Original Research

Is routine X-ray pelvimetry of value to decide on mode of delivery for women with labor dystocia?

Kaori Kawakami[1,2,†], Yuria Tanaka[1,2,†], Yuji Ikeda[1], Atsushi Komatsu[1,*], Osamu Kobayashi[1], Takahiro Nakajima[1], Takehiro Nakao[1], Chiaki Takeya[1], Mikiko Asai-Sato[1], Fumihisa Chishima[1], Misako Iwata[2], Kei Kawana[1,*]

[1] *Department of Obstetrics and Gynecology, Nihon University School of Medicine, 30-1 Oyaguchi-kamimachi, Itabashi-ku, 173-8610 Tokyo, Japan*

[2] *Department of Obstetrics and Gynecology, Tokyo Metropolitan Ohtsuka Hospital, 2-8-1 Minami Ohtsuka Toshima-ku, 170-8476 Tokyo, Japan*

*Correspondence: kkawana-tky@umin.org (Kei Kawana); atsukoma@yahoo.co.jp (Atsushi Komatsu)

† These authors contributed equally.

DOI:10.31083/j.ceog.2021.02.2336

Submitted: 26 October 2020 Revised: 21 January 2021 Accepted: 08 February 2021 Published: 15 April 2021

X-ray pelvimetry is used for evaluation of pelvic inlet generally to diagnose cephalopelvic disproportion (CPD) or contracted inlet. Cesarean section delivery (C/S) is often performed for labor dystocia without CPD or contracted inlet. We examined whether X-ray pelvimetry is useful to decide on mode of delivery in women with dystocia. A total of 1118 pregnant women received X-ray pelvimetry before or during labor. 205 women with cesarean deliveries for indications except for dystocia were excluded. 913 women undergoing induction/augmentation were retrospectively investigated. Obstetrical and maternal variables were analyzed by univariate, multivariate or ROC analysis. Among 913 women, 37 including three with contracted inlet and seven with CPD, gave birth by C/S, whereas 876 gave birth by vaginal delivery. Low maternal height, older age, small obstetrical conjugate, large weight and infant head size were associated with risk of C/S for dystocia. Multivariate analysis revealed that the obstetrical conjugate was an independent variable for risk of C/S. The area under the ROC curve and the optimal cut-off values, respectively, were as follows: obstetrical conjugate: 0.68 and 11.7 cm (odds ratio = 4.27), transverse diameter: 0.59 and 11.4 cm (odds ratio = 1.82), maternal height: 0.70 and 155.5 cm (odds ratio = 4.33), and maternal weight before pregnancy: 0.55 and 49.7 kg (odds ratio = 1.98). The obstetrical conjugate was an independent variable associated with risk of C/S for dystocia. Maternal height was comparable to the conjugate in term of diagnostic ability. Our data suggested that routine X-ray pelvimetry was not beneficial to identify women at risk of C/S for dystocia.

Keywords

X-ray pelvimetry; Labor dystocia; Cephalopelvic disproportion

1. Introduction

X-ray pelvimetry is a digital examination to evaluate the pelvic cavity of pregnant women and is often used for the diagnosis of contracted pelvic inlet and cephalopelvic disproportion (CPD). Women who are short in stature are occasionally subjects of pelvimetry since low maternal height is assumed to correlate with contracted pelvic inlet. In East Asia, pregnant women with low height less than 150 cm are observed, and such women are evaluated by pelvimetry as a screening test for contracted inlet. Additionally, unengaged fetal head during labor regardless of effective uterine contraction suggests CPD, and pelvimetry is considered as an objective mean precisely to distinguish CPD. Such women often receive labor induction or augmentation by oxytocin after excluding CPD. In terms of CPD diagnosis, X-ray pelvimetry is very useful because of the simple and rapid examination involved.

The guidelines of maternal-fetal medicine and/or the attached documents of pharmaceutical agents for labor induction/augmentation often show that X-ray pelvimetry is recommended to negate contracted inlet prior to induction/augmentation [1]. However, a Cochran review in 2017 reported that routine X-ray pelvimetry leads to the increased rate of cesarean delivery but does not improve other perinatal outcomes [2]. Dystocia sometimes occurs during labor due to various mechanisms, even when CPD or contracted inlet are negated. In such cases, cesarean delivery for dystocia is often performed following a trial of vaginal delivery, including pharmaceutical or mechanical induction/augmentation. The cesarean birth rate increased for a decade starting in 2000 and has remained unchanged from 2010 at 32–33% in the United States [3]. More than 85% of cesarean deliveries are performed for four major reasons: nonreassuring fetal status, fetal presentation, prior cesarean operation and dystocia. When repeat cesarean deliveries are included, approximately 60% of all cesarean deliveries are attributable to the diagnosis of abnormal labor [4]. Thus, the diagnostic criteria of the arrested labor have been revised to prevent unnecessary first cesarean deliveries for dystocia in the United State [5]. It is important for reducing the cesarean birth rate to understand the risk factors of cesarean delivery for dystocia.

