical funnel pelvis is approximately identical in both; while the generally contracted variety occurs four times more frequently in colored women, as is clearly shown by the following figures:

49 typical funnel pelvises in 670 whites	7.32%
34 typical funnel pelvises in 670 whites	
34 typical funnel pelvises in 530 blacks	6.42%
A ratio of 10 to 9.	
8 generally contracted funnel pelvises in 670 whites	1.19%
26 generally contracted funnel pelvises in 530 blacks	4.91%

A ratio of 10 to 42.

This latter observation is of more than statistical interest, and will be utilized later to justify the distinction between the two types of funnel pelvises, as well as to support the contention that they are dependent upon radically different etiological factions.

Etiology. Up to comparatively recently the views advanced concerning the mode of production of funnel pelvises were very vague and unsatisfactory, and although Breus and Kolisko had made important contributions in this regard, their teachings have not received general acceptance.

Thus, Schroeder stated that but little was known concerning the abnormality, and held that it should be regarded as a manifestation of imperfect development, particularly when the advance of the tip of the sacrum was associated with retrocession of the promontory. In other instances he was inclined to believe that the abnormality should be attributed to a kyphosis which had escaped recognition. Spiegelberg, likewise, taught that the etiology was uncertain, although he felt that the prime factor should be sought in faulty or imperfect

development of the alæ of the sacrum. At the same time, he considered that the diminished inclination of the sacrum probably indicated that the transformation from the foetal to the adult form of pelvis had not been entirely completed.

Schauta held that the condition should be attributed to some abnormality in development which had led to increased depth of the pelvic cavity. Under such circumstances the promontory of the sacrum would necessarily occupy a higher and more posterior position than usual, so that, when exposed to the action of the body weight, the entire sacrum would rotate in such a manner that its promontory would become retropulsed, while its tip approached the symphysis, just as happens to a more marked degree in typical kyphotic pelvises.

Fleischman, Bulius, Emminghaus and Richter were likewise very uncertain in their views, but were inclined to attribute the deformity to defective development, which was manifested by the infantile or masculine character of the entire pelvis later in life.

In 1900, Breus and Koliske, in the first section of their work upon deformed pelvises, made a distinct contribution to our knowledge, in that they directed attention to the surprising frequency of lumbo-sacral assimilation. When the last lumbar vertebra becomes assimilated to the sacrum, they held that a pelvis results in which the sacrum is made up of six vertebræ and whose promontory occupies a much higher position than usual. This they designated as high assimilation, and pointed out that such a pelvis may assume one of two forms. In the first, owing to the greater height and lesser width of the sacral alæ, its entire cavity may become narrowed transversely, although the contraction is usually more marked at the superior strait, which consequently assumes a more rounded shape. In the second variety on the other hand, the alæ retain their usual width, but the sacrum rotates in such a manner that its promontory becomes displaced backward and its tip forward, with the result that the antero-posterior diameter of the superior strait becomes lengthened while that of the inferior strait is shortened. At the same time, owing to the change in position of the sacro-

iliac joints, the lateral walls of the pelvis converge below, so that it becomes funnel-shaped, somewhat in the same manner as in lumbo-sacral kyphosis or spondylolisthesis. Breus and Kolisko did not attempt to explain the genesis of all funnel shaped pelvis in this manner, but they nevertheless insisted that assimilation must be considered as an important etiological factor. Their views were strongly endorsed by Bayer, and to a less extent by Schmitz in 1906 as the result of the study of 20 assimilation pelvis in the Giessen collection.

It is somewhat surprising that this relationship was not recognized earlier. Particularly, as close study of the copper plate illustrating the front view of a normal pelvis in Deventer's "New Light for Midwives," shows that he had to deal with a funnel pelvis, whose sacrum was made up of six vertebræ; while a similar condition was present in the specimen described by Scharlau. Moreover, Fleischmann suggested such a possibility in 1888, while Trachet in 1890 pointed out that the sacrum was composed of six vertebræ in about 25 per cent of all the dried female pelvis which he examined. He, however, failed to appreciate the part it might play in the production of outlet contractions, and contented himself with directing attention to the frequent occurrence of a false or double promontory in such cases, and to the prognostic errors which might ensue if it were taken as a basis for determining the length of the diagonal conjugate.

Returning to my own experience, it would appear that the question of etiology may be studied either from an theoretical point of view or from actual observation.

As I have already indicated, the incidence of typical funnel pelvis in my material was 7.32 and 6.42 per cent, respectively, in 670 white and 530 black women — a ratio of 10 to 9. So that taking the comparatively small number of cases into account, it would appear that the abnormality occurs approximately equally frequently in both races. On the other hand, the usual forms of contracted pelvis, — flat, generally contracted and rhachitic — occur much more frequently in the black race, as is evident from the statistics which T. F. Riggs collected in my clinic, which show that their incidence is 9.25 and 34.8 per cent, respectively.

I have repeatedly stated that this difference can be readily explained by the much greater prevalence of rhachitis and of imperfect general development in the black women living in large cities; but as typical funnel pelvis occur with about equal frequency in the two races, it would appear that they cannot be ascribed to the factors just mentioned, or to radical, social or hygienic influences. Consequently, the explanation for their development must be sought in some factor which is common to both races, and in the following lines I shall attempt to determine what it is.

The accompanying table shows the frequency of the several types of funnel, as well as of the other common varieties of contracted pelvis in the 1,200 consecutive cases under consideration, and also the ratio in which each occurs in the two races.

	Cases 670	% White	Cases 530	% Black	Ratio
Typical funnel pelvis...	49	7.32	34	6.42	10.9
Generally contracted funnel	8	1.19	26	4.91	10.42
Generally contracted rhachitic funnel.....	0	..	3	0.57	..
Flat rhachitic funnel	1	0.15	1	0.18	10.12
Generally contracted pelvis	26	3.88	80	15.09	10.40
Rhachitic pelvis	3	0.45	71	13.40	10.300
Simple flat pelvis	8	1.19	6	1.14	10.9
Various pelvis	2	0.30	0	..	..
Total	97	14.48	221	41.71	10.29

From these figures it is apparent that in my material abnormal pelvis of all varieties occurred in 14.48 and 41.71 per cent of the white and black women, respectively — a ratio of 10 to 29; whereas omitting the generally contracted and irregular types of funnel pelvis, the incidence becomes 6 and 30 per cent, respectively — a ratio of 10 to 50. Or, to put it more strikingly, 49 typical funnel pelvis were noted in 670 white women as compared with 39 presenting the so-called common varieties of contraction; so that it is evident that the former occur slightly more frequently than the latter. In the black women, on the other hand, the conditions are reversed, as only 17.8 per cent of the total number of contracted pelvis belong in the typical funnel shaped category.

Moreover, the generally contracted or just-minor pelvis occurred four times, and the

rhachitic pelvis 30 times, more frequently in the colored women; and this, as I have already indicated is due to the vastly greater prevalence of faulty general development and rhachitis among them. Therefore, if these factors played any part in the production of funnel pelves, the latter should necessarily occur much more frequently in the black race; but, as that is not the case, the inference is clear that they must be due to some other condition.

