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X-ray Pelvimetry Has No Impact on the Outcomes of Trial of Labor after Cesarean Delivery: A Retrospective Single-center Study

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Few studies have examined the relationship between pelvic size and the success or failure of trial of labor after cesarean delivery (TOLAC). Here we aimed to determine whether pelvic size and morphological data obtained from radiography contribute to the first successful TOLAC. This retrospective single-center observational study enrolled pregnant women who underwent TOLAC between 2010 and 2021. The results of X-ray pelvimetry data, including obstetric conjugate (OC), transverse diameter of the pelvic inlet (TD), anteroposterior diameter of the pelvic inlet (APD), shape of the pelvic inlet, and other obstetrical clinical data, were compared between the success and failure groups. Seventy-five patients in successful group after excluding 35 patients with previous successful TOLAC, and 21 patients in failure group were eligible. The failure group had a higher rate of previous cesarean sections due to failed labor trials (p = 0.042) and heavier newborns (p = 0.014). OC, TD, and APD on X-ray pelvimetry did not differ significantly between the two groups nor did the shape of the pelvic inlet affect the success rate for TOLAC. The generalized linear model identified a history of failed trials of labor as a significant predictor of failed TOLAC (odds ratio, 0.26; 95% confidence interval 0.071–0.923; p = 0.037), whereas no pelvimetric parameters were found. Pelvic size and morphological findings have no discernible impact on the outcomes of TOLAC. The universal application of X-ray pelvimetry in all women attempting TOLAC may not have significant clinical relevance.

INTRODUCTION

With an increasing cesarean delivery rate worldwide, the success of trials of labor after cesarean delivery (TOLAC) can reduce the surgical complications associated with cesarean section (CS) and the negative impact of cesarean delivery on subsequent pregnancies, such as the increased incidence of placenta accreta spectrum or cesarean scar pregnancy, thereby contributing to a reduction in overall CS rates and medical costs. Although TOLAC is generally considered to be safer than repeat CS (1), failure of TOLAC is associated with increased maternal and perinatal complications such as uterine rupture and fetal hypoxic-ischemic encephalopathy (2, 3); thus, selecting appropriate and likely successful cases is extremely important. According to a recent systematic review and meta-analysis, the factors that influence successful vaginal birth after cesarean section (VBAC) include obesity, hypertensive disorders in pregnancy, Bishop score, indications for previous CS, and previous successful VBAC (4). Nevertheless, accurately predicting the success or failure of vaginal delivery remains exceptionally challenging irrespective of prior CS history.

The size and shape of the pelvis, referred to as the passage (birth canal), is one of the three classical essential components of labor and delivery, along with the passenger (fetus) and power (strength of uterine contraction); thus, it should play a profound role in the success or failure of vaginal delivery. However, it is unclear whether radiographic pelvimetry is useful in predicting the success or failure of TOLAC. A Cochrane review in 2017 concluded that there is not enough evidence to support the use of X-ray pelvimetry for deciding the mode of delivery, although the evidence is too small and of low quality (5). However, the significance of pelvimetry should not be the same in TOLAC as in a simple trial of labor because in cases of TOLAC with a uterine scar, the occurrence of labor arrest itself may elevate the risk of uterine rupture to a considerable extent. Therefore, the usefulness of pelvimetry for TOLAC should be evaluated separately. Few studies have examined the relationship between pelvic size and the success or failure of TOLAC, and there are no data on pelvimetry in Asian women, whose pelvic size may be different from that of Caucasian women.

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In our institute, we performed X-ray pelvimetry using Martius and Guthmann views on women who underwent TOLAC to rule out a narrow pelvis that may potentially lead to cephalopelvic disproportion. In this study, we aimed to determine whether the pelvic size and morphological data obtained from X-ray pelvimetry contributed to the first successful TOLAC.

MATERIALS AND METHODS

Study design and patients

This retrospective observational study was approved by the Ethics Committee of Kyoto University (Kyoto, Japan) (R3868). Informed consent was obtained in the form of an opt-out. We retrospectively reviewed the data of all patients who underwent TOLAC at the Kyoto University Hospital between January 2010 and December 2021. Our hospital only permits TOLAC in cases that meet the following conditions: [1] Single prior CS with a transverse incision in the lower uterine segment; [2] the postoperative course was favorable and without infection or hematoma at the hysterotomy; [3] no history of uterine surgery involving myometrial incision; [4] lower uterine segment thickness >1 mm at 36 weeks of gestation; [5] singleton pregnancy and cephalic presentation; and [6] no findings suggesting a narrow pelvis or cephalopelvic disproportion. To examine condition 6, X-ray pelvimetry using Martius and Guthmann views have generally been performed in our institute. We employed the diagnostic criteria for narrow pelvis as defined by Japan Society of Obstetrics and Gynecology in 1972: obstetric conjugate (OC) <9.5 cm. We diagnosed cephalopelvic disproportion when the difference between OC and biparietal diameter of fetal head measured by ultrasound was less than 1 cm. However, there were no women with narrow pelvis or cephalopelvic disproportion diagnosed by X-ray pelvimetry in our cohort.

