X-ray Pelvimetry: Helpful or Harmful?

Norris Anderson, MD
Minneapolis, Minnesota

This study was performed (1) to clarify the usefulness of x-ray pelvimetry in diagnosing cephalopelvic disproportion (CPD), particularly in patients with abnormal labor, and (2) to examine the association between infant birthweight and mode of delivery.

The subjects were 100 consecutive patients who underwent x-ray pelvimetry. A retrospective chart review was done to collect demographic data and evaluate Friedman labor curves. Radiologic dimensions were tabulated for anteroposterior diameter, transverse diameter, and summation plane values of both inlet and midpelvic planes. Average pelvimetric values for subjects delivered vaginally and those delivered abdominally were compared, and Hotelling's T^2 analyses were conducted to determine whether the differences were statistically significant. Average birthweights of infants born to women in cesarean section and vaginal delivery groups were also compared, with *t* tests conducted to determine statistical significance.

Results showed that even in a select group of patients in abnormal labor with the highest probability of CPD—a condition it was believed x-ray pelvimetry could diagnose—no significant difference in bony pelvic dimensions existed between vaginal and cesarean delivered patients. The cesarean group did, however, deliver significantly heavier infants. The results question the usefulness of x-ray pelvimetry in diagnosing CPD.

The family physician's understanding of labor has increased greatly over the past several decades as data describing its normal progression, as well as various patterns of abnormal labor, have been presented. However, the management of abnormal labor still presents difficult decisions in obstetric care. Many factors can affect the course of labor, including the following:

1. Size and shape of the bony pelvis
2. Size of fetal head
3. Fetal presentation and position
4. Cervical resistance
5. Force and coordination of uterine contractions
6. Soft tissue resistance
7. Moldability of the fetal head
8. Pelvic girdle mobility, secondary to soft tissue relaxation under hormonal influence

Any one or a combination of these factors may influence the labor pattern to become abnormal.

From the Department of Family Practice and Community Health, University of Minnesota Medical School, Minneapolis, Minnesota. Requests for reprints should be addressed to Dr. Norris Anderson, Bethesda Family Physicians, 590 Park Street, St. Paul, MN 55103.

Although x-ray pelvimetry provides some information about several of these factors, it is primarily used to investigate the size and shape of the bony pelvis. Of all these factors, a contracted bony pelvis is statistically among the least frequent causes of abnormal labor, occurring in 1 to 2 percent of 2,500 patients selected for x-ray pelvimetry in one study.[1]

One frequently stated cause of abnormal labor is cephalopelvic disproportion (CPD). Often diagnosed without being clearly defined, CPD has been used interchangeably with such terms as failure to progress, dystocia, and inertia, causing confusion over the etiology of abnormal labor. In actuality, the diagnosis of CPD can be confirmed only when the fetal head fails to descend despite effective uterine action. Thus, an adequate trial of good-quality labor and the lack of progress of cervical dilatation and fetal descent are the requirements for the diagnosis. Short of these observations, the diagnosis of CPD is only an assumption.

Friedman[2] has clearly outlined specific abnormal labor patterns and their causative factors. In general, women having abnormal labor have an increased probability of CPD. Friedman's work showed that CPD was an etiologic factor in 25 percent of patients with protracted labor disorders and in 50 percent of patients with arrest disorders. Thus, specific abnormal labor patterns themselves tend to indicate the probability of having CPD.

X-ray pelvimetry has been the standard test to evaluate and diagnose CPD, ordered in 4 to 18 percent of all live births.[1,3] Controversy about the test has emerged in recent years,[1,4-6] and numerous studies have associated x-ray pelvimetry with potential maternal and fetal health hazards.[7-11] Despite these reports, many physicians still consider x-ray pelvimetry essential to diagnose and manage abnormal labor, particularly when CPD is the suspected cause. It is believed that x-ray pelvimetry will discern which patients have CPD due to small pelvic dimensions and, this being the case, which patients thus require cesarean section delivery. The contention has been that, among patients having abnormal labor and thus increased probability of CPD, bony pelvic diameters would be smaller in those patients delivered abdominally than in those patients delivered vaginally.