My experience leads me to conclude that the explanation must be sought in high assimilation, as indicated by Breus and Kolisko, and Bayer, as it seems to occur equally frequently in both races. Since none of my patients came to autopsy, it is impossible to adduce irrefutable anatomical evidence in favor of such a contention; but, at the same time, the findings on clinical examination were such that I have no hesitation in stating that it is probably the most important and usual factor concerned in the production of the typical funnel pelvis.

In the 83 cases coming under this category, the usual external pelvic measurements were uniformly excellent, the length of the diagonal conjugate varied within the normal limits, while the only abnormality consisted in the narrowing of the pelvic outlet. In every such case I attempted to count the number of sacral vertebrae through the vagina or rectum, and in 8 instances — 10 per cent — was able to ascertain with certainty that 6 vertebrae were present — in other words, that I had to deal with an assimilation pelvis. Naturally, it may be objected that it is not permissible to infer from so small a percentage of positive findings that the abnormality was present in the majority of cases, and on general principles it must be admitted that such a contention is correct. Nevertheless, when one considers how difficult it is to count the sacral vertebrae with certainty, even with the entire hand in the vagina of an anesthetized patient, it would seem that the relatively small number of positive results clearly indicates that the condition must occur comparatively frequently.

Moreover, in a much larger proportion of cases, I was able to detect the existence of a double sacral promontory; and my own experience, as well as the extended observation

of Breus and Kolisko, shows that its presence affords almost indubitable evidence of the existence of assimilation. In view of these facts, I therefore feel that I shall not go far wrong in holding in the majority of cases, at least, that the essential factor in the production of the typical funnel pelvis is lumbo-sacral assimilation, in which the last lumbar is assimilated to the first sacral vertebrae, and thus brings about the condition so clearly described by Breus and Kolisko. Upon another occasion, however, I hope to be able to adduce indisputable anatomical evidence of the correctness of this view, based upon the examination of a large series of dried female pelves.

On turning to the consideration of the etiology of the 34 cases, which I have designated as generally contracted funnel shaped pelves — 8 of which occurred in white and 26 in black women — I feel that we have to deal with a totally different condition. In this group, the usual external pelvic measurements are uniformly shortened, the diagonal conjugate is reduced to 11.5 cm. or less, while the outlet is contracted to a greater extent than is usual in the typical justo-minor pelvis.

Unlike the typical funnel pelvis, the generally contracted variety occurs much less frequently in white women — a ratio of 10 to 42, which would seem to indicate that it must be due to some condition more or less peculiar to the black race. On searching for such a factor, one is at once impressed with the fact that in my series of cases the ordinary generally contracted justo-minor pelves also occurred four times more frequently in black women. As this latter type of pelvis is a manifestation of imperfect general development, resulting from faulty nutrition and from the generally poor hygienic surroundings amid which the blacks grow up in large cities, I am inclined to attribute the formation of the generally contracted funnel pelvis to the same cause and to consider it etiologically as a sub-division of the justo-minor pelvis. At the same time, it is quite possible that the outlet contraction may also be partly due to assimilation, as I was able to palpate 6 sacral vertebrae in three of these cases. In that event, it would seem that two factors may be concerned in the etiology of the condition; namely, faulty general develop-

ment and assimilation; whereas, had the latter alone been concerned a typical funnel pelvis would have resulted.

Effect upon labor. When one recalls the dimensions of the inferior strait (antero-posterior 11.5 cm. transverse 11 cm.) and those of the full term foetal head (biparietal 9.25 and sub-occipito frontal 10.5 cm) it is apparent that more or less serious dystocia may result if either of the diameters of the outlet be materially shortened. Normally, as the head escapes from the pelvis, the occiput fills out the space included within the pubic arch, so that when the base of the occiput engages beneath the symphysis the sub-occipito-frontal diameter practically coincides with the antero-posterior diameter of the pelvic outlet, or more accurately speaking, with that of the plane of least pelvic dimensions — consequently, if the latter is materially shorter than the sub-occipito-frontal diameter, labor can be accomplished if at all, only after the head has undergone extensive moulding.

Generally speaking, more or less serious dystocia will occur when the distance between the symphysis and the tip of the sacrum is reduced to 9 cm. or less, even though the transverse diameter be normal, and will naturally become increased in proportion if the latter be shortened. The smallest antero-posterior diameter observed in my series of cases measured 8 cm. but the shortening did not give rise to dystocia for the reason that the child was macerated and weighed only 1,400 grammes.

On the other hand, if the transverse diameter be shortened, the tubera ischii are brought into closer apposition and the pubic arch becomes narrower. In this event, the sub-occipital region can no longer engage directly beneath the symphysis, but, as the contraction becomes more marked, will impinge lower and lower down upon the ischio-pubic rami so that in extreme cases the head can be extruded only posterior to a line joining the tubera ischii, which will be possible only when the antero-posterior diameter has become materially lengthened. Moreover, when labor occurs in this manner, the perineum becomes so unduly distended that delivery can be effected only at the expense of a deep lacer-

ation. Indeed it is my experience that a large proportion of complete perineal tears are attributable to such a condition.

As has already been stated, many writers consider the outlet as contracted whenever the transverse diameter falls below 9 or 9.5 cm., but I have placed the limit at 8 cm.; since, in my experience, dystocia does not occur above it unless the antero-posterior diameter is also materially shortened, which was not the case in any pelvis in my series. Moreover, it is impossible to base an opinion as to the outcome of labor merely upon the length of the transverse diameter or upon the extent to which the pubic arch is narrowed; as I have repeatedly been obliged to apply forceps when the distance between the tubera ischii measured 8 cm., have performed pubiotomy while it was 7 cm., and yet seen easy and rapid spontaneous labor occur when it was reduced to 5.5 cm.

This being the case, the question naturally arises as to whether it is possible in any way to predict the probable outcome of labor in funnel pelvis; and the answer is that it may be accomplished with a fair degree of certainty by aid of the conceptions introduced by Klien. He holds that the pelvic outlet is made up of two triangular planes, whose bases meet at the transverse diameter of the inferior strait. Normally the head occupies the entire anterior plane, as well as the anterior portion of the posterior one; but in cases of transverse contraction less and less of the anterior plane can be utilized, while in extreme cases only the posterior plane is available for its passage. In such an event it is evident that the possibility of spontaneous labor will depend not so much upon the length of the antero-posterior diameter of the outlet, as upon the space available posterior to the tubera ischii.

Klien believed that this could be ascertained by determining the distance between the center of a line joining the tubera ischii and the anterior margin of the tip of the sacrum. This he designated as the posterior sagittal diameter of the outlet, and the corresponding distance to the lower margin of the symphysis as the anterior sagittal diameter. In 113 normal pelvises these measurements averaged 9.75 cm. and 6 cm., respectively, while the antero-pos-

terior diameter of the outlet measured 11.5 cm. With these dimensions in mind, he calculated the extent to which the posterior sagittal may vary with increasing degrees of shortening of the transverse diameter, in order to permit spontaneous labor; and stated when the latter varied between 8.5 and 9 cm. that the posterior sagittal could not fall below 7 cm., and that it should measure at least 9 cm. when the transverse diameter was reduced to 8 cm. Below this latter limit, he held that the spontaneous birth of a full term child was out of the question, and contended that, even although unmutilated children had been extracted by means of forceps through a transverse diameter of 7 or 7.5 cm. the results were so unsatisfactory for both mother and child that the operation was contra-indicated.

