

A STATISTICAL STUDY OF THE FREQUENCY OF FUNNEL Pelves AND THE DESCRIPTION OF A NEW OUTLET PELVIMETER.\*

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(With illustrations.)

ABNORMAL female pelves may be divided into two groups; those in which the contraction occurs principally or entirely at the pelvic inlet and those in which the contraction occurs principally or entirely at the pelvic outlet. Concerning the former we possess a voluminous literature and the identity and classification of this group are well established. In the latter group, however, almost the reverse may be said to obtain. The literature is scanty in comparison, and in fact until very recently the so-called "funnel pelvic" was but briefly mentioned as a distinct entity.

When, however, we face the fact that the most frequent type of abnormal pelvis occurring in white women is a contraction of the pelvic outlet and that the resulting operative frequency is even greater than in the usual types of contracted pelves, we are compelled to acknowledge that this group deserves serious consideration.

The diagnosis of outlet contractions depends upon the external palpation of certain bony points and the mensuration of certain diameters taken between these points. These landmarks are namely, the points corresponding to the most widely distant portions of the inner lips of the tubera ischii, the lower margin of the symphysis pubis and the posterior surface of the tip of the sacrum. The method used in determining these measurements will be described later. It may be well, however, at this time to discuss the terminology employed in connection with outlet measurements.

The greatest distance between the inner lips of the tubera ischii is designated as the transverse diameter of the outlet. The shortest distance between the lower margin of the symphysis and the anterior surface of the tip of the sacrum is called the anteroposterior diameter. From the center of the transverse diameter extending forward to the lower margin of the symphysis a line may be drawn which is known as the anterior sagittal diameter. Likewise from the same point on the transverse diameter a line may

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be extended posteriorly to the anterior and lowermost point of the tip of the sacrum. This is spoken of as the posterior sagittal diameter. When one recalls these points on the bony pelvis it will be seen that the anteroposterior diameter lies in a different plane from the others and does not represent the sum of the anterior and posterior sagittal diameters. The anteroposterior diameter may be considered as the base of a triangle whose limbs are formed by the anterior and posterior sagittal diameters.

At the Johns Hopkins Hospital whenever the transverse diameter is 8 cm. or less the outlet is designated as contracted. This limit is set for two reasons; serious dystocia does not occur when it is exceeded and furthermore if the limit were set at a higher figure the incidence of funnel pelvis would be so great as to become ridiculous.

For practical purposes contractions of the pelvic outlet may be divided into three groups: the typical funnel, the generally contracted funnel, and the complicated funnel. In the first group the contraction is limited to the pelvic outlet while the superior strait remains normal. In the generally contracted variety there is associated with the narrowing of the inferior strait a diminution in the size of the entire pelvis. In other words, such a pelvis may be regarded as a generally contracted pelvis to which is superadded an outlet contraction. The last group, the complicated funnel pelvis, refers to a small number of flat or rachitic pelvises to which is added a contraction of the outlet.

In regard to the etiology of the typical funnel pelvis, probably the best explanation is found in the study of the so-called assimilation pelvis. In this condition we have the last lumbar vertebra assimilated to the sacrum which leads to the presence of an extra vertebra making six divisions to the sacrum. As a result of this abnormality, the innominate bones are forced to rotate to a greater or less degree about a horizontal axis. This causes the distance between the tubera ischii to be shortened and as a consequence the pubic arch is narrowed.

That this process may be considered as the etiologic factor in the formation of the majority of typical funnel pelvises was pointed out by Breus and Kolisko in 1900, Bayer in 1903, Schmitz in 1906 and Williams in 1909. The last-named author was able in 10 per cent. of his cases actually to count six sacral vertebra by vaginal examination without anesthesia.

Another fact pointing to lumbosacral assimilation as the etiologic factor is found in the consideration of the incidence of funnel pelvises in white and black women. When we consider that typical funnel



pelves occur in each race with equal frequency and that in the colored race contracted pelves occur four or five times as frequently as in the white, it will be seen that some etiologic factor other than that concerned in the usual contractions must be considered.