This study investigates that contention by performing such a comparison. The fundamental question is, Does x-ray pelvimetry provide important data necessary to evaluate and manage the patient with abnormal labor who is suspected of having CPD? Second, this study examines the association between birthweight and delivery type as it relates to CPD. Since CPD refers to a disproportion between infant and mother, it is logical to investigate the size of the infant as well as the size of the mother's bony pelvis. By comparing both pelvic dimensions and infant birthweights of women having babies delivered vaginally vs those having babies delivered by cesarean section, this study will provide evidence for the relative importance of these two factors in CPD.

Methods

Subjects

The subjects were 100 consecutive patients who underwent x-ray pelvimetry at Bethesda Lutheran Medical Center between January 1 and October 1, 1981. Although this sample may be potentially biased by being selected for x-ray pelvimetry, it was not possible for ethical reasons to require all patients with abnormal labor to undergo x-ray pelvimetry. Since this community hospital has a strong family practice base, more than 90 percent of these tests were ordered by family physicians. The radiologic procedure used was the Colcher-Sussman technique, and films were interpreted by any one of three hospital staff radiologists.

Through a retrospective chart review, data were collected on subjects' race, parity, indication for pelvimetry, and type of delivery. The newborn's birthweight, infant Apgar, and evidence of fetal distress were also noted. One of two physicians doing the data collection evaluated each Friedman labor curve in the chart for the presence or absence of an abnormal labor pattern at the time x-ray pelvimetry was ordered.

Pelvic Measurements and Delivery Type

To answer the primary research question, radiologic dimensions were obtained and tabulated for the anteroposterior diameter, transverse diameter, and summation plane value. Mengert's index for both the inlet and the midpelvis planes was calculated as well. Average pelvimetric values were calculated and compared between subjects who experienced vaginal delivery and those who experienced cesarean section. Hotelling's T^2 analyses were conducted to determine whether the vaginal delivery and cesarean section groups differed significantly in their pelvic dimensions.

Pelvic measurements of the vaginal delivery and cesarean section groups were compared for three segments of the study sample. Group A included the total sample, Group B included patients with in-labor assessment for abnormal labor patterns, and Group C included patients with in-labor assessment for two specific abnormal labor patterns: protraction and arrest disorders. Since patients with protraction and arrest labor disorders have the highest percentage of CPD and thus higher probability of small pelvic dimensions, one would expect the greatest average difference in pelvic diameter to occur between those women with protraction and arrest labor patterns whose babies were delivered vaginally and those women with the same labor patterns whose babies were delivered abdominally. In Groups B and C, subjects in the cesarean group included only patients for whom presumed CPD was the sole indication for abdominal delivery. A decision was made to exclude Southeast Asians because compared with the rest of the sample their pelvic dimensions were smaller ($P < .001$). Thus, considerable effort was made in the sample selection to provide the most select group available to give x-ray pelvimetry every chance to show benefit.

Positive Predictive Value

In an attempt to view the data from a different angle, a test of positive predictive value was performed. This test looks more at the individual benefit from a test than at the apparent benefit to a population by means of average values. In this study positive predictive value was defined as the percentage of patients with a defined contracted value whose babies were delivered by cesarean section because of presumed CPD. Various defined radiologic values thought to represent contracted or borderline measurements were chosen based on a literature review and knowledge of average values. Group B was used to provide enough subjects to yield reliable results. It should be remembered that this group comprised patients who had an in-labor assessment of some form of abnormal labor and whose delivery outcome may certainly have been biased by the x-ray pelvimetry results.

Delivery Type and Birthweight

To answer the second study question, the average birthweights of infants born to women in the cesarean section and vaginal delivery groups were compared for several sample subsets. These subsets included not only Groups A, B, and C, but went further to break down Group C into multiparas and primiparas. To determine whether the differences were statistically significant, *t* tests were conducted on the data.

