1962

Measurement of the bispinous diameter of the obstetricpelvis

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MEASUREMENT OF THE BISPINOUS DIAMETER OF THE OBSTETRIC PELVIS

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Submitted in Partial Fulfillment for the
Degree of Doctor of Medicine

College of Medicine, University of Nebraska

February 2, 1962

Omaha, Nebraska

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Introduction.

Since the emergence of obstetrics as a field in itself, and probably before, physicians have dreamed of making delivery of a fetus through a specific pelvis a mathematical problem that could be calculated with precision and certainty; and innumerable instruments and techniques have been devised in the past to reach this goal.

Early Methods of Internal Pelvimetry.

One of the earliest methods of internal pelvimetry was that described by Robert Wallace Johnson in 1769. It has later become known as Johnson's hand method[1] and involves direct measurement of internal diameters by inserting the hand or fist, held in certain characteristic positions, into the vagina. This method is claimed to be fairly accurate in measuring diameters less than 4 inches, but can for obvious reasons only be utilized in the postpartum period.

During the early period of internal pelvimetry, major emphasis was placed upon measurement of the true conjugate, which is the distance between the middle of the sacral promontory and upper margin of the symphysis pubis.[2] It wasn't until 1896 when Klien[3] called attention to the fact a narrowed bispinous diameter

(the distance between the ischial spines) might be the etiologic factor in persistent occiput posterior position, that serious efforts were made toward objective estimates of this pelvic diameter. De Lee[4] in the years shortly before 1900 was the first to develop an instrument for this particular purpose. De Lee's instrument consisted essentially of an uncrossed pair of pliers, the pointers of which were simultaneously approximated against the ischial spines as the handle was closed. The distance was then read on a calibrated scale mounted across the handle. The use of this instrument, although it was accurate, was much too painful for the patient to allow widespread popularity.

Shortly after the advent of x-ray pelvimetry, Ayers[5] in 1900 developed an instrument almost similar to that of De Lee, but in addition enabling the operator to measure the angle of the pubic arch. One advantage of this instrument over x-ray pelvimetry was that it gave a more accurate estimate of the bispinous diameter by including the soft parts overlying the spines; but again the painful stretching of the vaginal wall prevented its general use. The further evolution of clinical pelvimetry at the turn of the century was greatly hampered by x-ray pelvimetry, although the latter at its conception had a rather dubious future.

The first radiography of the human pelvis was performed in

1896 on the cadaver, and required 3 hours exposure.[6] The following year Budin accomplished the same thing in a patient with 45 minutes exposure. The various diameters of the pelvic brim were estimated, by comparing the obtained skiagrams with standard skiagrams of dried pelves placed in the same position. It is readily appreciated that attempts to obtain two such identical views left room for a high degree of error. However, different methods were gradually introduced in an attempt to reduce the errors in measurement. In 1900 Varnier tried to correct the effects of distortion due to divergence of the x-ray beam by utilizing a focal distance of 5 meters. The frame method was introduced by Fabre in 1900. A metal frame was placed in the same plane as the pelvic brim around the pelvis. The frame was distorted to the same degree as the pelvis, and could thus be used as a reference for correction. Along these same lines Albert in 1897 developed a technique in which he placed the patient so as to bring the plane of the pelvic brim parallel to the x-ray plate. The calculation of the anteroposterior and transverse diameters by this method were relatively simple, requiring only knowledge of the focus-film distance, the distance from the upper border of the symphysis to the film and the length of the projected diameters on the film itself. Albert's technique was applied to a modified frame method in the United States by Thoms. He inserted a notched ruler

on the plane of the pelvic brim, producing a corrected ruler on the negative. Of course, one difficulty or shortcoming of the early x-ray pelvimetry was the lack of serviceable lateral projections. Indeed, this problem was not solved until much later with introduction of the Potter-Bucky diaphragm.

Midpelvic Contraction.