We have perform routine X-ray pelvimetry to evaluate the pelvic cavities of all pregnant women prior to pharmacological induction/augmentation. No study has ever conducted X-ray pelvimetry on all pregnant women undergoing the induction/augmentation. In this study, we retrospectively investigated their obstetrical variables, including evaluation of the pelvic inlet (obstetrical conjugate and transverse diameter) to determine whether routine X-ray pelvimetry can identify women at risk of cesarean delivery for dystocia. Our data could provide obstetricians with a basis of for considering the indications for X-ray pelvimetry in the management of labor and delivery.

Clinical and Experimental Obstetrics & Gynecology

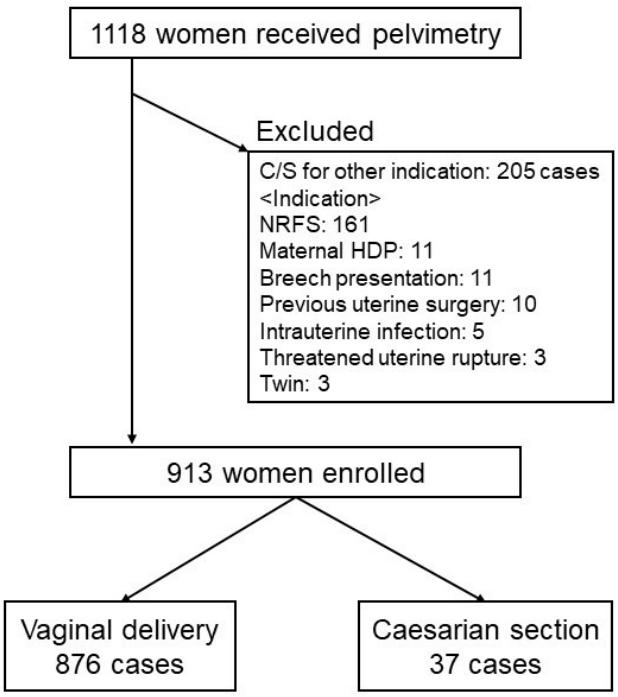

Fig. 1. Subject of this study. Among 1118 women who received X-ray pelvimetry, 205 women with C/S due to reasons other than dystocia were excluded. The remaining 913 were divided into two groups: cesarean (n = 37) and vaginal (n = 876) delivery groups.

2. Materials and methods

2.1 Study design

This study was a retrospective survey study of pregnant women who delivered at the Tokyo Metropolitan Otsuka Hospital. This study was approved by the Ethics Committee of our hospital, and decisions of enrolled pregnant women to be included in this study were expressed by the opt-out approach.

2.2 Patients (sample size and inclusion/exclusion criteria)

A total of 1118 pregnant women had received X-ray pelvimetry at the end of pregnancy from 2014–2017 in the Tokyo Metropolitan Otsuka Hospital. The X-ray pelvimetry was performed routinely prior to pharmaceutic and/or mechanical methods of labor induction/augmentation to negate contracted inlet or CPD. Among 1118 women who received X-ray pelvimetry, 205 women with C/S due to reasons as following were excluded; nonreassuring fetal status, twin pregnancy, maternal hypertensive disorder, breech presentation, threated uterine rupture after previous uterine surgery, and intrauterine infection. The remaining 913 were included in our analysis dividing into two groups: cesarean (n = 37) and vaginal (n = 876) delivery groups (Fig. 1).

2.3 Methods and data collection

X-ray pelvimetry was performed by the Guthmann and Martius methods, which are standard for the evaluation of the pelvic inlet [6]. The obstetrical conjugate and transverse diameter of all cases were measured using a ruler by a specialist in maternal-fetal medicine. CPD was diagnosed due to unengaged fetal head, suspected large for date infant and maternal contracted inlet. Maternal contracted inlet was diagnosed by the definition of the Japanese Society of Obstetrics and Gynecology (JSOG) as follows: the obstetrical conjugate measures 10.5 cm or more for normal, 9.5–10.5 cm for relatively contracted, and less than 9.5 cm for contracted inlet; and the transverse diameter measures 11.5 cm or more for normal, 10.5–11.5 cm for relatively contracted, and less than 10.5 cm for contracted inlet [7].