The following cases were excluded: those in which X-ray pelvimetry was not performed and those with a previous successful TOLAC. In this study, we defined success and failure of TOLAC cases wherein vaginal delivery was achieved and cases that resulted in CS for any reason or uterine rupture, regardless of the mode of delivery, respectively.

X-ray pelvimetry

Pelvimetry was performed retrospectively using Martius and Guthmann views. The obstetric conjugate (OC), transverse diameter of the pelvic inlet (TD), and anteroposterior diameter of the pelvic inlet (APD) were defined as follows: OC (cm), shortest distance from the promontory to the symphysis in the Guthmann view (Figure 1A); TD (cm) the maximum diameter between the right and left coxal bones in the Martius view; APD: maximum anteroposterior diameter on the pelvic inlet plane in the Martius view (Figure 1B). All measurements were performed independently by two obstetricians (M.K. and Y.C.), and the average values were used.

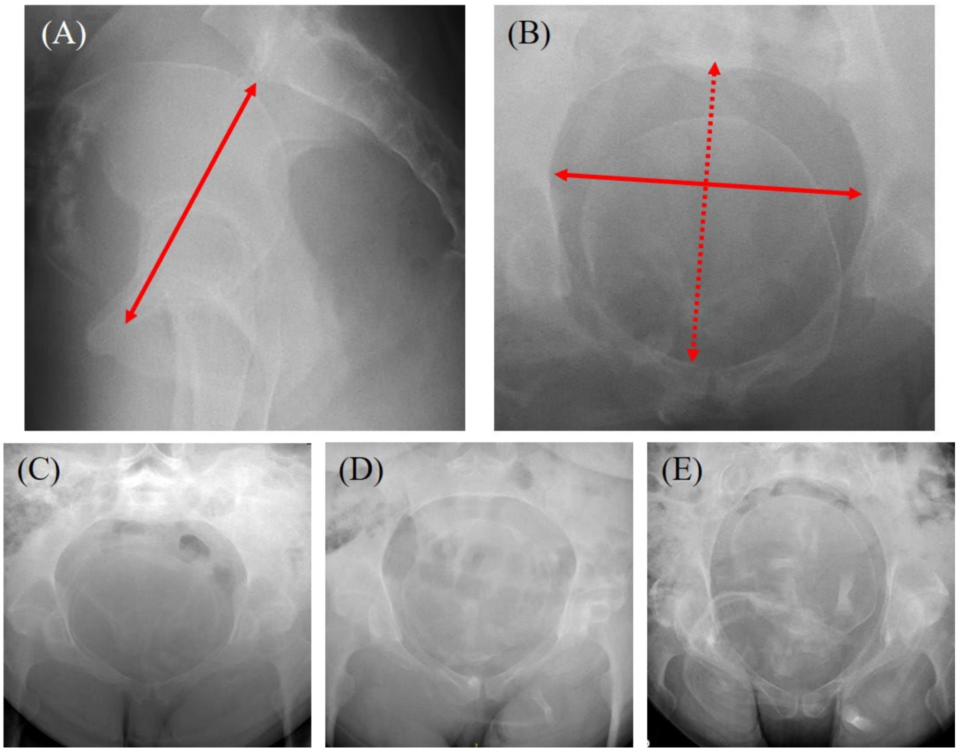

Figure 1. Representative images of X-ray pelvimetry. Measurement of the obstetric conjugate in the Guthmann view (A), and transverse diameter (solid line) and anteroposterior diameter (dashed line) of the pelvic inlet in the Martius view (B). Representative images of a platypelloid pelvis with a BDI of 85 (C), gynecoid pelvis with a BDI of 93 (D), and anthropoid pelvis with a BDI of 124 (E). BDI, brim depth index.

Classification of pelvic type

Classically, based primarily on the shape of the pelvic inlet, Caldwell and Moloy classified the pelvis into four types: gynecoid, anthropoid, android, and platypelloid (6). In this study, to be more accurate and less subjective, we determined the pelvic type using the brim depth index (BDI) (7). The BDI denotes the ratio between the APD and TD multiplied by 100 (APD/TD × 100). Based on BDI values, the pelvises were classified into three different types: platypelloid (BDI <90), gynecoid (90≤ BDI <100), and anthropoid (BDI ≥100) (7) (Figure 1C, 1D, and 1E).