The midpelvic plane, which is the area of least pelvic dimensions, is a plane extending from the lower inner border of the symphysis posteriorly through a line connecting the ischial spines to a point on the anterior surface of the sacrum at the junction of the fourth and fifth sacral vertebrae.[7] The following measurements are those largely accepted as being standard averages: bispinous 10.5 cm, anteroposterior 11.5 cm, and posterior sagital, which is that portion of the anteroposterior diameter that lies posterior to its intersection by the transverse diameter, 5 cm.

Criteria of midpelvic contraction are a less tangible subject inasmuch as all diameters should be considered as a whole. However, most authors agree that a bispinous diameter of less than 10 cm, and an anteroposterior distance of less than 11.5 cm constitutes some degree of contraction. If one considers all diameters in midpelvic contraction, several methods may be utilized to deter-

mine their significance. One method uses the sum of the bispinous and posterior sagital diameters; by this technique Swain[7] has observed that delivery from below rarely occurred with sums of 13.5 cm or less. The other method considers the midplane as an area estimated by multiplying the bispinous and the anteroposterior diameters. 125 is considered average and 106 is considered borderline. Swain[7] has summarized the work of various authors in the following tables.

Table 1.

	Number	Difficult	Percent Difficult
Above 106	78	15	19
Below 106	41	17	41

Table 2.

	Number	Difficult	Percent Difficult
Over 13.5 cm (B.S. + P.S.)	73	15	21
Below 13.5	46	17	37

Table 3.

	Spontaneous	Difficult	Percent Difficult	Asphyxia	Percent Asphyxia
A.P. less than 11.5 cm B.S. 10 cm or more	47	10	21	7	15

Table 3 (continued)

	Spontaneous	Difficult	Percent Difficult	Asphyxia	Percent Asphyxia
A.P. greater than 11.5 cm B.S. less than 10 cm	19	7	37	4	21
A.P. less than 11.5 cm B.S. less than 10 cm	21	15	71	11	52

Although the term difficult delivery was not defined any further, reducing somewhat the significance of the above, it may be observed that the degree of difficulty and the incidence of asphyxia are closely related to the midpelvic diameters. The lowest incidence of both was found in the group of patients who had an anteroposterior diameter of less than 11.5 and a bispinous diameter of greater than 10 cm. It is obvious that knowledge of multiple midpelvic diameters is of greater significance than one measurement alone.[8] However, the point brought forth above, that difficult delivery and asphyxia occur at a lower incidence with bispinous diameters of 10 cm or above, regardless of other diameters, was corroborated by Hanson in 1934 through a different study. Hanson was probably one of the first to seriously investigate the significance of the small bispinous diameter.[9] In his study of 143 primipara,[3] in whom the bi-

spinous diameter was narrowed (average 9.9 cm), the other pelvic measurements being normal, there were 27 cases (18.9%) of persistent occipitoposterior positions. This incidence is 13 times normal. The narrow bispinous diameter as an etiology of occiput posterior is readily appreciated when one considers that it is at the spines, that the cardinal movements of internal rotation and descent must occur simultaneously, while flexion must be maintained or re-established.[10] Deflexion is generally considered one of the most important factors in the etiology of persistent posterior position.[3] The maintenance of flexion, of course, depends upon the circumstances that the forces acting against the sinciput must overbalance those exerted against the occiput. Thus, any factor which increases the resistance encountered by the occiput, tends to favor deflexion. It is apparent that narrowing of the bispinous diameter would have just this effect of causing obstruction to the advance of the occiput, with deflexion as an inevitable consequence. Aside from this effect of deflexion, the narrow diameter would also tend to prevent rotation directly by offering increased resistance to the presenting part. The above becomes doubly important when one considers that Hanson[11] in one series of 620 bispinous measurements found the incidence of measures below 9.5 cm to be 21%.