Results

Subjects

The study sample consisted of 14 percent Southeast Asians. Primigravidas made up 75 percent of the study population; multigravidas, the remaining 25 percent. Table 1 displays indications for obtaining x-ray pelvimetry as noted on the patients' charts. Most were done because of the presence of an abnormal labor pattern, as defined by Friedman.[2] Ten charts contained no recorded reason for x-ray evaluation.

Of the 100 subjects, 57 had their babies by vaginal delivery, either spontaneously or with the aid of a low outlet forceps, while the remaining 43 patients had their babies delivered by means of cesarean section. There was no known morbidity in subjects or any fetal mortality. There were also no differences in Apgar scores or fetal distress in infants delivered vaginally vs those delivered ab-

Table 1. Frequency of Various Indications for X-ray Pelvimetry

Indications	Number of Women
Preinduction	17
Correlation with clinical assessment	4
Evaluation for vaginal breech delivery	4
History of pelvic trauma	1
History of difficult delivery	1
Evaluation for twin delivery	1
Previous cesarean section (evaluation for vaginal delivery)	1
Assessment of presentation	5
Abnormal labor pattern	56
Failure to progress in latent phase (22)	
Secondary arrest of dilatation (23)	
Protracted active phase (4)	
Prolonged deceleration (3)	
Arrest of descent (4)	
Not known	10
Total	100

dominally. During this time period, the cesarean section rate was 15 percent and the x-ray pelvimetry rate was 11 percent for all patients experiencing labor and delivery.

Pelvic Measurements and Delivery Type

Table 2 presents average pelvic dimensions for the study's three subsets: Groups A, B, and C. There was no significant difference in any diameter value between cesarean section and vaginal delivery groups, even in Group C, the most selected population. Further, there was no significant difference in the average Mengert's index for cesarean and vaginal delivery groups in the subset of women with abnormal labor patterns (Table 3). Thus, pelvic dimension seemed to show no association with types of delivery.

A test of positive predictive value was also conducted for subjects in Group B as a second means of testing the association between pelvic measurement and delivery mode. Even in this select subset of the study sample, subjects with defined contracted pelvic dimensions were delivered by cesarean section generally no more than 60 to 70 percent of the time (Table 4). The only contracted measurement that seemed to have positive predictive value was a midpelvis transverse (bispinous) diameter of less than 9.5 cm. All of the three patients having a midpelvis transverse diameter of less than 9.5 cm were delivered of their babies by cesarean section. However, two of the three patients went on to abdominal delivery within one-half hour, implying probable bias in the decision concerning mode of delivery. In comparison, three patients in the total vaginal delivery groups had a midpelvis transverse diameter of less than 9.5 cm.

Table 5 displays average birthweights of infants born in several sample subsets. In Group A, infants delivered by cesarean section were significantly heavier than those delivered vaginally. The difference in average birthweight became more substantial as the population became more selected for abnormal labor and suspected CPD. In Groups B and C, birthweight averaged 1 lb heavier in the cesarean section group. In Group C this difference was magnified to more than 2 lb in those having a parity of greater than or equal to 1. To ensure that the birthweight difference in Group C was not due entirely to the multiparous women, primiparas were examined separately, and the infants delivered by cesarean section were still about .75 lb heavier than infants delivered vaginally. (Interestingly, differences in birthweight are due to the increasingly larger birthweights in the cesarean section group, the vaginal delivery group having birthweights almost identical throughout the sample subset.)