From a practical standpoint, the first important communication in this country in regard to the funnel pelvis was made in 1909 by Williams. At that time the findings in the pelvic measurement of 1200 women delivered at full term at the Johns Hopkins Hospital well emphasized the value of outlet pelvimetry as a routine procedure. Two years later the same author reported the findings in 1015 additional women making a total of 2215 pelves. In the present paper it becomes my pleasure to add to these the findings in 1785 additional women, making a total of 4000 women delivered at full term in which the pelvic outlet had been measured. This number of cases is drawn from a series of 4957 consecutive patients (cases 2000-6957). The results of the findings in the entire series may be tabulated as follows:

TABLE I.—SHOWING FREQUENCY OF SEVERAL TYPES OF ABNORMAL PELVES IN 4000 CONSECUTIVE FULL-TERM LABORS.

White (2459 patients)	Total number	Incidence percentage	Percentage of contracted pelves	Spon-taneous	Opera-tive
Funnel.....	122	4.96	36.97	79	43
Gen. contracted.....	112	4.56	33.94	86	26
G. C. funnel.....	18	0.73	5.45	12	6
Simple flat.....	52	2.11	15.75	31	21
G. C. rachitic.....	11	0.44	3.36	5	6
Atypical.....	7	0.28	2.12	2	5
Flat rachitic.....	5	0.20	1.51	2	3
Atypical funnel.....	3	0.12	0.90	1	2
	330	13.40	100.0	218	112

Black (1541 patients)	Total number	Incidence percentage	Percentage of contracted pelves	Spon-taneous	Opera-tive
Gen. contracted.....	279	18.10	45.22	246	33
G. C. funnel.....	69	4.47	11.18	53	16
G. C. rachitic.....	155	10.06	25.12	89	66
Funnel.....	89	5.76	14.42	79	10
Flat rachitic.....	15	0.97	2.43	9	6
Simple flat.....	7	0.45	1.14	4	3
Atypical.....	3	0.19	0.49	1	2
	617	40.00	100.0	481	136

Thus it is seen that in the 4000 women, 2459 of whom were white and 1541 colored, there were 211 typical funnel pelves, an incidence of 5.3 per cent. Of these 122 occurred in white and the remaining 89 in colored women, or 4.96 and 5.76 per cent. respectively.

The foregoing table gives the frequency of all types of contracted pelves observed in the series. In addition to 122 funnel pelves in the 2459 white women there were 208 contractions of the pelvic inlet, as compared with 89 and 528 in the 1541 colored women—a total incidence of 13.40 and 40 per cent. respectively.

It will also be noted that the most common variety of contracted pelvis in white women is the funnel pelvis, while in colored women this type ranks fourth in the order of frequency.

In the 122 funnel pelves found in the white series the distance between the tubera ischii measured:

8.0 cm. in 60 cases.  
7.5 cm. in 26 cases.  
7.0 cm. in 9 cases.  
6.0 cm. in 1 case.

In the 89 funnel pelves found in the colored series this distance measured:

8.0 cm. in 60 cases.  
7.5 cm. in 22 cases.  
7.0 cm. in 4 cases.  
6.5 cm. in 1 case.  
6.0 cm. in 1 case.  
5.5 cm. in 1 case.

In the 122 white women interference was necessary in 43 cases, as compared with 10 in the 89 colored women: a percentage of 35.24 and 11.24 respectively. In the same series the operative frequency in the usual types of contracted pelvis was 33.17 and 23.67 per cent. respectively. This shows that contractions of the outlet and inlet are of almost equal importance in the causation of dystocia in white women, but to a less extent in the colored race. The fact that operative interference is much less prevalent in the colored race notwithstanding the greater incidence of more marked contractions of the pelvis is due to the smaller size of the children. In his report, Williams stated that in the operative cases the white children averaged 500 grams heavier than the colored children.

In the 211 cases presenting funnel pelvis were found 112 perineal lacerations, an incidence of 57.8 per cent. While this in itself is striking, it becomes more so when we note that 48 of these were second degree tears and that in three cases the laceration ex-



tended through the sphincter ani. The reason for the increase in number and severity of perineal lacerations in these cases becomes apparent, when we consider the effect of the deformity upon the course and direction that the child's head must take.

When the child's head passes through the normal pelvic outlet the course is more or less anteriorly, fitting under the pubic arch. If for any reason, this arch becomes narrowed, as in funnel pelves, it is evident that the head will be forced to pursue a more posterior course than normal, and thus the soft parts will be jeopardized to a greater or less degree. In extreme degrees of narrowing of the arch it is evident that birth cannot occur unless the posterior-sagittal diameter is correspondingly increased.