The resultant effect of midpelvic contraction, whether it in-

volves all diameters or only the bispinous depends upon the type management instituted and the latter is almost as varied as the number of authors who have described it. Kaltreider[9] feels that a trial of labor is permissible, providing the vertex is presenting, and even advocates the trial of forceps to see if the midplane can be negotiated. Mengert,[10] who has stated that there can be no serious outlet contraction without a commensurate contraction of the midpelvis, concurs with Kaltreider's treatment. Swain[7] on the other hand found that almost 20% of cases where the bispinous diameter was below 10.0 cm terminated in Cesarean section and feels that this, performed relatively early in labor, is the treatment of choice. The conventional attitude, toward the contracted midplane, is one of "watchful expectancy",[3] and this policy is generally recommended until operative intervention becomes urgent. Hanson[3] in general agrees with the aforementioned conventional therapy but feels that if the midplane contraction is further complicated by occipitoposterior position, the indication for early operative intervention is present. Breech presentation can probably be considered as another indication for early or perhaps routine abdominal delivery in cases where the bispinous diameter is less than 10 cm.

From the above it is apparent that all available data should be utilized in guiding therapy. This includes the midpelvic dimensions, the curvature of the sacrum, the subpubic angle, the slope

of the lateral pelvic walls, the outlet dimensions, and the presence or absence of an engaged head at the onset of labor.

Hanson Pelvimeter.

Before 1929 a simple and accurate method of midplane pelvimetry had not been available. In the methods hitherto proposed, an attempt had been made to reach both ischial spines simultaneously through the vagina. Because of marked pain during the examination, this type of pelvimeter never gained popularity. In 1929 Samuel Hanson[13] proposed a method by which one spine was reached through the vagina and the other through the rectum. The instrument consists of two detachable curved blades joined crosswise to resemble a pair of scissors. A ring, into which the examining finger is inserted, is attached to that end of each blade which is to be used internally. The right blade carries a scale at the opposite end from the ring. The smallest divisions on this scale represent a distance of 0.5 cm between the rings. The bispinous diameter is measured by inserting the tip of the right index finger into the vaginal blade, and the left index finger into the ring of the rectal blade. The rings are then steadied against the spinous processes and a reading is made on the scale.

One advantage of this instrument is that the measurement ob-

tained is rather accurate. However, as its inventor reluctantly admits, there is moderately severe pain associated with its use, and for this reason it has not become popular.

X-ray Pelvimetry.

The method of pelvimetry used for evaluating the accuracy of the new pelvimeter under study, was that described by Colcher and Sussman in the late forties.[15] This technique utilizes two views, an anteroposterior and a lateral. For determination of the transverse diameters, the patient is placed in the supine position, the knees and thighs being flexed to such a degree as to bring the greatest transverse diameter of the inlet, the interspinous diameter, and the intertuberous diameter in the same plane and parallel to the film. A radio opaque ruler is then placed at the level of the ischial tuberosities, thus distorting the ruler to the same degree as the diameters in point. For the lateral projection, the patient is placed on her side and the ruler is placed at the level of the mid-sacral line. Inasmuch as the accuracy of the Colcher-Sussman technique depends primarily on proper positioning of the patient, it does not lend itself well to comparison with dried pelves. For this reason Freeman[16] in 1956 chose the parallax technique, one of recognized accuracy, as the basis for comparison. In a series of almost 50 cases he obtained the following results.

Table 4.

Diameter	Transverse of Inlet	Inter-spinous	Inter-tuberous
Mean difference C.S.-Par. (cm)	+ 0.28	- 0.06	+ 0.06
Standard deviations of difference	0.35	0.22	0.26
95% confidence interval	Par = C.S. -0.28 ± 0.71	Par = C.S. $+0.06 \pm 0.45$	Par = C.S. -0.06 ± 0.53

Thus, for example if one obtained an interspinous measurement by the Colcher-Sussman method of 10.0 cm, the parallax would yield at best 10 + 0.06 or 10.06, and one could be 95% certain that the parallax measure would fall between 9.61 and 10.51 cm. These figures are indeed impressive but do leave the observer with a number of questions. Were these cases a selected group, excluding such things as anatomic defects or obesity, which would certainly enhance the difficulty of positioning both the patient and the radio opaque marker? Was x-ray pelvimetry performed by technicians or by radiologists with a high degree of skill and experience in this field? Answers to these questions would probably alter somewhat the significance of the above figures. The advantages of the Colcher-Sussman technique seem to be its relative simplicity and low cost as compared to other methods.