While I thoroughly endorse Klien's theoretical considerations and consider that they constitute one of the most important contributions to the subject, yet I cannot confirm his statements as to the normal dimensions of the diameters in question, nor the conclusions which he draws as to the prognostic significance of their variation.

Thus, in a series of 105 normal pelves, in which the distance between the tubera ischii was not less than 10 cm I found that the average length of the anterior sagittal, posterior sagittal, and antero-posterior diameters was 5.44, 7.28 and 10.35 cm. respectively — the lowest and highest measurements being 4.5 and 7; 6 and 10; 8 and 16 cm., respectively. These figures, as well as the statement that I have never observed serious dystocia when the transverse diameter measured more than 8 cm. indicate the existence of a serious discrepancy between my observations and those of Klien, which can be explained only by some difference in the technique employed by us in mensuration, although our methods were practically identical.

Generally speaking, in addition to the dimensions of the transverse and sagittal diameters of the outlet, the outcome of labor will depend upon the size of the child, the malleability of its head and the force of the uterine and abdominal contractions. By way of illustrating the effect of variations in these diameters, I may state that I observed spontaneous labor

in one case in which the distance between the tubera ischii measured 5.5 cm., but in which the anterior and posterior sagittal and antero-posterior diameters measured 7.75, 10 and 14 cm. respectively; while I performed pubiotomy for a transverse diameter of 7 cm., when the measurements were 5, 7.5 and 10 cm., and was obliged to resort to Cesarean section with a transverse diameter of 6.5 cm., while the other dimensions were 6.25, 7 and 11 cm. respectively. (See Figs. 6 and 7).

I have carefully analyzed my material in the hope of formulating more general rules concerning the extent to which the transverse and posterior sagittal diameters may vary and yet permit the spontaneous birth of a normal sized child, and have obtained the following results:

Spontaneous labor is unlikely to occur with a transverse diameter of 8 cm. unless the posterior sagittal measures at least 7.5 cm.

Spontaneous labor is unlikely to occur with a transverse diameter of 7 cm. unless the posterior sagittal measures at least 8 cm.

Spontaneous labor is unlikely to occur with a transverse diameter of 6.5 cm. unless the posterior sagittal measures at least 8.5 cm.

Spontaneous labor is unlikely to occur with a transverse diameter of 5.5 cm. unless the posterior sagittal measures at least 10 cm.

In other words, when the transverse diameter is 8 cm. spontaneous labor cannot be expected unless the posterior sagittal diameter possesses the average normal length of 7.5 cm., while the latter must become materially lengthened for every centimeter the former falls below 8 cm. It should, however, be remembered that these figures are only approximately correct and too much should not be expected from them; as is shown by the fact that I have been obliged upon several occasions to apply forceps when the transverse and posterior sagittal diameters measured 8 and 8.5 cm. respectively, and yet, on the other hand, have occasionally seen spontaneous labor occur when the latter diameter did not exceed 7.5 cm.

When one comes to consider the actual course of labor in our series of cases, it is necessary to differentiate sharply between that occurring in the typical and generally contracted types of funnel pelves, for the reason that in the

former the dystocia is entirely dependent upon the outlet contraction, while in the latter the general small size of the entire pelvic canal is the dominant factor, so that it usually happens if the head becomes sufficiently moulded to pass through the upper part of the contracted pelvis, it will emerge from the outlet without great difficulty.

For this reason, I shall first take up the consideration of the course of labor in the typical funnel pelvis. Of the 83 patients in this category, 14 either aborted or left the hospital before delivery, leaving only 69 available for study. Of these 41 were white and 28 colored women, with 16 and 3 operative deliveries respectively, an incidence of 39 and 11 per cent, as is shown by the accompanying table:

A. WHITE

Tubera	Total Cases	Operations	Due to Pelvis	Other Causes
8 cm.....	25	9	5	4
7.5 cm.....	10	3	2	1
7 cm.....	5	4	3	1
5.5 cm.....	..	..	..	..
	41	16	10	6

B. BLACK

Tubera	Total Cases	Operations	Due to Pelvis	Other Causes
8 cm.....	16	2	1	1
7.5 cm.....	10	1	..	1
7 cm.....	1	0	..	..
5.5 cm.....	1	0	..	..
	28	3	1	2

Upon analyzing these figures more carefully, it is found that the outlet contraction, per se, necessitated operative interference in 10 white and 1 colored woman, an incidence of 24.4 and 3.6 per cent respectively, while the remaining operations were performed upon indications not connected with the pelvic deformity. This difference, which at first glance appears somewhat surprising, is readily explained when one recalls the fact that the infants are generally smaller and have more malleable heads in the colored race. This general rule is also borne out in this group of cases, in which two-thirds of the white and only one quarter of the colored children weighed 3,250 grams or more.

In the white women, with typical funnel pelvis there were 9 low forceps operations

(cases 2531, 2576, 2737, 2805, 2860, 2861, 3000, 3314 and 3459), and one pubiotomy (case 3175); while in the colored women the single operation was the application of low forceps (case 2892). In the low forceps cases, the distance between the tubera ischii measured 8, 7.5 and 7 cm., in 7, 2 and 1 instances respectively, and the operation was undertaken only after the head had been visible at the vulva for a period varying from one and a half to three hours, and showed no tendency to advance in spite of strong, expulsive efforts on the part of the mother. In the pubiotomy case, labor progressed rapidly and normally until the head passed below the ischial spines, where it remained without advancing for four hours, notwithstanding the fact that the labor pains were most satisfactory. In this instance the distance between the tubera ischii was 7 cm., while the anterior and posterior sagittal and antero-posterior diameters measured 6, 6 and 10 cm. respectively. The forceps delivery following the section of the pubic bone was quite difficult, and the child, which weighed 3,275 grains, bore upon its forehead a vertical pressure mark, indicating where it had been dragged over the tip of the sacrum.

The perineum was torn in 36 of the 69 cases, an incidence of 52 per cent. In itself this figure is not particularly high, but the effect of the outlet contraction becomes evident upon analyzing the extent of the laceration, which was of the first, second and third degree in 21, 13 and 2 cases respectively. I am inclined to attribute the two complete tears, as well as a large part of the deep second degree lacerations, to the undue distension to which the perineum was subjected, in consequence of the mechanism of expulsion dependent upon the pelvic contraction.

Turning to the consideration of the effect of the generally contracted funnel pelvis upon the course of labor, we find that 29 of the 34 cases in this category were delivered at term — 6 white and 23 colored women. Operative interference was necessary in four of the former and six of the latter, but was due to the pelvic deformity in only two cases in each group.

In both of the white women (cases 2533 and 3377) delivery was effected by pubiotomy and the distance between the tubera ischii was 7 cm.