Discussion

This study compared the average pelvic diameters of women whose babies were delivered vagi-

Table 2. Average Pelvic Measurements of Women Who Delivered Vaginally or by Cesarean Section

			Pelvic Measurements (cm)						
		No.	Inlet Antero-posterior	Inlet Trans-verse	Mid-pelvis Antero-posterior	Mid-pelvis Trans-verse	T^2	*df*	P
	Mode of Delivery								
Group A Total sample	Vaginal	47	12.5	13.1	12.7	10.3	6.897	4,80	.17
	Cesarean section	38	12.1	13.2	12.2	10.2			
Group B Women with abnormal labor patterns	Vaginal	22	12.5	13.2	12.5	10.4	1.952	4,42	.77
	Cesarean section	25	12.2	13.3	12.3	10.3			
Group C Women with selected abnormal labor patterns	Vaginal	13	12.8	13.3	12.7	10.3	3.226	4,24	.59
	Cesarean section	16	12.2	13.3	12.2	10.3			

nally with those of women whose babies were delivered by cesarean section. Comparisons were made for three sample subsets: Group A, which included the total sample; Group B, which included patients with in-labor assessment for abnormal labor patterns; and Group C, which included patients with in-labor assessment for either protraction or arrest disorders.

Since patients with protraction and arrest labor disorders have the highest percentage of CPD and thus higher probability of small pelvic dimensions, one would expect the greatest average difference in pelvic diameter to occur between patients experiencing vaginal vs abdominal delivery with these labor patterns. This study, however, found no significant differences in diameter values for this sample subset. Nor did Mengert's index or the summation plane value demonstrate any real difference. Thus, even in a select group having the greatest probability of cephalopelvic disproportion, pelvimetry did not reveal correspondingly small pelvic dimensions.

Table 3. Mengert's Indexes for Women With Abnormal Labor Patterns Whose Babies Were Delivered Vaginally or by Cesarean Section

		Mengert's Indexes	
Mode of Delivery	No.	Inlet	Midpelvis
Vaginal	22	114%	104%
Cesarean section	25	112%	102%

$T^2 = .359$, $df = 2,44$, $P = .84$

One may still question whether knowing specific pelvic diameters might help the physician determine CPD on a case-by-case basis. The test of positive predictive value examined this question using Group B. Yet even in this skewed population, those patients with contracted pelvic dimen-

Table 4. Women With Contracted or Borderline Pelvic Measurements Who Require Cesarean Section Delivery* (Includes Women With Abnormal Labor Patterns Only)

Pelvic Measurements	Number of Women	Percent Requiring Cesarean Section (Positive Predictive Value)
Mengert's index		
Inlet		
< 85%	0	–
85 to 90%	1	0
90 to 95%	4	50
Midpelvis		
< 85%	6	67
85 to 90%	12	67
Inlet anteroposterior		
< 10 cm	1	0
10 to 11.5 cm	9	78
11.5 to 12.5 cm	20	55
Midpelvis transverse		
< 9.5 cm	3	100**
9.5 to 10 cm	15	60
10 to 10.5 cm	12	25
Inlet sum		
< 22 cm	0	–
22 to 25.5 cm	24	58
Midpelvic sum		
< 21 cm	9	67
21 to 22 cm	11	36

*Average values: Mengert's index, 100; inlet anteroposterior, 12.5 cm; midpelvis transverse, 10.5 cm; inlet sum, 25.5 cm; and midpelvic sum, 22 cm
**Two of these three patients went on within one hour for cesarean section. Four patients with ≤ 9.5 were delivered of babies vaginally

sions (according to the predetermined values) and having cesarean section for presumed CPD generally made up no more than 60 to 70 percent of the sample. Thus, even among patients having abnormal labor and small pelvic capacity, the percentage of patients going on to cesarean section for CPD is inconsistent. This outcome suggests that x-ray pelvimetry provides insufficient data for determining decisions concerning delivery type.

Birthweight is another factor contributing to the presence of CPD (although, unlike pelvic dimension, not one that can be determined during labor). In this study, average birthweight differed significantly between infants born in the cesarean section and the vaginal delivery groups. This difference (large babies in the cesarean section group) held for both primiparas and multiparas in this population. Thus, infant size appeared to be a prominent etiologic factor in CPD. Given this association, the physician should consider large infant size before small bony pelvic dimensions as the cause of possible CPD in patients having abnormal labor.