Fortunately, we are able in the great majority of both normal and funnel pelves to temporarily increase this diameter. This may be accomplished by placing the patient in any one of three positions, namely, the exaggerated lithotomy position, the squatting posture, or the so-called modified Sims' position. The first two positions cannot be maintained for any great length of time, and so are not practical; while the squatting posture is not compatible with aseptic technic. The modified Sims' position has been found to obviate both of these difficulties and to be equally efficacious in producing the desired result. This posture is the ordinary Sims' position in which the legs are more sharply flexed than usual. It may also be referred to as the lateral posture.

With this in view 500 consecutive cases were measured, first in the ordinary obstetrical posture and immediately afterward in the modified Sims' position. The increase in the anteroposterior diameter was found to be as follows:

Increase of 0.00 cm. in	20 cases.
Increase of 0.25 cm. in	6 cases.
Increase of 0.50 cm. in	53 cases.
Increase of 0.75 cm. in	18 cases.
Increase of 1.00 cm. in	122 cases.
Increase of 1.25 cm. in	17 cases.
Increase of 1.50 cm. in	121 cases.
Increase of 1.75 cm. in	11 cases.
Increase of 2.00 cm. in	89 cases.
Increase of 2.25 cm. in	3 cases.
Increase of 2.05 cm. in	29 cases.
Increase of 3.00 cm. in	10 cases.
Increase of 3.50 cm. in	1 case.

In other words, it becomes evident then that by this procedure we may expect a gain of 1 cm. or more in 80.6 per cent. of all cases.

Before taking up the technic of mensuration it is essential that some idea of the normal outlet dimensions be gained. Various authors have from time to time given measurements that might be considered as the normal standard, but looking them over more or less variation is noted. According to Klien in 113 normal pelves these measurements were:

Transverse.....	11.0 cm.
Anterior sagittal.....	6.0 cm.
Posterior sagittal.....	9.5 cm.
Anteroposterior.....	11.5 cm.

Williams reported the average measurements in 185 normal pelves:

Transverse.....	10.5 cm.
Anterior sagittal.....	5.0 cm.
Posterior.....	7.5 cm.
Anteroposterior.....	11.5 cm.

Cummings measured 70 normal pelves with the following averages:

Transverse.....	10.2 cm.
Anterior sagittal.....	5.4 cm.
Posterior.....	8.5 cm.
Anteroposterior.....	11.3 cm.

It is evident from the above that to attain a standard which will approximate normal the average measurements of a greater number of pelves are necessary. Accordingly from the records of 1000 white women presenting normal pelves, I have calculated the following average measurements:

Transverse.....	9.5 cm. (9.556)
Anterior sagittal.....	5.0 cm. (4.962)
Posterior.....	7.5 cm. (7.497)
Anteroposterior.....	10.5 cm. (10.545)

It is interesting to note that the transverse and posterior-sagittal measurements correspond almost exactly with those of Emmons who measured 217 dried female pelves, specimens of the American Indian squaw. His average for these diameters were 9.79 and 7.56 cm. respectively.

In order that the physician may correctly recognize any contraction of the pelvic outlet it becomes necessary that he employ means by which the various diameters here referred to may be measured. For this purpose the ordinary pelvimeter is available for only one measurement, namely, the anteroposterior diameter. For the determination of the transverse diameter a special instrument has been devised by Williams, who has also devised another



instrument for the mensuration of the anterior and posterior sagittal diameters. The object in the design of the instrument here presented was to devise a single instrument which would obviate the necessity of using two separate instruments or an assistant, as was heretofore necessary.

Accordingly a device was sought which would combine the Williams' instrument for measuring the anterior and posterior sagittal diameters with one by which the transverse diameter could also be measured. Therefore, the following additions and changes in the Williams' instrument have been made. In place of the solid horizontal bar a telescopic measuring arrangement was added (Fig. 2). This consists of two tubes of unequal size, the smaller of