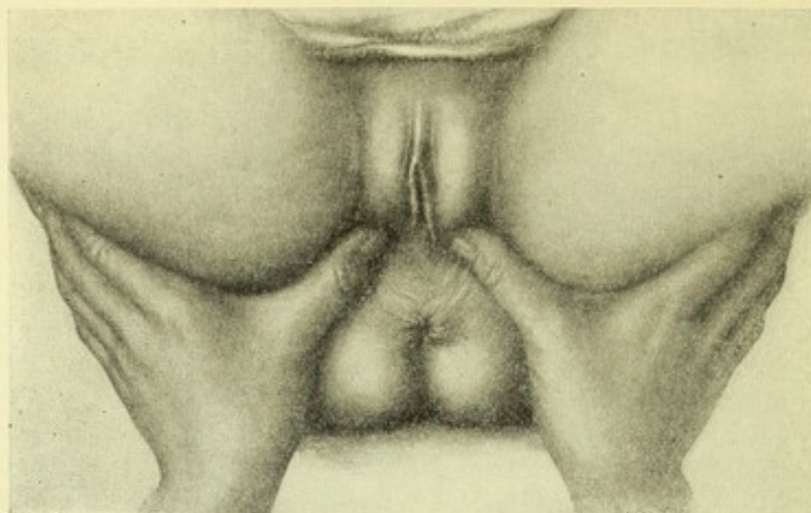


Fig. 1. Palpation of the pubic arch.

In one case the child presented by the breech and in the other by the vertex, and in both instances the operation was undertaken with the presenting part at the superior strait. It might be objected that in these cases the interference was necessitated by the general contraction rather than by the abnormality of the outlet, and I am not prepared to deny such a possibility in the first case, particularly as I

have records only of the length of the transverse diameter. In the second case, on the other hand, the outlet contraction was so marked that it would have given rise to serious dystocia had the head been able to descend to that inferior strait, as the anterior and posterior sagittal and antero-posterior diameters measured 5, 6.5 and 9.5 cm. respectively, while the child weighed 3,820 grams. Moreover, in

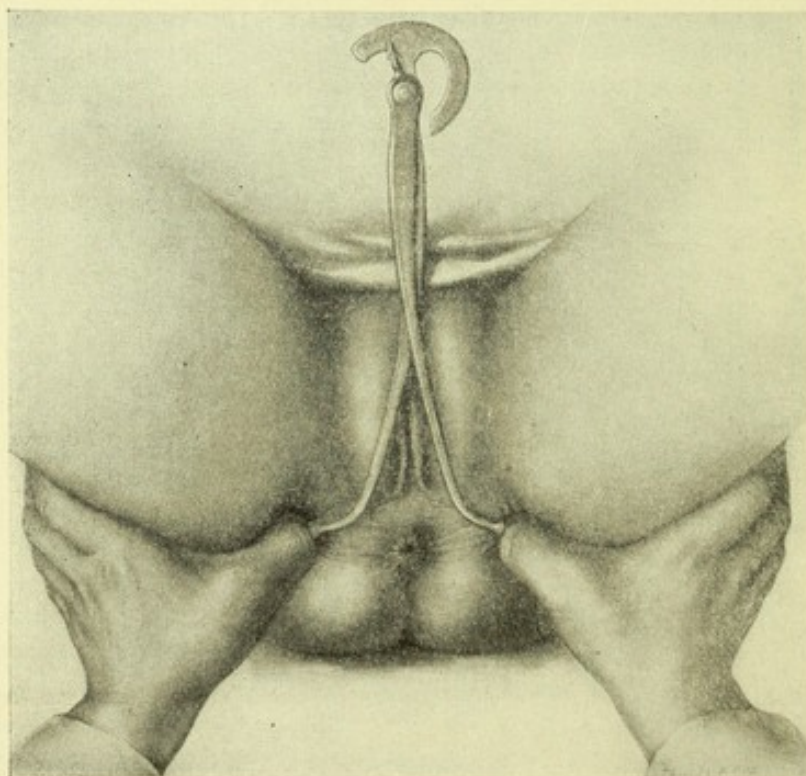


Fig. 2. Mensuration of the transverse diameter by Frankenhauser's method.

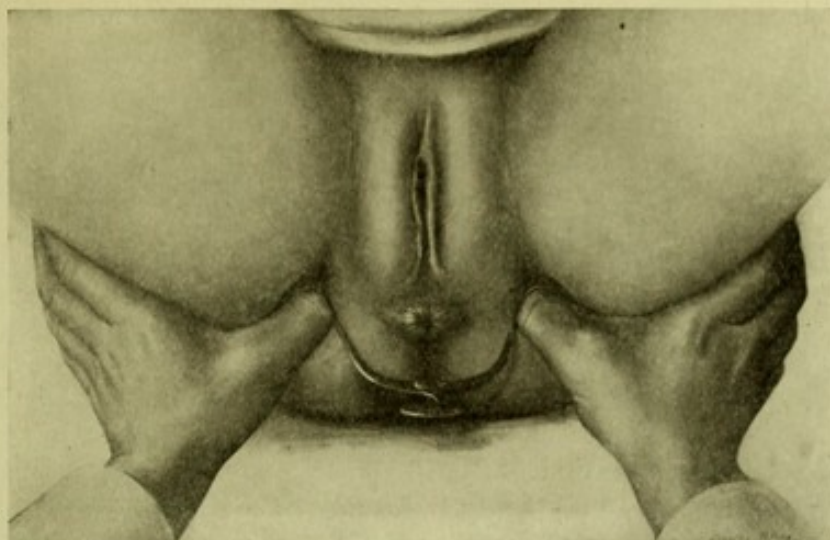


Fig. 3. Mensuration of transverse diameter with Williams' pelvimeter.

her previous labor, which had been conducted by a thoroughly competent man, a most difficult mid-forceps operation terminated in the delivery of a child with a fractured skull.

In one of the colored women in which the outlet contraction necessitated interference (case 2502), version was performed on account of prolapse of the cord, and the after-coming head had to be perforated in order to permit its extraction through an outlet whose transverse

diameter measured 7.75 cm. In the other patient (case 2891) the distance between the tubera ischii was 8 cm., and the anterior and posterior sagittal diameters measured 6, 6.5 and 9 cm. respectively, and delivery was effected by low forceps.

The perineum was torn in 11 cases — 38 per cent; the lacerations being of the first, second and third degrees in 4, 5 and 2 instances respectively. Here, just as in the typical fun-

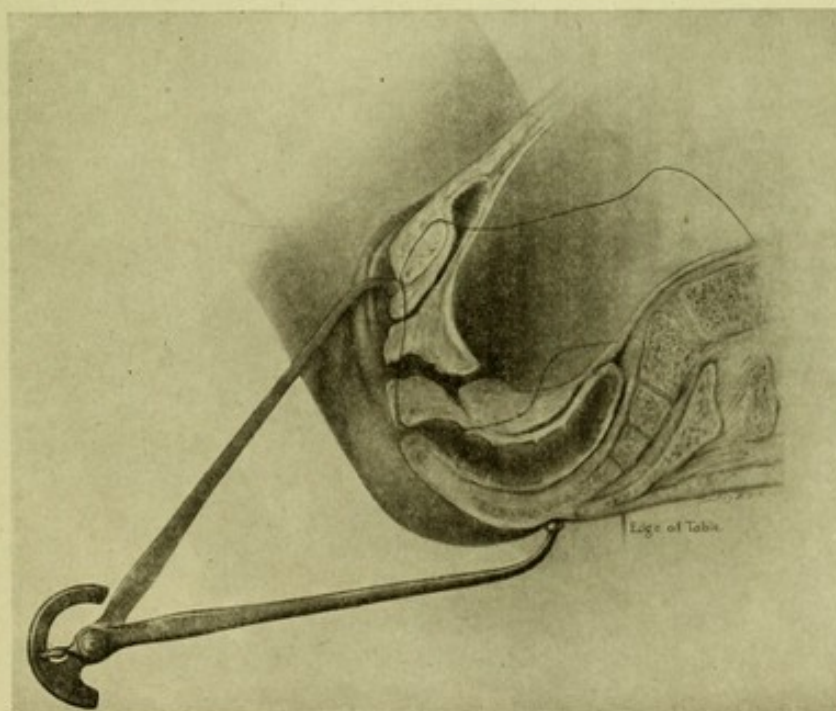


Fig. 4. Diagram showing mensuration of antero-posterior diameter by Williams' modification of Breisky's method.

nel group, the complete tears and a large part of the deep second-degree lacerations must be attributed to the outlet contraction.