Results of this study parallel those of other studies that show that x-ray pelvimetry for presumed CPD yields findings contrary to the ration-

Table 5. Average Birthweights of Infants Born to Six Groups of Women Whose Babies Were Delivered Vaginally or by Cesarean Section

	Infant Birthweights			
Group	Vaginal Delivery	Cesarean Section Delivery	*t* Value	Probability
A. Total	7 lb 9 oz (47)*	8 lb 5 oz (39)	−2.72	.008
B. Abnormal labor pattern	7 lb 8 oz (22)	8 lb 11 oz (25)	−3.67	.001
C. Selected abnormal labor pattern**	7 lb 11 oz (13)	8 lb 12 oz)16)	−2.34	.027
Multiparas with selected abnormal labor pattern	7 lb 11 oz (5)	10 lb 2 oz (3)	−2.25	.065
Primiparas with selected abnormal labor pattern	7 lb 10 oz (8)	8 lb 6 oz (13)	−1.67	.110
Total without abnormal labor pattern	7 lb 10 oz (25)	7 lb 10 oz (14)	.05	.964

*Numbers in parentheses refer to the number of women in each group
**Selected abnormal labor patterns include secondary arrest of dilatation, protracted active phase, prolonged deceleration, arrest of descent

ale for expectations of this technique. In one study, 22.5 percent of patients with x-ray–diagnosed CPD in either inlet or midpelvis planes proceeded to vaginal deliveries.[5] In the reverse comparison, another study showed that 48.3 percent of all subjects having cesarean section delivery for presumed CPD had a normal-sized pelvis as measured by x-ray pelvimetry.[1] And further, among patients with a previous cesarean section for CPD who were allowed an adequate trial of labor in a subsequent pregnancy with a similar-sized baby, about one half were able to have their babies delivered vaginally.[12]

Patients having x-ray pelvimetry have significantly more abnormal deliveries, by cesarean section, by forceps, or by vacuum extractor. The cesarean section rate alone for patients having pelvimetry is 40 percent in one study,[13] 43 percent in another study,[5] and 43 percent in this study. The physician referring a patient for x-ray assessment during labor is actually placing the patient in a group likely to have problems during labor for whatever reason.

As for the usefulness of x-ray pelvimetry in the management of labor, a recently published prospective study revealed that "in 98 percent of patients, no change in immediate clinical management plan was made on the basis of x-ray pelvimetry findings."[6]

X-ray pelvimetry is not an innocuous test. Foremost of risks inherent in the procedure is the radiation hazard, which poses potential oncogenic risk to the unborn fetus.[7,11] Additional risk exists in the trip to the radiology department, where the fetus is usually unmonitored for one-half hour or more, eliminating the opportunity for early diagnosis of fetal distress. If the baby were to be born there, the x-ray room would not be an optimal setting for delivery, treatment of immediate postpartum complications, and resuscitation of a depressed or asphyxiated infant. Thus, even disregarding patient discomfort, inconvenience, and expense, ample evidence of risk potential exists to require greater proof of the usefulness of x-ray pelvimetry.

If x-ray pelvimetry does not reliably aid the physician in determining the necessity for operative delivery, then virtually every woman deserves an adequate trial of good-quality labor. The key to evaluating failure to progress in labor is distinguishing between cephalopelvic disproportion and inefficient uterine action as the reason. Therein lies the usefulness of active management of labor as proposed by O'Driscoll and Strange.[14] This management plan recommends acceleration of labor through careful use of intravenous oxytocin in predetermined circumstances: primigravidas with vertex presentation in confirmed labor who deviate from the normal labor curve in carefully defined ways. Management would include rupturing membranes, observing presence or absence of meconium, continuous fetal monitoring, and quantitation of uterine force. Research following this protocol has shown that uterine action is the dominant factor in failure to progress, with CPD being very uncommon, affecting about one in 200 primigravidas.[14] With careful acceleration of labor, there is no increase in fetal morbidity or mortality.[14]