Patient back grounds and obstetrical and infant variables were investigated retrospectively. The data including the obstetrical conjugate and transverse diameter were collected by examining medical records. All data were anonymized and kept strictly confidential by the investigators.

2.4 Statistical analysis

Comparisons in these variables between cesarean versus vaginal delivery groups were made by the Mann-Whitney U test since the distribution of each data was non-uniform. Chi square test was also performed for categorical data. The independent risk factor for cesarean birth was analyzed by multivariate regression analysis. P value < 0.01 was defined as a significant difference (α error and power were 0.01 and 0.8, respectively). Areas under the ROC curve (AUCs) and cut-off values of each variable for cesarean delivery were calculated by ROC analysis. Statistical software (IBM SPSS statistics version 26) (IBM, NY) was used for all analysis.

3. Results

3.1 Comparison of maternal and obstetrical variables between the C/S (for dystocia) group and the vaginal delivery group

To determine which variables are related to risk of C/S for labor dystocia, we focused on women with cesarean delivery for dystocia and then compared them to those with vaginal delivery. 913 women were included for final analysis. Overall, 37 (4%) of 913 women underwent C/S for dystocia, while 876 women gave birth by vaginal delivery (summarized in Fig. 1). Among them, seven cases were diagnosed as CPD according to the clinical situation.

Next, we compared between the C/S for dystocia vs. vaginal delivery groups in various obstetrical variables to identify a possible warning sign of C/S for dystocia (Table 1). Low maternal height, older age, small obstetrical conjugate, large weight and head size of infant were associated with risk of C/S for dystocia with significant differences (Mann-Whitney U test; $P < 0.01$). The differences in the transverse diameter, gestational week of delivery and fetal biparietal diameter (BPD) between the two groups were marginally significant, with P values from 0.01–0.05. The other variables did not differ between the two groups. Among the variables to show significant associations with C/S for dystocia, maternal height and the obstetrical conjugate were the only personal maternal characteristics that did not depend on the condition of the birth canal, uterine contractions or the newborn infant. Maternal height in the C/S group (154.0 $\pm$ 5.8 cm) was clearly shorter than that in the vaginal group (158.0 $\pm$ 5.4 cm), and the obstetrical conjugate in the C/S group

Table 1. Comparison between C/S for dystocia vs. vaginal delivery groups.

Obstetrical variable	C/S (n = 37)	Vaginal delivery (n = 876)	*P* value**
Mother			
Age*	37.0 ± 5.5	33.0 ± 5.4	**0.004**
Parity*	0.0 ± 0.8	0.0 ± 0.7	0.675
Height*	154.0 ± 5.8	158.0 ± 5.4	**< 0.001**
BW before pregnancy*	49.7 ± 9.8	52.0 ± 8.8	0.275
BW at delivery*	62.6 ± 10.4	63.7 ± 9.4	0.862
Pelvimetry			
Gestational week of measure*	39.0 ± 2.1	39.0 ± 1.6	0.353
Obstetrical conjugate*	11.6 ± 0.9	12.2 ± 0.8	**< 0.001**
Transverse diameter*	11.8 ± 0.8	11.8 ± 0.7	0.050
Delivery			
Gestational week of delivery*	40.0 ± 1.3	40.0 ± 1.3	0.016
Intervention for delivery			0.148***
No intervention	9	183	
Induction	16	270	
Augmentation	12	423	
Newborn infant			
BW*	3315.0 ± 317.0	3112.5 ± 411.0	**< 0.001**
Head circumference*	34.3 ± 1.3	33.5 ± 1.2	**< 0.001**
Biparietal diameter (BPD)*	9.6 ± 0.5	9.3 ± 0.4	0.036
Gender			0.759***
Male	17	425	
Female	20	451	

*: Median and SD. **: *P* value by Mann-Whitney U test.