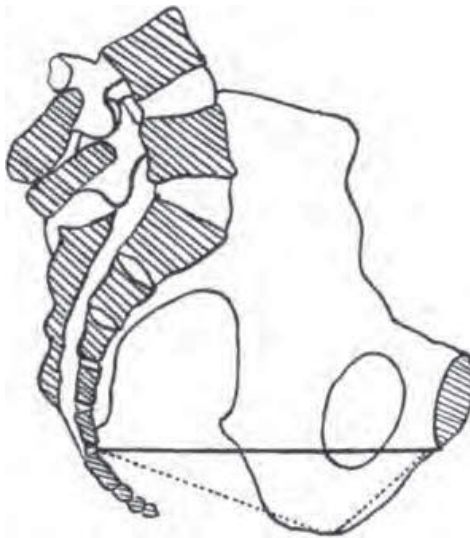


FIG. 1.—Sagittal section of pelvis showing planes of antero-posterior diameter (solid black line) and anterior and posterior sagittal diameters (dotted lines).

which slides easily within the larger. At the end of each is an adjustable thumb bracket which may be bent so that it will fit the thumbs snugly. Upon the smaller of these tubes is calibrated a centimeter scale so that when this tube is completely telescoped into the larger, the distance between the thumb nails is 6 cm. Running lengthwise upon the upper side of the smaller tube is a square groove by means of which lateral turning is prevented, and which also keeps the tubes together when they are drawn out to their fullest extent, a distance of 11.75 cm. between the thumb nails.

It will also be noticed that the original centimeter scale of the Williams' instrument has been changed. In place of the single scale at the side of the instrument, two scales have been added which read at the opposite end of the instrument from the horizontal

bar. By means of this change one scale is always directly in front of the user, so that the reading is facilitated.

The following is the routine procedure for outlet mensuration with this instrument. The patient is placed in the ordinary obstetrical examining position, on the back with the legs flexed and the buttocks slightly protruding over the end of the table so that the end of the sacrum is easily reached. The tubera ischii are first palpated. This is accomplished by grasping the buttocks in each

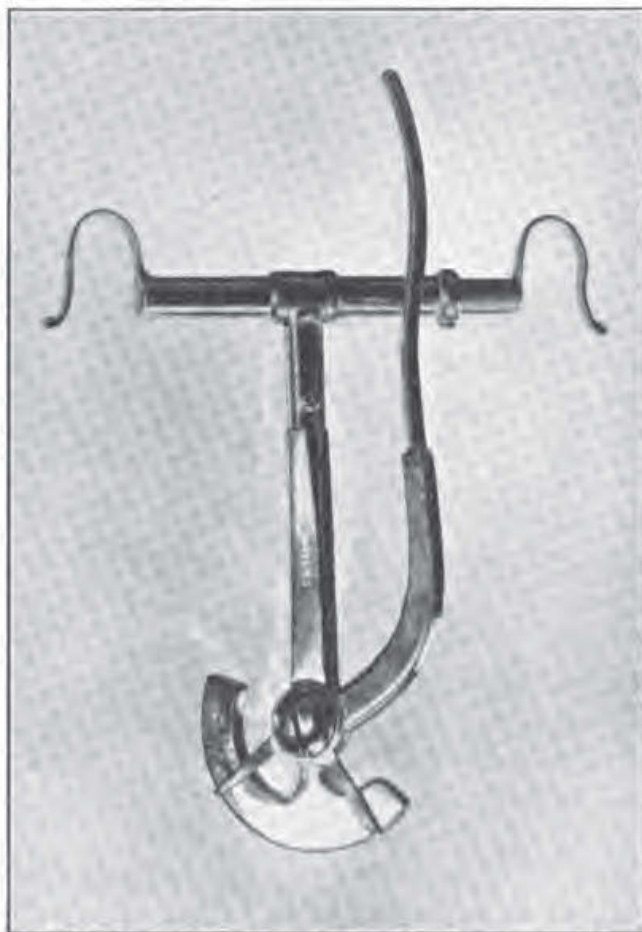


FIG. 2.—Outlet pelvimeter.  $\frac{1}{2}$  size.

hand in such a way that the inner surface of the ischiopubic rami may be outlined by the inner surface of the thumbs. By this maneuver we can locate the tubera and also roughly estimate the width of the arch. After palpating the most widely distant portions of the tubera, the thumbs are placed in such a position that their nails form a prolongation of the inner surface of the most widely separated portions of the ischial bones. The pelvimeter is now fitted upon the thumbs, as in the accompanying il-



lustration, and the most widely distant portions of the tubera again found, when the distance between the thumb nails is read directly on the centimeter scale. With the instrument still in position, the tubes are closed and one thumb is disengaged. The disengaged hand grasps the center of the horizontal larger tube and maintains it with slight pressure so that the axis of this part of the instrument corresponds to the transverse diameter. The anterior and posterior sagittal diameters are then measured by the method described by Williams. In this the curved blade of the instrument is carried forward so that its tip reaches the lower margin of the