The limitations of x-ray pelvimetry are multiple, and in in-

stances very serious. The most important is probably the potential danger to the fetus (see below). A second limitation is the lack of a method to adequately measure the size of the fetal head.[17] This plus the fact that most radiologists do not have a wide background in the field of obstetrics reduces the significance of a clinical prognosis based on x-ray pelvimetry. Other limitations include unavailability of apparatus and personnel, and the cost.

As noted above, the most important limitation to the use of x-ray pelvimetry is the effect on the reproductive systems of both mother and fetus. These effects are cumulative and irreversible.[18] The suggested maximum dose to the gonads during the first 30 years of life from manmade sources is 10 roengtens.[19] The amount of exposure with each pelvimetric exam of course varies with the size of the patient and the type of apparatus utilized, but the following figures are in general well accepted. Ovarian irradiation in an anteroposterior view varies between 50 and 700 milliroentgens, and in a lateral view varies between 200 and 2800 milliroentgens. By contrast a single film of the abdomen in the non-pregnant female delivers 20-200 milliroentgens.[18,20] Thus it is apparent, that during x-ray pelvimetry the fetus may receive one-third of its total permissible exposure during the first 30 years of life.

The immediate effects of irradiation, at least during early

pregnancy, are according to Douglas[18] and Mills,[19] an increased incidence of abortions, microcephaly, stillborns, congenital deafness, congenital cataracts, and other non-specific congenital deformities. It is also known[19] that irradiation of the gonads of mother and fetus may result in gene mutation which might appear only in future generations. The influence of irradiation upon subsequent development of malignancy has for some time been a controversial subject. Steward,[21] in a survey of 547 children who died of malignant disease, before the age of 10 years, found 85 cases whose mothers had received x-ray during pregnancy comparing to 45 in the control group. Mills[19] on the other hand, strongly disagrees with Steward and bases his opinion on a study of 226 children delivered in 1946. In all cases, the mothers had x-ray pelvimetry during the last trimester of pregnancy. The average dose of radiation at the depth of the fetus was calculated as being 3.5 roentgens. Of the 226 children, 155 were followed for 10 years. In none of these were there any cases of leukemia or other malignant diseases. This study loses its significance when one considers that the death rate from cancer including leukemia for children less than 15 years in the general population is 10 per 100,000.

Thus, it appears that the maximum permissible exposure x-ray during the first 30 years of life, but especially during the

antenatal period, must be reduced even further in the future.

New Pelvimeter.

The instrument developed for this study differs from those heretofore mentioned, in that it does not measure the bispinous diameter by touching both spines simultaneously. Instead, the measuring arm of the instrument transcribes an arch from one spine to the other, the distance between these being read from a pre-calibrated scale. The smallest divisions of this scale represent a distance of 2 mm.

The instrument consists basically of a "T" shaped frame, upon which rides the scale and measuring arm (see Fig. 1 and 2). On each arm of the T is situated a small, (3 cm) curved, movable disk. These are held firmly against the pubic arch at the time of measurement. Around the leg of the T is a movable bar (see Fig. 2 D), which carries the triangular shaped scale. The apex of this triangle serves as the fulcrum for the measuring arm. The tip of the measuring arm is forked, so as to produce less excursion at the introitus. In viewing the instrument from the side, it will be noted that the forked end of the measuring arm is curved to a degree which brings it in approximately the same plane as the movable disk on the frame. This enables one to maintain the instru-

Table 5.

No.	Bispinous Diameter in Millimeters		Date of Exam (weeks gestation)	Parity	Age	Weight in lbs.	Pubic Arch	T.I. in MM.
	Clinical	X-ray						
1	104	96	30	1001	42	116	> 90°	102
2	100	90	28	1001	17	137	< 90°	107
3	100	102	39	1001	28	122	> 90°	107
4	94	85	37	0000	16	169	< 90°	90
5	98	92	34	0000	16	137	< 90°	100
6	108	103	38	0000	13	165	90°	101
7	102	110	40	0000	17	138	90°	106
8	102	98	36	0000	18	125	> 90°	104
9	104	100	37	4004	26	153	> 90°	88
10	104	110	36	1011	17	134	> 90°	105
11	95	90	36	1001	22	128	> 90°	88
12	106	99	37	4004	27	141	> 90°	109
13	96	97	38	0000	16	140	< 90°	93