The goal of an active approach to labor is not to deliver all babies vaginally. Rather, it is to make more certain the diagnosis of CPD by allowing patients with abnormal labor patterns a good trial of labor, if need be by carefully monitored acceleration of labor. The decision of delivery mode then is based entirely on observing labor progress while monitoring maternal and fetal status. Thus, fetal pelvic capacity is validated by the presence or absence of steadily increasing cervical dilatation or fetal descent. The trial continues either until labor fails to progress or until full dilatation and descent occur to allow vaginal delivery. If progress ceases in the face of adequate uterine activity, the diagnosis of CPD is made, and the need for abdominal delivery is apparent.

Conclusions

This and other studies question the usefulness of x-ray pelvimetry. Even in a select group of patients with the highest probability of cephalopelvic disproportion, a condition it was believed x-ray pelvimetry could diagnose, no real difference in bony pelvic dimensions existed between patients having their babies delivered vaginally and those undergoing cesarean section. Further, the predictive value of small pelvic dimensions is weak and provides insufficient data for determining decisions concerning delivery type. Thus, x-ray pelvimetry findings are not reliable guides to physicians deciding mode of delivery, for in fact they may be misleading.

In the past, physicians have felt that the potential benefits of x-ray pelvimetry outweighed the risks. Now, however, given better descriptions and understanding of normal and abnormal labor patterns, more data on various factors associated with failure to progress, improved technology for safe intravenous administration of oxytocin, and reliable continuous fetal monitoring, the risk-benefit ratio for x-ray pelvimetry has been altered. The physician should carefully consider the hazards of the technique as well as its limited predictability before ordering x-ray pelvimetry. In the very few instances when pelvimetry appears desirable, then, as the Food and Drug Administration recently advised, the rationale for requesting pelvimetry should be documented on the patient's chart.[3]

References

1. Barton J, Garbaciak J: Is x-ray pelvimetry necessary? Contemp Ob/Gyn, June 1979, pp 27-30
2. Friedman EA: Labor: Clinical Evaluation and Management, ed 2. New York, Appleton-Century-Crofts, 1978
3. Brown RF: The selection of patients for x-ray examinations. Public Health Service, Bureau of Radiological Health (Rockville, Md). DHEW publication No. (FDA) 80-8104. Government Printing Office, 1980
4. Campbell JA: X-ray pelvimetry: Useful procedure or medical nonsense? J Natl Med Assoc 68:514, 1976
5. Fine A, Bracken M, Berkowitz LR: An evaluation of the usefulness of x-ray pelvimetry: Comparison of the Thoms and modified Ball methods with manual pelvimetry. Am J Obstet Gynecol 137:15, 1980
6. Laube WD, Varner WM, Cruikshank PD: A prospective evaluation of x-ray pelvimetry. JAMA 246:2187, 1981
7. Stewart A, Webb J, Hewitt D: A survey of childhood malignancies. Br Med J 1:1495, 1958
8. McMahon B: Prenatal x-ray exposure and childhood cancer. US Cancer Instit J 28:1173, 1968
9. Bross I, Natarajan N: Leukemia from low-level radiation. N Engl J Med 287:107, 1972
10. Griem ML, Meier D, Dobben GD: Analysis of the morbidity and mortality of children irradiation in fetal life. Radiology 88:347, 1967
11. Stewart A, Kneale GW: Radiation dose effects in relation to obstetric x-rays and childhood cancers. Lancet 1:1185, 1970
12. Jagani N, Shulman H, Prasanta C, et al: The predictability of labor outcome from a comparison of birthweight and x-ray pelvimetry. Am J Obstet Gynecol 139: 507, 1981
13. Kelly MK, Madden DA, Arcarese JS, et al: The utilization and efficacy of pelvimetry. Am J Roentgenol 125:66, 1975
14. O'Driscoll K, Strange J: The active management of labour. Clin Obstet Gynecol 2:3, 1975