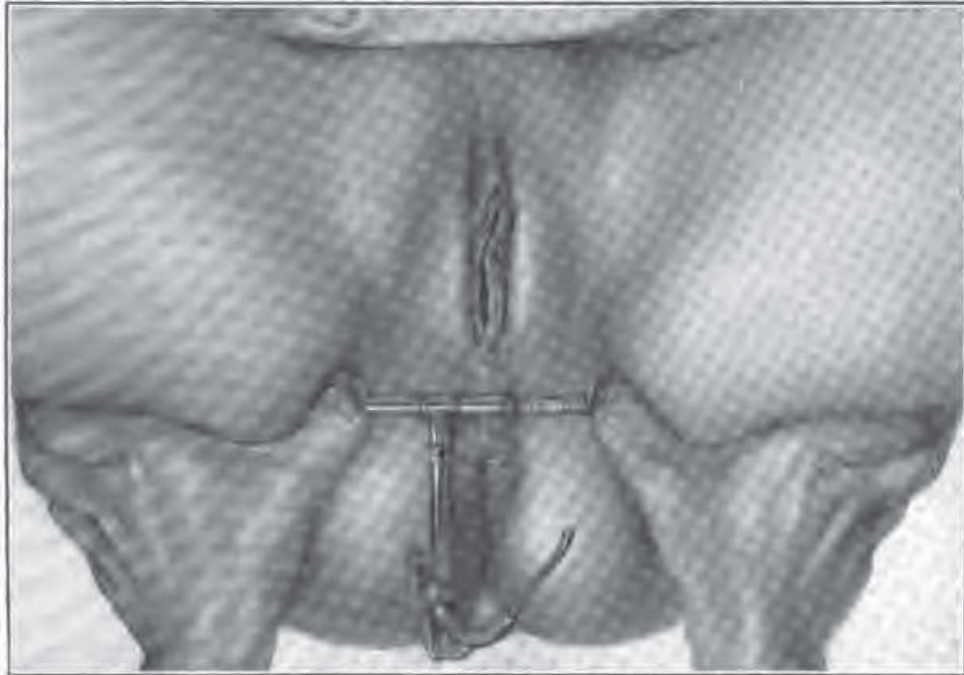


FIG. 3.—Measurement of transverse diameter of outlet.

symphysis. The distance is read from the scale nearest the examiner. With the horizontal tube still in position, the curved blade is swung around and its tip carried to the posterior surface of the tip of the sacrum, and the reading taken as in the preceding measurement.

The anteroposterior diameter may be taken with an ordinary pelvimeter or preferably by one in which the blades are only slightly curved. The blades are grasped in either hand as in the usual pelvimetric method. The end of one blade is made to rest upon the lower margin of the symphysis and the end of the other upon the external surface of the tip of the sacrum. Owing to the thick-

ness of the sacral bone, which is estimated at 1 cm., it is necessary to deduct that amount from the readings in which to obtain the true anteroposterior and posterior sagittal diameters.

I have not taken up the operations resulting from the funnel pelvis except in a general way in the table. These have been considered at length in Williams' papers, and in these additional cases the experience has been practically the same. However, later experience shows that when marked outlet contraction gives rise



FIG. 4.—Measurement of anterior sagittal diameter.

to serious dystocia, pubiotomy is the operation of choice, for the reason that it not only affords a means of effecting delivery at the time, but in many instances leads to a permanent increase in the size of the outlet which makes possible spontaneous labors in the future. In many instances, this increase is very striking, as may be noted in the study of the outlet measurements before and after pubiotomy, in the cases here presented.



Case I.—Patient No. 3797 presenting a simple funnel pelvis.

On admission.		On discharge.	
Transverse.....	7.0 cm.	Transverse.....	8.25 cm.
Ant. sagittal....	6.0 cm.	Ant. sagittal....	14.5 cm.
Post. sagittal....	8.0 cm.	Post. sagittal....	9.5 cm.
Ant. post.....	11.5 cm.	Ant. post.....	11.5 cm.