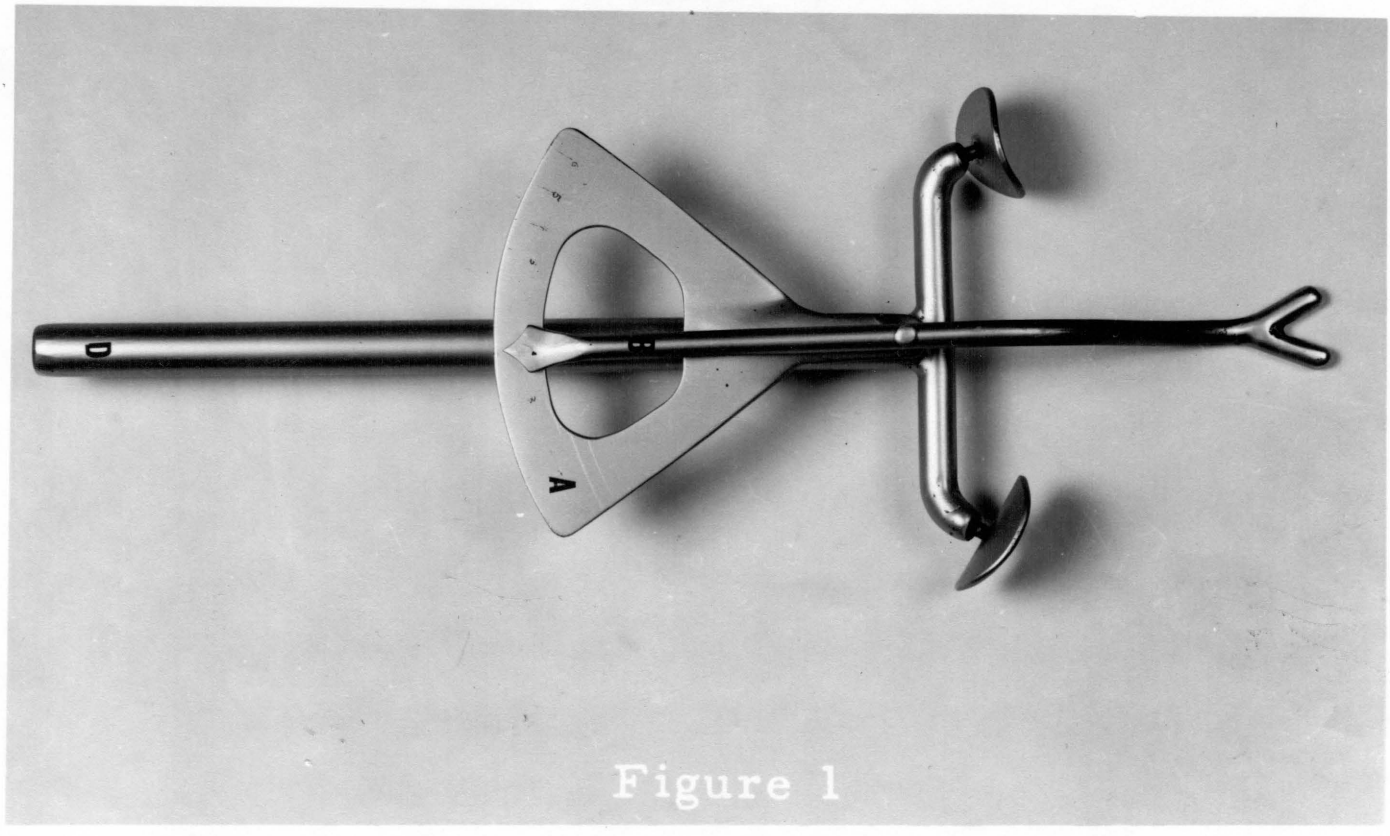

Figure 1

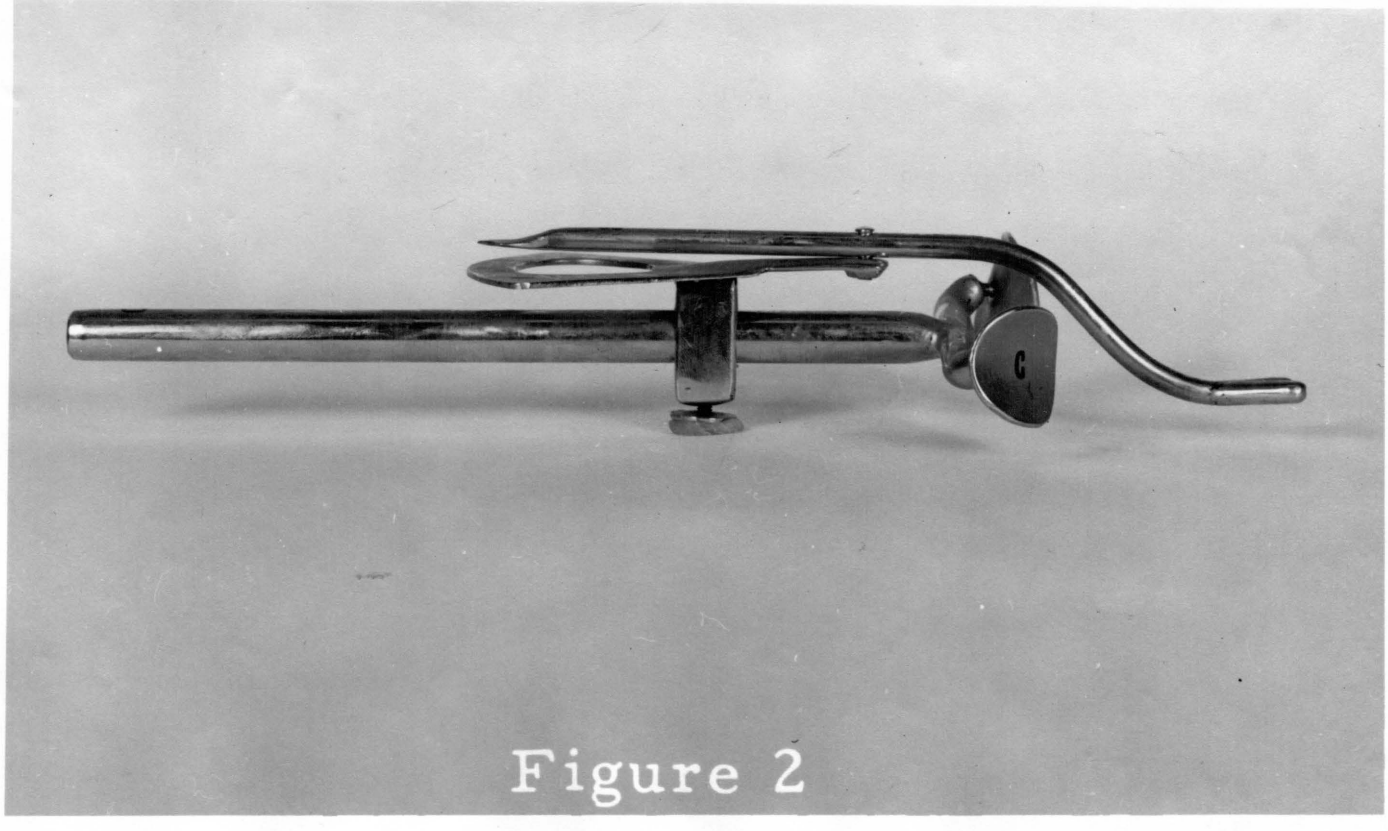

Figure 2

ment in a horizontal position during the examination.

The bispinous diameter is obtained by introducing the forked end of the measuring arm, guided by the right index finger into the vagina. The left hand is applied firmly to the leg of the T frame or handle, and the disks are pressed against the pubic arch. The measuring arm is then advanced or retracted until the desired level is reached, whereupon the sliding bar (see Fig. 2 D) carrying the scale is secured by tightening the stop screw. At this point the measuring arm is approximated against first the right, then the left and finally again against the right spine, the reading being noted each time.