Statistical analyses

Data are presented as mean ± standard deviation. Continuous variables were assessed by the Mann–Whitney test, and categorical variables were assessed using Fisher's Exact Test between the successful and failed groups in vaginal delivery using GraphPad Prism (version 9, San Diego, CA, USA). A generalized linear model was used to predict the success or failure of vaginal delivery using the glm function in R software (version 4.2.2, R Foundation for Statistical Computing, Vienna, Austria). The significant cut-off value was determined at 0.05 for two-sided p values in all analyses.

RESULTS

Figure 2 shows a flow diagram of the patients included in this study. During the study period, 137 cases of TOLAC were attempted, 116 (85%) were successful, and 21 (15%) failed. Of the 116 successful cases, six were excluded because X-ray pelvimetry was not performed, and 35 were excluded because of a previous successful TOLAC. Ultimately, 75 patients were enrolled in the group. Of the 21 cases in the failure group, 20 resulted in repeat CS. The indications for CS for 20 patients are as follows: 13 for arrest of labor, four for suspected uterine rupture, two for non-reassuring fetal status, and one for prolonged pregnancy (42 weeks of gestation). Four patients with suspected uterine rupture presented persistent lower abdominal pain during labor. Intraoperative assessment revealed very thin myometrium in one patient, however, none of the four patients were ultimately diagnosed with uterine rupture. In one case, uterine rupture was evident after vaginal birth. Immediately after delivering her baby and placenta vaginally, she complained of severe lower abdominal pain. At the same time, she developed hypotension and tachycardia. Transabdominal ultrasound examination showed ascites around the uterus. Based on these findings, she underwent laparotomy, and uterine rupture was confirmed intraoperatively. The uterine laceration was surgically repaired, and the uterus was successfully preserved. None of the women with a previous successful TOLAC were in the failure group.

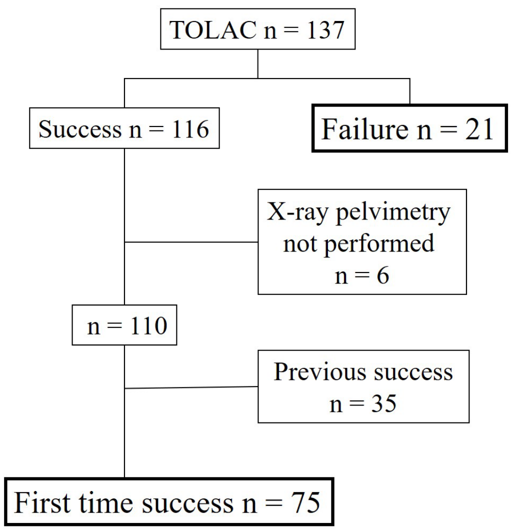

Figure 2.
Flow diagram of patients included in the study.
TOLAC, trial of labor after cesarean delivery.

Table I shows the patient characteristics in both groups. There were no significant differences in maternal age, physique, time since previous CS, lower uterine segment thickness, gestational age at delivery, or blood loss at delivery between the two groups. In the success group, 10 patients (13.3%) had a history of vaginal delivery preceding CS, while there were none in the failure group. In terms of the indication for previous CS, the rate of failed trials of labor, such as protracted active phase of labor, fetal malposition, or arrest of descent, was significantly different between the two groups: 17.3% in the success group vs. 38.1% in the failure group (p = 0.042). Newborn's weight at birth was significantly heavier in the failure group compared to that in the success group: 3,117 ± 356 g vs. 3,344 ± 397 g (p = 0.014), while newborn's head circumference did not differ between two groups.

Next, we compared the pelvimetry results between the groups. OC, TD, and APD on X-ray pelvimetry did not differ significantly between the two groups (Figure 3 and Table II). Regarding the pelvic type based on the BDI, there was no significant difference in the proportion of the three pelvic types between the two groups, although the rate of the anthropoid type in the successful group tended to be higher (57.3% vs. 38.1%) (Table II). The BDI values themselves also did not differ significantly: 100.9 ± 7.26 in the success group vs. 100.4 ± 7.84 in the failure group (p = 0.51).