In this group of cases the less frequent necessity for operative interference, as well as the slighter incidence of perineal injury, is attributable to the smaller size of the children. This applies not only to the blacks, as in the typical funnel cases, but to the whites as well, as only 33 per cent of the white and 22 per cent of the colored children weighed 3,250 grams or more, as compared with 66 and 25 per cent in the former group. To my mind this can be interpreted only as a manifestation of the effect of the imperfect general development of the white mothers upon the size of the child.

Diagnosis. In view of the comparatively frequent occurrence of contractions of the pelvic outlet and their serious effect upon the course of labor, it is manifest that it is the duty of the obstetrician to keep such a possibility constantly in mind, and to make the investigation of its condition a routine part of the

preliminary examination of every pregnant woman.

An approximate idea of the distance between the tubera ischii can readily be obtained by palpation of the pubic arch as suggested by Sellheim. For this purpose the patient is brought to the edge of the bed with her legs flexed, the buttocks are then grasped with each hand in such a manner that the tissues covering the ischial tuberosities lie upon the web of the hand, while the course of the ischio-pubic rami is outlined by the inner surface of the thumbs, the remaining fingers of either hand encircling the corresponding buttocks (Fig. 1). In this way the shape of the pubic arch, as well as the distance between the tubera ischii can readily be approximated so that it is possible to determine whether the former possesses a normal curvature, or is slightly or markedly narrowed, and with a slight amount of practice one can describe it as "wide," "fairly wide," or "narrow." In private practice accurate mensuration is neces-

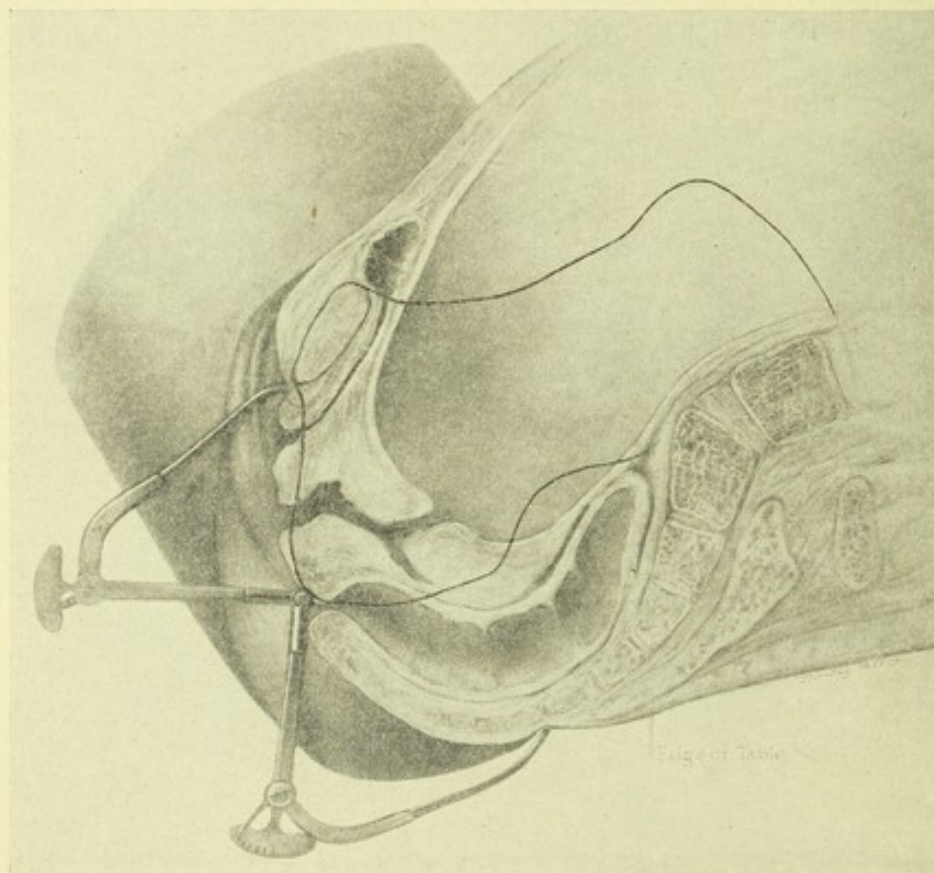


Fig. 5. Diagram showing mensuration of anterior and posterior sagittal diameters of Williams' modification of Klein's pelvimeter.

sary only in the last-named condition; but in hospital work it is advisable to make the accurate determination of the length of the various diameters an integral part of the routine pelvimetry.

Various methods have been suggested for determining the length of the transverse diameter. Thus, Breisky in 1870 palpated the most widely distant portions of the inner surface of the tubera ischii, and, after determining the distance between them by means of a pelvimeter, made a deduction of one half to two centimeters according to the thickness of the overlying soft parts. He admitted the theoretical objections to such a procedure, but nevertheless claimed that it gave fairly accurate results. Schroeder suggested palpating the tubera ischii, marking their outlines with a dermatographic pencil, and then measuring the greatest distance between the lines. In my experience, however, this method is even less accurate than that of Breisky, for the reason that the position of the lines must change to some extent as soon as the pressure of the palpating fingers is relieved.

Frankenhäuser in 1879 believed that the disadvantages of both these methods could be overcome if after palpating the most widely distant portions of the tubera, the thumb nails were placed in such a position as to represent the continuation of the inner surface of the ischial bones, and the distance between them measured directly with a pelvimeter (Fig. 2).

This method was employed in our series of cases and has apparently given fairly accurate results. Unfortunately, it is not available for the ordinary practitioner as it requires the services of an assistant to manipulate the pelvimeter. In order to overcome this objection I have advised a very light pelvimeter with broad, flat ends, which can be attached to the thumbs by means of adjustable rings (Fig. 3). After palpating the tubera by Frankenhäuser's method, the flat ends of the instrument are brought into apposition with the thumb nails, and the distance between them read directly from the scale. As the results obtained by its means are identical with those furnished by the original method of Frankenhäuser, I believe that the device may serve a useful purpose.

The length of the antero-posterior diameter of the outlet is obtained, as recommended by Breisky, by measuring the distance between the lower margin of the symphysis and the posterior surface of the tip of the sacrum, and afterwards deducting one or one and a half centimeters according to the thickness of the intervening bone. While making this measurement Breisky placed the patient upon her side, but I have found that equally satisfactory results may be obtained, with far less trouble, by having the patient upon her back with the buttocks protruding a short distance beyond the edge of the table and using a pelvimeter whose blades are only slightly curved (Fig. 4).