The results obtained clinically are compared to results obtained by the Colcher-Sussman technique as outlined in table 5. In none of the patients examined were there any complaints of pain, this in spite of the fact that some were measured as early as the 28th week of gestation.

The results obtained were as follows: Of 13 patients examined, the greatest disparity between x-ray pelvimetry and clinical measurement was 10 mm, and the smallest was 1 mm. In two-thirds of the cases, the clinical measurement exceeded x-ray measurement, contrary to what one would expect. This finding reduces the significance of the pelvimeter, because in absence of a perfect measure-

ment, one would rather see one slightly below the true measure than one slightly above. In one-third of the cases, the x-ray measurement exceeded that obtained clinically, the range being -1mm to -6 mm. The mean deviation was found to be 5.75 mm. There is slight positive correlation, with some exceptions, between the large size of the pubic arch, low weight of the patient, and the accuracy of clinical measurement.

Four factors should be considered, when viewing the less than optimal results obtained. 1. A lack of experience in using the instrument. 2. The low number of patients does not allow one to draw broad conclusions of any great significance. 3. The weak point of the instrument lies in holding it steady against the pubic arch. 4. The 95% confidence interval of the Colcher-Sussman method is the absolute value $\pm$ 5 mm:, which means that some of the results are more accurate, but probably just as many are less accurate, than are indicated by the figures in table 5.

Summary.

An attempt has been made to illustrate the possibility of a practical clinical bispinous measurement and the significance of midpelvic contraction, with special emphasis on the bispinous diameter. The midpelvis is usually considered contracted, when the

transverse diameter is less than 10 cm, and the anteroposterior diameter is less than 11.5 cm. Methods utilizing the area of the midpelvis have also been devised to determine midpelvic contraction. The result of a small bispinous diameter is an increased incidence of difficulty during labor, fetal asphyxia, and increased incidence of persistent occiput posterior positions. The conventional management of the small bispinous diameter is watchful expectancy during labor, unless the narrowing is further complicated by an occiput posterior position.

The easiest, although the most expensive, means of obtaining accurate knowledge of midpelvic dimensions is through x-ray pelvimetry. This is also a potentially dangerous procedure both to the fetus and mother. The total amount of irradiation delivered to the fetus during routine x-ray pelvimetry may be approximately one-third of the total recommended exposure, from manmade sources, during reproductive life. There have been numerous reports incriminating irradiation as the cause of congenital defects, mutations, and an increased incidence of childhood malignancy; and in some cases impressive statistics have been brought forth to illustrate these.

In view of these findings, a new bispinous pelvimeter was developed; one which unlike its predecessors could be used without

pain to the patient. The accuracy of the pelvimeter was determined by comparing the results obtained to those obtained by the Colcher-Sussman technique. In two-thirds of the cases the clinical measurement exceeded that obtained by x-ray, and the mean deviation was found to be 5.57 mm, with a range of 1 mm to 10 mm. Although these results are not very startling, I feel that clinical pelvimetry development should be carried on to a far greater extent in hopes of some day relinquishing the necessity for routine x-ray of the "questionable" or contracted pelvis.

Conclusions.

1. The distance between the ischial spines is the most important measurement in the midpelvis; knowledge of this distance enables one to predict the degree of difficulty during labor.

2. X-ray pelvimetry cannot predict the course of labor more accurately than clinical pelvimetry, if bispinous measurements are included in the latter, because the cephalic size cannot be measured by x-ray.

3. Clinical pelvimetry should be continued because of the potential dangers from exposure to irradiation.

4. A bispinous pelvimeter has been developed to perform this measurement painlessly; however, accuracy must be determined by further experience.

Acknowledgements.

I wish to express my gratitude to my father, Mr. Egon Rosholm, who gave so freely of his time and abilities in making this instrument. I also wish to express my gratitude and appreciation to my adviser, Dr. Warren H. Pearse, for his encouragement and helpful advice in preparation of this thesis.

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