***: *P* value by Chi square test.

(11.6 ± 0.9 cm) was clearly smaller than that in the vaginal group (12.2 ± 0.8 cm). One woman was shorter in stature than 150 cm (height = 142 cm), and she was diagnosed as contracted inlet (conjugate = 9.3 cm) and underwent elective C/S. Eight women were diagnosed with relatively contracted inlets by the obstetrical conjugate, and seven gave birth vaginally, whereas one gave birth by C/S. Among 37 women with C/S, only seven were diagnosed as CPD by abnormal labor conditions, including fetal head unengagement. Of seven with CPD, three were diagnosed as contracted inlet and one as relatively contracted inlet by the transverse diameter. The remaining 29 women underwent C/S for dystocia under conditions that did not include either contracted inlet or CPD.

3.2 Multivariate analysis of obstetrical variables to identify women with risk of C/S for dystocia

Older pregnant women are likely to undergo C/S due to not only their cervical resistance, uterine dysfunction or both but also maternal exhaustion. Indeed, maternal age in the C/S group (37.0 ± 5.5) was four years older than that in the vaginal delivery group (33.0 ± 5.4) in this study. Infant head size and birth weight in the C/S group were also greater than those in the vaginal delivery group, although these variables might be influenced by gestational week of delivery. Thus, there were several confounding variables in the univariate analysis shown in Table 1. We then tried to identify independent variables to be associated with C/S for dystocia by logistic regression analysis (Table 2). Eight variables that showed significant differences ($P < 0.05$) between the C/S and vaginal delivery groups by univariate analysis were evaluated. The multivariate analysis revealed that the obstetrical conjugate was just an independent variable for C/S. The obstetrical conjugate was related inversely to the incidence of C/S for dystocia, with an odds ratio of 3.13 (95% CI: 1.32–7.14, $P = 0.01$), while the transverse diameter did not show a significant inverse correlation. Maternal age and height, infant weight and head size were not independent variables associated with the risk of C/S for dystocia. Univariate and multivariate analyses revealed that maternal height and the obstetrical conjugate are important variables associated with the risk of C/S for dystocia.

Table 2. Multivariate analysis of risk factors for C/S.

Variables	Odds ratio	95% CI	*P* value*
Mother			
Age	0.95	0.86–1.04	0.30
Height	1.05	0.92–1.20	0.49
Pelvimetry			
Obstetrical conjugate	**3.13**	**1.32–7.14**	**0.01**
Transverse diameter	2.44	0.95–6.25	0.06
Delivery			
Gestational week of delivery	0.93	0.55–1.59	0.80
Newborn infant			
BW	1.00	1.00–1.01	0.42
Head circumference	0.83	0.47–1.45	0.51
BPD	0.36	0.06–2.22	0.27

**: *P* value by Logistic regression analysis.

3.3 Correlation of the obstetrical conjugate to maternal height

A correlation between maternal height and the obstetrical conjugate in Asian women has not been clarified, although the two maternal physical characteristics are likely to correlate to each other. We then plotted the two variables of 913 women, as shown in Fig. 2. The open and closed dots indicate women with vaginal delivery (n = 876) and cesarean delivery (n = 37), respectively (Fig. 2A). The dots show the significant correlation between maternal height and the conjugate ($R = 0.483$, $P < 0.001$). Among them, women with C/S delivery were then plotted in Fig. 2B, and the correlation between maternal height and the conjugate was also observed ($R = 0.661$, $P < 0.001$). By comparison between the open and closed dots, the closed dots were likely to be plotted at a lower height and a smaller conjugate than the open dots, corresponding to our data in Table 1. These data indicated that maternal height was correlated with the obstetrical conjugate regardless of the mode of delivery.

3.4 ROC curve analysis to evaluate maternal variables for discrimination of mode of delivery

Our multivariate analysis revealed that the obstetrical conjugate was an independent variable associated with risk of C/S for dystocia. We also demonstrated the correlation be-