Whenever the transverse diameter measures 8 cm. or less, or the antero-posterior 9 cm., a diagnosis of funnel pelvis should be made, while the determination of the special type will depend upon the other pelvic measurements. The typical, or generally contracted funnel pelvis being diagnosed according as the usual external measurements and the diagonal conjugate are normal or shortened. Unfortunately, as has already been indicated, such a diagnosis gives no information as to the probable outcome of labor, so that whenever the transverse or antero-posterior diameters are shortened it becomes necessary to determine the length of the anterior and posterior sagittal diameters.

This can be accomplished without great difficulty by means of the pelvimeter invented by Klien, or by a modification which I have devised. The latter consists of a longer curved and a shorter straight blade and a horizontal bar. The latter is 5 cm. long and is so shaped that it can be conveniently held in position by two fingers of an assistant. To its center, what would ordinarily be the free end of the shorter blade is attached in such a way as to permit free rotation in a vertical direction. Moreover, the lower part of this blade is made up of two portions, which are so articulated with one another as to permit the upper to rotate freely in a lateral sense upon the lower portion, which in turn can rotate vertically, but not laterally, upon the horizontal bar. As a result of this mechanism, it follows that the tip of the curved blade of

the pelvimeter may be moved in any direction, while that of the straight one remains in relation with the axis of the horizontal bar (Fig. 5).

When it is desired to use the instrument the patient lies upon her back with the leg flexed and the buttocks protruding sufficiently far beyond the edge of the table to render the lower end of the sacrum readily accessible. By palpation the operator then determines the location of the transverse diameter, upon which the assistant places the horizontal bar of the pelvimeter and maintains it in position with two fingers, at the same time making sufficient pressure to keep its axis in accurate correspondence with the transverse diameter. Naturally the amount of pressure will vary considerably according to the thickness and elasticity of the perineal region. In thin women with a flabby pelvic floor practically no force is required, while in stout women with a thick and resistant perineum deep and firm pressure will be necessary. After the horizontal bar has been placed in position the operator palpates the lower portion of the sacrum, and after having determined the location of its tip, and depresses the pelvimeter so as to bring the tip of the curved blade in close relation with its posterior surface. The distance is then read off upon the scale, and the measurement obtained represents the length of the posterior sagittal diameter, plus the thickness of the lower part of the last sacral vertebra and the skin covering it. A deduction of one centimeter is usually sufficient to give the actual length of the diameter, although when the bone is unusually thick it may be necessary to deduct $1\frac{1}{2}$ cm. Moreover, in the exceptional cases in which the coccyx is ankylosed, the measurement must be made to the tip of the coccyx, instead of the tip of the sacrum.

In order to measure the anterior sagittal diameter, the entire pelvimeter is rotated about the horizontal bar so as to bring the curved blade anteriorly, after which the lower margin of the symphysis pubis is palpated, the tip of the curved blade brought into relation with it, and the measurement read off upon the scale of the pelvimeter. In this case the layer of tissue covering the lower margin of the symphysis is so thin that no deduction is neces-

sary. It will be remembered that my investigations show that the normal length of the anterior and posterior sagittal diameters average 5.5 to 6, and 7.5 cm. respectively.

From the description just given it will be seen that the patient may remain in the same position for the palpation of the pubic arch, the determination of the transverse diameter and the mensuration of the anterior and posterior sagittal diameters. Accordingly it is my practice to make the usual pelvic examination, to determine the mobility of the coccyx and to measure the length of the diagonal conjugate with the patient in the usual obstetrical position, and afterwards to draw her down upon the table to such an extent that the buttocks project sufficiently beyond the edge to render the lower portion of the sacrum easily palpable. Then the pubic arch is palpated, the transverse diameter measured, and while the thumbs are still in position, the outlet pelvimeter is adjusted and the length of the anterior and posterior sagittal diameters determined, while the mensuration of the antero-posterior diameter of the outlet concludes the examination.

Prognosis. Upon reading the statement in most text-books one would be inclined to believe that the usual types of funnel pelvis rarely gives rise to serious dystocia, and consequently have but little influence upon the prognosis for either the mother or child. On the other hand, many of the monographs upon the subject convey a very different impression, and to judge from several of them one would be forced to conclude that the condition is fraught with very serious danger.

Thus, Mansbach, in a dissertation which appeared in 1891, collected from the literature the histories of 35 labors complicated by funnel pelvis and estimated that the maternal and foetal mortality was 34 and 60 per cent respectively. Likewise, Walther, after studying the results in 117 cases described in the literature, stated that labor ended spontaneously in but 22 instances; 13.6 per cent of the mothers were lost, and that 25.7 per cent of the children were born dead, not including an additional 4.5 per cent which died within a few days after delivery as the result of fracture of the skull.

Such an appalling mortality is susceptible of two explanations. In the first place, par-

ticularly in the earlier literature, only such cases were described as had given rise to serious dystocia; while in the second many of the cases had occurred in pre-antiseptic times and therefore were much more likely to succumb to infection than at present. The correctness of this supposition is borne out by Walther's personal experience, as there were no foetal or maternal deaths in the seven cases which he observed.

Turning to my own experience, 122 examples of outlet contraction were observed in 1,200 consecutive pregnant women, which were classified as follows: 83 typical, 34 generally contracted, and 5 irregular funnel pelvis. One hundred and three of the patients were delivered at or near full term without a death, while 7 of the children were lost. Five of them were born in a macerated condition and consequently their death could not be attributed to the condition of the pelvis; while one of the other two children perished during version and extraction from an transverse presentation, and the other from craniotomy upon the after-coming head following an attempted, rapid extraction, necessitated by prolapse of the cord.

Our results might be construed as indicating that the condition is practically devoid of danger, but closer study of our material shows that such is not the case, as a large number of children would apparently have been lost had the condition not been recognized and appropriate treatment instituted. Moreover I have indicated that the funnel pelvis is a potent factor in the production of complete perineal tears, a frequent cause of prolonged arrest of the head of the vulva, and occasionally may give rise to most serious dystocia. In the 69 full-term labors complicated by typical funnel pelvis, 9 low forceps operations and one pubiotomy were rendered necessary by the contraction of the outlet, while in the 29 cases complicated by generally contracted funnel pelvis, two pubiotomies, one low forceps operation and one craniotomy upon the after-coming head were indicated. Moreover the histories of the multiparous women showed that in previous labors many children had been born dead, as the result of fracture of the skull or following craniotomy.

Unfortunately, in the individual case, it is impossible to prognosticate the outcome of labor merely from the size of the antero-posterior or transverse diameters of the outlet, and it therefore becomes essential to take into consideration the length of the posterior sagittal diameter. On page 627, I have given the minimum length which it must present with varying degrees of shortening of the transverse diameter in order to render spontaneous labor possible. Accordingly it is only necessary to repeat in this place that a reduction to 8 cm. in the distance between the tubera ischii should be regarded as a danger signal, and as an urgent indication for the most thorough study of the pelvis before attempting any operative procedure, as neglect in this regard may convert what promises to be an easy low forceps delivery into a most difficult operation, which can be completed only by the sacrifice of the child and occasionally of the mother as well (Figs. 6 and 7).