Case II.—Patient No. 3844 presenting a generally contracted rachitic funnel pelvis.

On admission.		On discharge.	
Transverse.....	8.0 cm.	Transverse.....	10.5 cm.
Ant. sagittal....	5.0 cm.	Ant. sagittal....	5.5 cm.
Post. sagittal....	7.75 cm.	Post. sagittal....	8.0 cm.
Ant. post.....	12.0 cm.	Ant. post.....	12.5 cm.

Case III.—Patient No. 4707 presenting a simple funnel pelvis.

On admission.		On discharge.	
Transverse.....	6.5 cm.	Transverse.....	9.0 cm.
Ant. sagittal....	16.0 cm.	Ant. sagittal....	6.0 cm.
Post. sagittal....	9.0 cm.	Post. sagittal....	19.0 cm.
Ant. post.....	11.5 cm.	Ant. post.....	13.0 cm.

Case IV.—Patient No. 5116 presenting a generally contracted funnel pelvis.

On admission.		On discharge.	
Transverse.....	8.0 cm.	Transverse.....	10.0 cm.
Ant. sagittal....	15.0 cm.	Ant. sagittal....	4.0 cm.
Post. sagittal....	8.0 cm.	Post. sagittal....	8.5 cm.
Ant. post.....	12.0 cm.	Ant. post.....	11.5 cm.

*Note.*—This patient was delivered twenty-three months later of a full-term child, born spontaneously.

Case V.—Patient No. 6037 presenting a flat funnel pelvis.

On admission.		On discharge.	
Transverse.....	7.5 cm.	Transverse.....	8.5 cm.
Ant. sagittal....	5.5 cm.	Ant. sagittal....	4.5 cm.
Post. sagittal....	8.5 cm.	Post. sagittal....	7.5 cm.
Ant. post.....	12.0 cm.	Ant. post.....	11.0 cm.

To recapitulate briefly:

1. The most frequent type of contracted pelvis occurring in white women is the funnel pelvis: constituting 37 per cent. of all contracted pelves found in that race.
2. It is of equal incidence in both the white and black races, but owing to the greater frequency of the usual types of contracted pelvis in the latter race it constitutes but 14.5 per cent. of all contracted pelves in black women.
3. Owing to the course the child's head must take in funnel

pelves, we must expect an increase in the number and severity of perineal lacerations.

4. By means of the modified Sims' posture we have an excellent means of increasing temporarily the anteroposterior diameter of the outlet.

5. In severe contractions of the outlet pubiotomy is the operation of choice, in many instances transforming the deformed pelvis into one with practically normal measurements.

6. The following may be taken as the average measurements of the normal outlet.

Transverse.....	9.5 cm.
Ant. sagittal.....	5.0 cm.
Post. sagittal.....	7.5 cm.
Anteroposterior.....	10.5 cm.

7. By use of the pelvimeter herein described we have an easy and accurate means of determining the diameters of the pelvic outlet.

In conclusion I wish to thank Prof. J. Whitridge Williams for the use of the material in the preparation of this paper and for many valuable suggestions.

#### REFERENCES.

Bayer. Trichterförmig verengte Becken.-*Vorlesungen über Allgemeine Geburtshilfe* 1903, i, 216.

Breus and Kolisko. Assimilationsbeckens. *Die path. Beckenformen*, 1900, i, 1 Theil, 169-256.

Cummings. External Pelvimetry with Special Reference to the Method of Measuring the Outlet. *Phys. and Surg.*, 1911, xxxiii, 279-288.

Emmons. A Study in the Variations in the Female Pelvis, Based on Observations made on 217 Specimens of the American Indian Squaw. *Biometrika*, Cambridge, 1913, ix, 34-57.

Klein. Die gedurtshülfliche Bebeutung der Verengerungen des Beckenausgangs, insbesondere des Trichterbeckens. *Volkmann's Sammlung Klin. Vorträge*, 1896, Nr. 169.

Williams. Frequency Etiology and Practical Significance of Contractions of the Pelvic Outlet. *Surg., Gyn. and Obs.*, 1909, viii, 619-638.

Williams. The Funnel Pelvis. *Trans. Am. Gyn. Soc.*, 1911, xxxvi, 131-153.

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