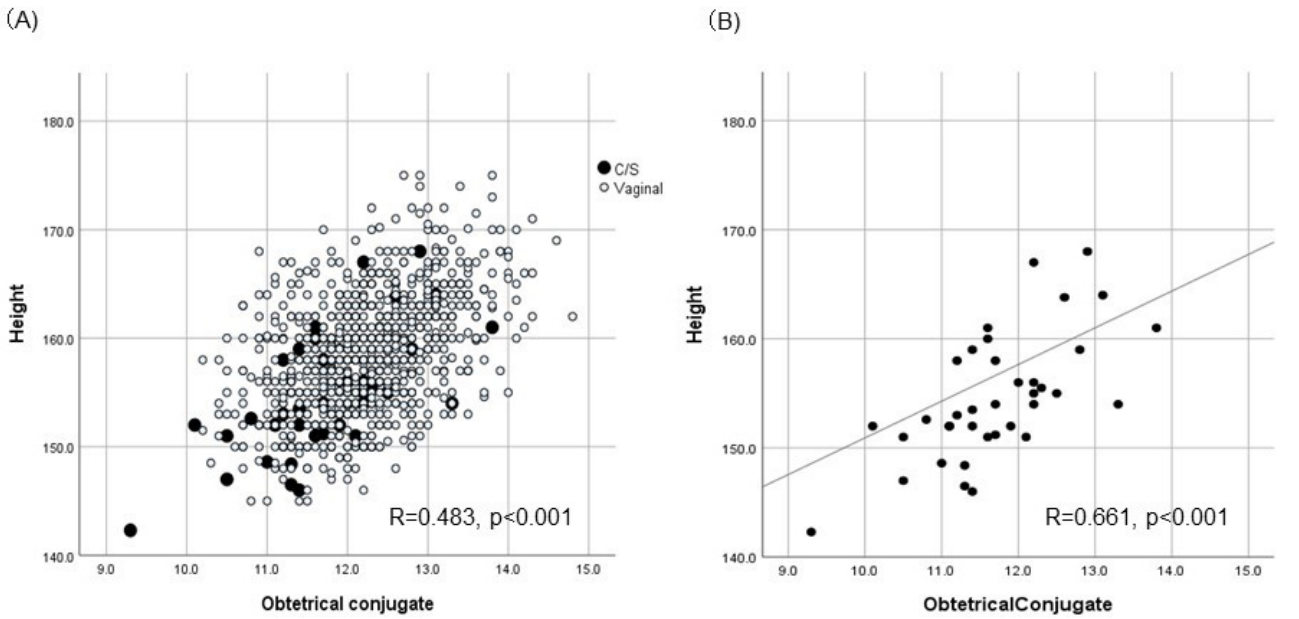

Fig. 2. Correlation between the obstetrical conjugate and maternal height. (A) Open dots indicated women with vaginal delivery and close dots indicated women with C/S for dystocia. (B) Close dots (women with C/S) were taken up and linear line indicated correlation (R = 0.661).

tween the conjugate and maternal height. We then tried to examine whether alternative maternal variables could be warning signs of C/S for dystocia compared with the obstetrical conjugate by ROC curve analysis (Fig. 3). We considered that ROC curve analysis can evaluate various maternal variables as measures that either confirm the presence of risk of C/S or rule out the risk. ROC curves of the maternal variables height, weight before pregnancy, the obstetrical conjugate and transverse diameter were calculated by plotting the sensitivity versus 1-specificity of each threshold value. These ROC curves provided areas under the ROC curve (AUCs) and the optimal cut-off value of each variable and enabled us to compare the diagnostic abilities of the four variables to discriminate the possible risk of C/S in women with dystocia. The AUCs and the optimal cut-off values, respectively, were as follows: maternal height (bold line): 0.70 and 155.5 cm (odds ratio = 4.33, sensitivity = 64.9%), maternal weight before pregnancy (dotted thin line): 0.55 and 49.7 kg (odds ratio = 1.98, sensitivity = 51.3%), obstetrical conjugate (bold dotted line): 0.68 and 11.7 cm (odds ratio = 4.27, sensitivity = 59.5%), and transverse diameter (thin line): 0.59 and 11.4 cm (odds ratio = 1.82, sensitivity = 40.5%) (Fig. 3). The lines for maternal height and the obstetrical conjugate overlapped each other, and these AUCs (0.70 vs. 0.68) were clearly higher than those of maternal weight and transverse diameter. The odds ratios of C/S at the optimal cut-off value were 4.33 for maternal height and 4.27 for the obstetrical conjugate, indicating that maternal height was comparable to the obstetrical conjugate as a measure to discriminate the maternal risk of C/S.