Generally speaking, it may be said that the prognosis is somewhat more favorably in black than in white women, owing to the smaller size and greater malleability of the heads of colored children. Likewise it is somewhat more serious in the generally contracted than in the typical type of funnel pelvis, for the reason that in the former dystocia may occur in all portions of the pelvic canal, while it is limited to the outlet in the latter. At the same time the prognostic import in the former condition may be less serious than the pelvic measurements would appear to indicate, as the imperfect general development which has resulted in the pelvic deformity may likewise manifest itself in a somewhat smaller-sized child. It should, however, be remembered that such considerations are merely of a general character, and while they hold good in a large series of cases, may nevertheless lead to erroneous conclusions in the individual woman.

Treatment. As has already been indicated, a reduction in the length of the transverse diameter to 8 cm. should be regarded as a danger signal, although the actual outcome of the case can be predicted only after taking consideration the size and malleability of the child's head, and more particularly the length of the posterior sagittal diameter of the outlet.

The essential factor in the treatment of labor complicated by outlet contraction, just as in all other varieties of pelvic deformity, is exact knowledge of the extent of the abnormality prior to the onset of labor. Consequently, preliminary pelvimetry is the necessary prerequisite to intelligent treatment, as without the information obtained by its means the condition of the outlet is usually overlooked until serious difficulty, in the performance of what at first sight promises to be an almost trifling operation, leads to a careful examination and the consequent recognition of the cause of the dystocia.

Generally speaking, it may be said that the case should be treated expectantly whenever the shortening of the transverse diameter is compensated for by a corresponding lengthening of the posterior sagittal diameter, as indicated on page 627. In typical funnel pelvis, under such circumstances, the head will descend to the pelvic floor without difficulty, and, after more or less delay at the outlet, will usually be born spontaneously, although frequently at the expense of a deep or even a complete perineal tear. Occasionally the delivery may even be precipitate in character, as was strikingly illustrated in one of my cases

in which the transverse and posterior sagittal diameters measured 5.5 and 10 cm. respectively, and yet the second stage was so rapid that a normal-sized child was born before the assistant on duty could reach the ward.

When the perineum is rigid, or the abdominal contractions are deficient in force, the head may soon appear at the vulva, but remain there for an indefinite period until delivery is effected by low forceps. When operative interference becomes necessary in such cases it is essential that the operator bear in mind the peculiar conformation of the pubic arch, and make traction directly outward, or even downward and outward, instead of upward, as in low forceps deliveries, through a normal outlet. If, however, the head does not advance after a few vigorous tractions it should be assumed that it is unusually large or hard, or else that an error has been made in the measurement of the various diameters of the outlet.

Under such conditions the attempt at forceps delivery should be discontinued as persistence may lead to serious consequences—usually fracture of the child's skull, or occasionally, as in one of my consultation cases, to rupture of the symphysis pubis. If the patient is in good condition pubiotomy should be performed; while in exceptional cases in which the patient has been subjected to prolonged manipulation, or presents signs of infection, craniotomy may be the operation of choice, as the results following pubiotomy under such circumstances are so questionable as to make its employment inadvisable.

On the other hand, if the transverse and posterior sagittal diameters are so shortened as to render spontaneous or forceps delivery out of the question, Cæsarean section should be performed at an appointed time at the end of the pregnancy, or at the very onset of labor. Otherwise, in typical funnel pelvis, pubiotomy should be resorted to after the head has become arrested at the pelvic floor, while in the generally contracted type one should not always wait for such an occurrence, as the presenting part may become arrested at any part of the birth canal.

Whenever the contraction is extreme I consider that early elective Cæsarean section is

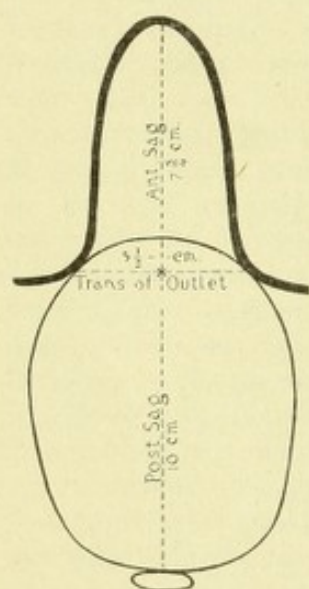


Fig. 6.

Fig. 6. Diagram of pelvic outlet, through which spontaneous labor occurred notwithstanding a transverse diameter of 5½ cm.

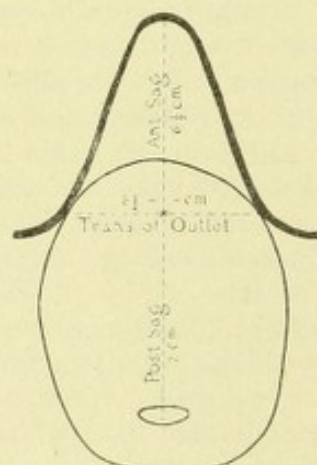


Fig. 7.

Fig. 7. Diagram of pelvic outlet necessitating Cæsarean section; transverse diameter of 6½ cm.

the operation of choice, but contend that it is inferior to pubiotomy in patients who have been long in labor, or in whom the presenting part has descended to the pelvic floor. This conclusion is based partly upon my own experience, but more particularly upon the convincing demonstration by Reynolds that the mortality of the former operation increases directly, with the duration of labor. Both of us hold that when performed at the end of pregnancy or very early in labor, its mortality is very slight, and no greater, and possibly less than that of pubiotomy; while at the same time there is no comparison between the convalescence of the patient after the two operations, not to speak of the fact that she had been spared the strain of labor. On the other hand, my own experience has shown that the mortality of Cæsarean section, performed after several hours of second-stage pains, is many times greater than that of pubiotomy, and that the slightly more comfortable convalescence in no way compensates for the added danger of death.

Emminghaus has performed Cæsarean section successfully, under these conditions, upon a patient in whom the transverse and antero-posterior diameters of the outlet measured 5 and 7 cm. respectively. I did not have occasion to resort to the operation in this series of cases, but performed it with most satisfactory results upon a patient with a kyphotic pelvis, in which the transverse and posterior sagittal diameters measured 6.5 and 6 cm. respectively.

In the present series of cases pubiotomy was performed upon three patients. In one with a typical funnel pelvis it was resorted to after the head had become arrested just below the ischial spines, and showed no tendency to advance in spite of strong pains; while in the other two patients I had to deal with the generally contracted type of funnel pelvis, and in both the operation was done before the presenting part had descended. In the first case the child presented by the breech and a most satisfactory result was obtained. Moreover it is interesting to note that the operation was followed by a permanent increase of one centimeter in the length of the transverse diameter, with the result that a second labor terminated easily and spontaneously. In the other case the patient came to me with a history of a diffi-

cult mid-forceps delivery resulting in fracture of the child's skull. In her second labor I performed pubiotomy while the head lay at the superior strait in a posterior parietal presentation. In this instance the pelvic measurements were such that the possibility of spontaneous delivery was entertained, but, notwithstanding the fact that the pubiotomy was most successful for both mother and child, I have regretted that I did not do Cæsarean section at the onset of labor and thus have saved the patient a prolonged labor.