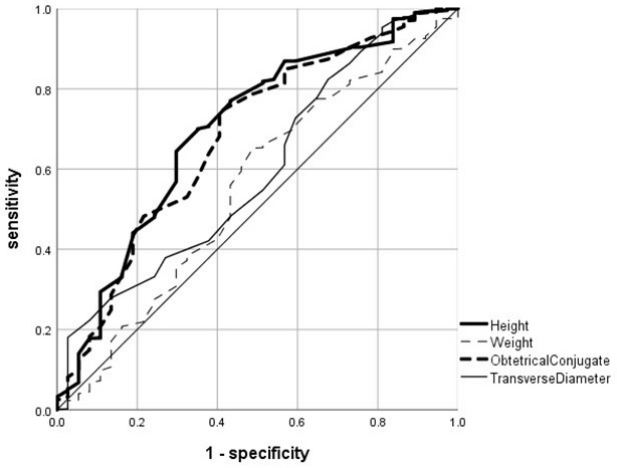

Fig. 3. ROC curve analysis of four maternal variables for risk of C/S. ROC curves of maternal height (bold line), maternal weight before pregnancy (dotted thin line), obstetrical conjugate (bold dotted line), and transverse diameter (thin line) were shown. The curves were calculated by plotting sensitivity (Y-axis) versus 1-specificity (X-axis) of each threshold value.

4. Discussion

In this study, we investigated the association between measures (the obstetrical conjugate and transverse diameter of pelvic inlet) of X-ray pelvimetry and cesarean delivery for labor dystocia using data from 913 women in labor. Our data indicated that the obstetrical conjugate was an independent variable correlating inversely with the incidence of C/S for dystocia but that maternal height could be a comparable variable to the conjugate in terms of the discrimination of the risk of C/S.

X-ray pelvimetry is a useful measure to evaluate the inlet to exclude CPD or contracted inlet and is recommended prior to labor induction/augmentation to negate the contracted inlet according to a guideline of maternal-fetal medicine in Japan [1]. Thus, we have routinely performed pelvimetry on all women who are to undergo induction or augmentation for various reasons. However, among 913 women, contracted inlet was only observed in four women (4/913 = 0.4%). Conversely, a Cochran systematic review demonstrated that women who receive X-ray pelvimetry are likely to undergo C/S. Dystocia is not only one of the major reasons for C/S but is also associated with pelvic disproportion, which is evaluated by pelvimetry. Then, we took an interest in the clinical question of whether measurements obtained from X-ray pelvimetry are associated with the incidence of C/S and influence our decision of mode of delivery in the cases of dystocia. Our database of more than one thousand measures obtained from routine X-ray pelvimetry was valuable to clarify this question. The Cochran review performed in 2017 identified five studies with a total of 1159 women, and these studies compared X-ray pelvimetry (n = 582) versus no pelvimetry (n = 577) [2]. The number of women who received X-ray pelvimetry in our study was greater than that in the Cochran review.

In this study, we excluded women undergoing C/S due to nonreassuring fetal status, fetal presentation or prior uterine operation from the subject of analysis. All of the remaining 913 women received X-ray pelvimetry prior to labor induction and/or augmentation and delivered a baby by either cesarean or vaginal deliveries. Overall, 37 women with C/S for dystocia and 876 women with vaginal delivery were compared. Univariate analysis revealed that maternal height and age, infant weight and head size, and the obstetrical conjugate were associated with risk of C/S, with significant differences. Regarding measures of X-ray pelvimetry, a significant difference ($P < 0.01$) was found in the obstetrical conjugate, but not the transverse diameter. These obstetrical variables are likely to confound each other; thereby, multivariate analysis was needed to identify an independent variable. Multivariate analysis revealed that the obstetrical conjugate was the only independent variable associated with C/S for dystocia. Taken together with data from the 2017 Cochran review, measures of the obstetrical conjugate might influence us to make decisions of mode of delivery. In our data, although the obstetrical conjugate identified a woman with contracted inlet and eight women with relatively contracted inlet, only two of them underwent C/S, suggesting that the obstetrical conjugate was not involved in the decision of mode of delivery. In other words, our statistical analysis indicates that a larger obstetrical conjugate resulted in a reduction of risk of C/S for dystocia (Odds ratio = 3.13).

Previous studies [8, 9] and a systematic review [2] have demonstrated that X-ray pelvimetry does not improve perinatal outcome and that routine X-ray pelvimetry is not useful to women with normal presentation. Regarding women with previous C/S or breech presentation, some studies have reported the usefulness of X-ray pelvimetry [10]. Our study did not address the usefulness of X-ray pelvimetry from the viewpoint of perinatal outcome, and thereby, we did not compare the outcome with the no-X-ray pelvimetry group.