In all of these cases the enlargement of the outlet following the pubic section was quite sufficient to permit easy extraction of the head by means of forceps, and our results amply confirm the prediction of Van de Velde that pubiotomy should offer an almost ideal method of overcoming this variety of dystocia.

Schauta, Klien, Sonntag and others have recommended the induction of premature labor in moderate degrees of outlet contraction. In my experience the operation is rarely justified — primarily on account of the difficulty of arriving at definite indications for its performance, with the resulting tendency to unnecessary interference; but more particularly on account of the decreased vitality of the premature children. For this reason the operation was not performed in this series of cases, although it gave satisfactory results in one of my private patients, whose previous labor had been ended by one of the extremely difficult low forceps operations which caused me to undertake this study.

In rare instances the outlet contraction may be limited entirely to the antero-posterior diameter, and when its length falls much below 9 cm. serious dystocia may be expected. With the exception of the occasional cases in which the shortening is due to ankylosis of the coccyx with the tip of the sacrum, pronounced uncomplicated antero-posterior shortening is rarely observed and was not noted in any of my patients. On the other hand, it is not infrequently associated with transverse contraction, as in the cases of Emminghaus, myself and Bauer, in which it was reduced to 7, 8 and 9 cm. respectively. In the former event the treatment to be instituted will depend solely upon the length of the antero-posterior

diameter, while in the latter it will be dependent upon the ratio between the transverse and posterior sagittal diameters, as the pubic arch is normal in the first and narrowed in the second case. When the antero-posterior shortening is due to ankylosis of the coccyx, serious difficulty should not be anticipated unless the distance from the tip of the sacrum to the lower margin of the symphysis is likewise materially diminished, as in most cases the dystocia can be overcome by dislocating the coccyx.

The rules which I have given for the treatment of labor complicated by funnel pelvis are based upon my own personal observations; but as they yet differ materially from those laid down by Schauta and Klien, it is manifest that radical revision of their teachings is necessary.

The former stated that Cæsarean section was indicated in primiparæ, when in suitable surroundings, whenever the transverse diameter falls below 8 cm., yet my experience indicates that such teaching is far too extreme. This is clearly shown by the fact that the distance between the tubera ischii was reduced below that limit in 28 of the 69 typical funnel pelvis cases at term, and measured 7.5, 7 and 5.5 cm. in 20, 7 and 1 instances, respectively, and yet operative interference was necessary in only five of them, — one pubiotomy and 4 low forceps operations. Moreover, the fact that there were no maternal and only 2 foetal deaths attributable to the pelvic deformity in 103 labors, included in our entire series, clearly demonstrates that neither the mothers or children suffered. Such results, therefore, justify the conclusion that the indications laid down by Schauta were far too extreme and would be a dangerous guide in practice. Moreover, the investigations of Klien and myself have clearly demonstrated that neither the shape of the pubic arch nor the distance between the tubera ischii affords any definite clue as to the outcome of labor, and that their only value, from a prognostic point of view, is in serving as a danger signal, which imperatively demands thorough investigation of all dimensions of the outlet, and especially of the relation between the length of the transverse and posterior sagittal diameters.

Moreover, while I thoroughly endorse the

theoretical considerations advanced by Klien, I cannot accept the practical deductions which he draws from them for the reason that they are contrary to the results of my own experience as laid down in this paper. For example, he contends that spontaneous labor cannot occur with a distance of 8.5 to 9 cm. between the tubera ischii unless the posterior sagittal diameter measures 7 cm.; while the extraction of a normal-sized head is absolutely out of the question should the latter be reduced to 6 cm. This is diametrically opposed to my own observations, as I have not encountered serious dystocia when the transverse diameter exceeded 8 cm. no matter what might be the length of the posterior sagittal diameter.

Again, he states, "Since with a distance of 8 cm. between the tubera ischii the full term head must utilize for its exit almost the entire available space posterior to the transverse diameter, it must follow that its diminution below 8 cm. indicates that the space is absolutely too small to permit the passage of an unutilized full-term head. I believe that we are justified in promulgating such a law, even though cases are on record in which unutilized full-term children have been extracted by means of forceps through a transverse diameter of 7 or 7.5 cm. In these cases, however, the results for both mother and child are so discouraging that its use should be held to be contra-indicated."

I regret that I cannot accept these conclusions, but they are absolutely opposed by my own experience. This is clearly demonstrated by the fact that the distance between the tubera ischii was reduced to 7.5 cm., or less in 28 of the typical and 9 of the generally contracted funnel-shaped pelvis in our series, and yet operative interference was necessary in only 6 and 2 cases respectively. Moreover, in one instance rapid spontaneous delivery occurred through an outlet, whose transverse diameter was shown by repeated examination to measure only 5.5 cm.

As has already been indicated, I am at present unable to offer a satisfactory explanation for such a discrepancy, and can only express the hope that future investigations, which may be stimulated by this report, may reveal its source.

Conclusions. 1. Funnel-shaped pelvis frequently give rise to more or less serious dystocia, are an important factor in the causation of deep perineal tears, and occasionally convert what promise to be easy low forceps deliveries into most difficult and dangerous operations.

2. Typical funnel pelvis, in which the usual external measurements as well as those of the superior strait are normal, while the distance between the ischial tuberosities measures 8 cm., or less, were observed in 6.92 per cent of 1,200 consecutive pregnant women, and occurred with equal frequency in both the white and black race.

3. Generally contracted funnel pelvis, in which shortening of the usual external measurements as well as of the diameters of the superior strait is associated with a distance of 8 cm. or less between the ischial tuberosities, occurred in 1.19 per cent of the white and 4.91 per cent of the colored women, being 4 times more frequent in the latter.

4. Typical funnel pelvis constituted 55.7 per cent of all cases of pelvic deformity in white, as compared with 17.8 per cent in colored women, and therefore are of especial practical importance in the former.

5. While a shortening of the transverse diameter of the outlet to 8 cm., or less, indicates the existence of a funnel pelvis, it should be regarded merely as a danger signal; as the possibility of dystocia will depend upon the relation between its length and that of the posterior sagittal diameter. The latter is the distance from the center of the former to the tip of the sacrum, and must increase in length as the transverse diameter becomes shortened.

6. Typical funnel pelvis are apparently due to the presence of 6 vertebræ in the sacrum — so called high assimilation, which so changes the relations at the sacro-iliac joints as to permit the lower portions of the innominate bones to approach one another. In the generally contracted type the outlet contraction probably represents only an exaggeration of the faulty development which characterizes the entire pelvis.

7. In view of the frequent occurrence of funnel pelvis, palpation of the pubic arch should form an integral part of the examination of every pregnant woman. Whenever it

appears to be narrowed, the distance between the tubera ischii should be measured, and when it is 8 cm., or less, the length of the anterior and posterior sagittal diameters should also be determined. Only by so doing can one avoid being occasionally placed in the unenviable predicament of being obliged to resort to a serious obstetrical operation after having assured the patient that her pelvis was normal.

8. Fortunately the great majority of labors complicated by funnel pelvis end spontaneously. In the lesser degrees of contraction low forceps may give satisfactory results, while in the more pronounced cases the operation of choice is Cæsarean section at the end of pregnancy, or pubiotomy after the head has reached the pelvic floor.

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