In this study, the transverse diameter identified three cases of contracted inlet and one relatively contracted inlet, and all underwent C/S with CPD, while the obstetrical conjugate identified only two women with C/S among nine with contracted or relatively contracted inlet. The transverse diameter was more significant than the obstetrical conjugate in terms of the diagnostic measure of contracted inlet. Nevertheless, the abnormality detected by X-ray pelvimetry rarely occurred in our population (contracted inlet: 4/913, relatively contracted: 9/913, and CPD: 7/913 women). Several studies have reported that maternal height with or without a measure of pelvimetry can be a variable to predict dystocia [11] or CPD [12]. Maternal height is also reported to correlate to the obstetrical conjugate [13]. Indeed, our data clearly indicated the correlation between maternal height and the obstetrical conjugate, regardless of mode of delivery. Since the obstetrical conjugate was associated with risk of C/S for dystocia, maternal height in our population was thought to be an alternative variable for the conjugate. Our ROC analysis demonstrated the hypothesis that maternal height is comparable to the obstetrical conjugate to discriminate maternal risk of C/S for dystocia. Numerous previous studies have demonstrated that maternal height is inversely related to risk of not only C/S [14–18] but also labor dystocia [19–23]. Taken together with our ROC curve, maternal short stature is sufficient to be an independent variable associated with the decision of mode of delivery.

In contrast, the transverse diameter did not show high diagnostic capacity. Interestingly, the 11.4 cm cut-off value for the transverse diameter on the ROC curve was concordant with the upper criterion (11.5 cm) of a relatively contracted inlet, while 11.7 cm for the obstetrical conjugate was quite different from the upper criterion (10.5 cm) of a relatively contracted inlet.

This study has some limitations. Since this was a retrospective study, the variability of the obstetricians in charge of decision making in the choice of delivery mode could not be ruled out. We also cannot deny the possibility that the diagnosis of dystocia also varied among the obstetricians in charge. On the other hand, the strength of this study was that the X-ray pelvimetry data were available for all of the more than 900 women in labor and the data were measured by the same obstetrician using the same rules.

5. Conclusions

X-ray pelvimetry is an important measurement to evaluate the pelvic inlet, especially prior to labor induction/augmentation. However, contracted inlet is a very rare event (approximately 1%) in Asian women, and maternal height can be comparable to measures of X-ray pelvimetry. Our data indicated that routine X-ray pelvimetry is not of value to decide on mode of delivery for women with dystocia.

Abbreviations

AUC, areas under curve; CPD, cephalopelvic disproportion; C/S, cesarean section.

Author contributions

KaK, YT and MI conducted this study and measured X-ray pelvimetry. YI and AK made figures and tables. OK, NakajT, NakaoT, CT, MAS, FC investigated data of patients and analyzed them by statistical methods. KeiK and AK organized this study and described the article. All authors have read and approved the manuscript.

Ethics approval and consent to participate

All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Tokyo Metropolitan Ohtsuka Hospital (2018-77). The decision of enrolled pregnant women to be included in this study was expressed by opt-out approach, which is posted on the board in the hospital and our hospital's web site.

Acknowledgment

We are very thankful to Mrs. Naoko Tomita for her excellent management of clinical data and edit of the manuscript.

Funding

This research was supported by Japan Agency for Medical Research and Development under Grant Number JP 20gk0110042h0002.

Conflict of interest

The authors declare no conflict of interest.

References

[1] Minakami H, Maeda T, Fujii T, Hamada H, Iitsuka Y, Itakura A, *et al.* Guidelines for obstetrical practice in Japan. Japan Society of Obstetrics and Gynecology (JSOG) and Japan Association of Obstetricians and Gynecologists (JAOG) 2014 edition. Journal of Obstetrics and Gynaecology Research. 2014; 40: 1469–1499.

[2] Pattinson RC, Cuthbert A, Vannevel V. Pelvimetry for fetal cephalic presentations at or near term for deciding on mode of delivery. Cochrane Database of Systematic Reviews. 2017; 3: CD000161.

[3] Martin JA, Hamilton BE, Osterman MJK, Driscoll AK, Mathews TJ. Births. Final data for 2015. National Vital Statistics Reports. 2017; 66: 1.

[4] American College of Obstetrics and Gynecology Committee on Practice Bulletins-Obstetrics. ACOG practice bulletin number 49, December 2003: dystocia and augmentation of labor. Obstetrics & Gynecology. 2003; 102: 1445–1454.

[5] Spong CY, Berghella V, Wenstrom KD, Mercer BM, Saade GR. Preventing the first cesarean delivery: summary of a joint Eunice Kennedy Shriver National Institute of Child Health and Human Development, Society for Maternal-Fetal Medicine, and American College of Obstetricians and Gynecologists Workshop. Obstetrics & Gynecology. 2012; 120: 1181–1193.

[6] Cunningham FG, Leveno KJ, Bloom SL, Dashe JS, Hoffman BL, Casey BM, *et al.* Chapter 2: maternal anatomy. In Williams Obstetrics (pp. 31–35). 24th edn. McGraw-Hill Medical. 2014.

[7] Maeda M, Nakaoka Y, Tanaka M, Furukawa T, Usui A, Yuda K. Management of full term breech presentation-criteria for safe vaginal delivery (without extraction of the breech head). Nihon Sanka Fujinka Gakkai Zasshi. 1986; 38: 1540–1546.

[8] Korhonen U, Taipale P, Heinonen S. The diagnostic accuracy of pelvic measurements: threshold values and fetal size. Archives of Gynecology and Obstetrics. 2014; 290: 643–648.

[9] Parsons MT, Spellacy WN. Prospective randomized study of X-ray pelvimetry in the primigravida. Obstetrics and Gynecology. 1985; 66: 76–79.

[10] Harper LM, Odibo AO, Stamilio DM, Macones GA. Radiographic measures of the mid pelvis to predict cesarean delivery. American Journal of Obstetrics and Gynecology. 2013; 208: 460.e1–460.e6.

[11] Rozenholc AT, Ako SN, Leke RJ, Boulvain M. The diagnostic accuracy of external pelvimetry and maternal height to predict dystocia in nulliparous women: a study in Cameroon. BJOG: An International Journal of Obstetrics & Gynaecology. 2007; 114: 630–635.

[12] Toh-Adam R, Srisupundit K, Tongsong T. Short stature as an independent risk factor for cephalopelvic disproportion in a country of relatively small-sized mothers. Archives of Gynecology and Obstetrics. 2012; 285: 1513–1516.

[13] Adadevoh SW, Hobbs C, Elkins TE. The relation of the true conjugate to maternal height and obstetric performance in Ghanaians. International Journal of Gynaecology and Obstetrics. 1989; 28: 243–251.

[14] Mogren I, Lindqvist M, Petersson K, Nilses C, Small R, Granåsen G, *et al.* Maternal height and risk of caesarean section in singleton births in Sweden-a population-based study using data from the Swedish Pregnancy Register 2011 to 2016. PLoS ONE. 2018; 13: e0198124.

[15] Sokal D, Sawadogo L, Adjibade A. Short stature and cephalopelvic disproportion in Burkina Faso, West Africa. Operations Research Team. International Journal of Gynaecology and Obstetrics. 1991; 35: 347–350.

[16] Cnattingius R, Cnattingius S, Notzon FC. Obstacles to reducing cesarean rates in a low-cesarean setting: the effect of maternal age, height, and weight. Obstetrics & Gynecology. 1998; 92: 501–506.

[17] Chan BC, Lao TT. The impact of maternal height on intrapartum operative delivery: a reappraisal. Journal of Obstetrics and Gynaecology Research. 2009; 35: 307–314.

[18] Kara F, Yesildaglar N, Uygur D. Maternal height as a risk factor for Caesarean section. Archives of Gynecology and Obstetrics. 2005; 271: 336–337.

[19] Dujardin B, Van Cutsem R, Lambrechts T. The value of maternal height as a risk factor of dystocia: a meta-analysis. Tropical Medicine International Health. 1996; 1: 510–521.

[20] Place K, Kruit H, Tekay A, Heinonen S, Rahkonen L. Success of trial of labor in women with a history of previous cesarean section for failed labor induction or labor dystocia: a retrospective cohort study. BMC Pregnancy and Childbirth. 2019; 19: 176.

[21] Zhao R, Zhang W, Zhou L, Chen Y. Building a predictive model for successful vaginal delivery in nulliparas with term cephalic singleton pregnancies using decision tree analysis. Journal of Obstetrics and Gynaecology Research. 2019; 45: 1536–1544.

[22] Prasad M, Al-Taher H. Maternal height and labour outcome. Journal of Obstetrics and Gynaecology. 2002; 22: 513–515.

[23] Ikhena SE, Halligan AW, Naftalin NJ. Has pelvimetry a role in current obstetric practice? Journal of Obstetrics and Gynaecology. 1999; 19: 463–465.