Table I. Patients' characteristics

		Success (n = 75)	Failure (n = 21)	p value
Age (years old)		33.2 ± 3.5	34.1 ± 4.2	0.35
Height (cm)		159.4 ± 6.0	157.9 ± 3.4	0.28
Pre-pregnancy weight (kg)		51.9 ± 8.1	53.2 ± 8.1	0.56
Pre-pregnancy BMI		20.5 ± 2.5	21.4 ± 3.1	0.21
Weight at delivery (kg)		63.2 ± 8.6	64.9 ± 9.5	0.44
History of vaginal delivery (n, [%])		10 (13.3)	0 (0)	0.077
indication for previous CS	failed trial of labor (n, [%])	13 (17.3)	8 (38.1)	0.042
	other than above [a] (n, [%])	62 (82.7)	13 (61.9)	
Time from previous CS (months)		37.1 ± 19.3	33.8 ± 12.8	0.88
Lower uterine segment thickness (mm)		2.7 ± 1.2	2.5 ± 1.0	0.35
Gestational age		39w 4.8d ± 7.1d	39w 4.5d ± 8.1d	0.77
Blood loss (g)		677 ± 381	656 ± 286	0.82
Newborn's weight at birth (g)		3,117 ± 356	3,344 ± 397	0.014
Newborn's head circumference (cm)		33.6 ± 1.2	34.1 ± 1.0	0.055

Data represent mean ± standard deviation.
BMI, Body mass index; CS, Cesarean section.
[a] Fetal malpresentation, placenta previa, non-reassuring fetal status, and preterm birth.

Table II. Results of X-ray pelvimetry

		Success (n = 75)	Failure (n = 21)	p value
OC (cm)		12.45 ± 0.79	12.17 ± 0.77	0.12
TD (cm)		12.44 ± 0.67	12.39 ± 0.72	0.52
APD (cm)		12.53 ± 0.90	12.42 ± 0.94	0.48
Pelvic shape n (%)	Anthropoid	43 (57.3)	8 (38.1)	0.16
	Gynecoid	25 (33.3)	12 (57.1)	
	Platypelloid	7 (9.3)	1 (4.8)	

Data represent mean ± standard deviation.
OC, obstetric conjugate; TD, transverse diameter of the pelvic inlet;
APD, anteroposterior diameter of the pelvic inlet.

Finally, we used a generalized linear model to predict the success or failure of vaginal delivery using clinical variables, i.e., OC, TD, APD, history of vaginal delivery preceding CS, newborn weight at birth, and indications for previous CS (such as protracted active phase of labor, fetal malposition, or arrest of descent) (Figure 4). A history of failed trials of labor was significant in the generalized linear model (odds ratio [OR], 0.26; 95% confidence interval [CI]: 0.07–0.92, p = 0.037). However, there was no association in the outcome and clinical variable as shown by the following: OC (OR: 0.83, 95% CI: 0.22–3.06, p = 0.775), TD (OR: 1.52, 95% CI: 0.50–4.62, p = 0.464), APD (OR: 0.93, 95% CI: 0.26–3.28, p = 0.912), history of vaginal delivery preceding CS (OR: 1.56*107, 95% CI: 0–Infinity, p = 0.989), and newborn weight at birth (OR: 0.89, 95% CI: 0.31–2.60, p = 0.83). Multiple regression analysis included a history of vaginal delivery; however, the failure group had no cases of previous vaginal delivery. Therefore, they were excluded from the forest plots.

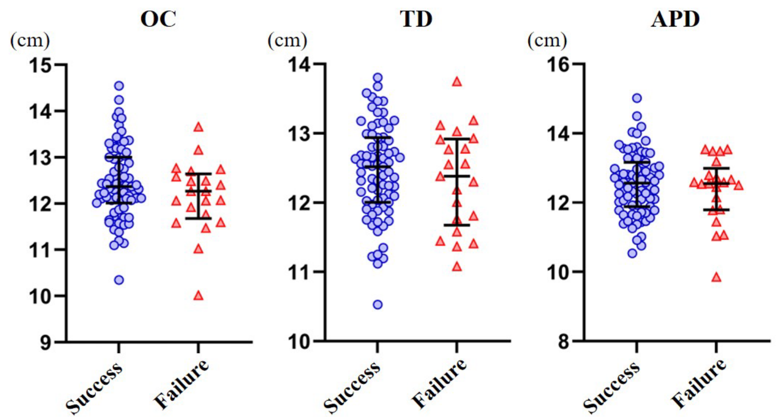

Figure 3.
Comparison of OC, TD, and APD in the success (n = 75) and failure (n = 21) groups.
OC, obstetric conjugate; TD, transverse diameter of pelvic inlet; APD, anteroposterior diameter of pelvic inlet. Black lines indicate medians with interquartile ranges.

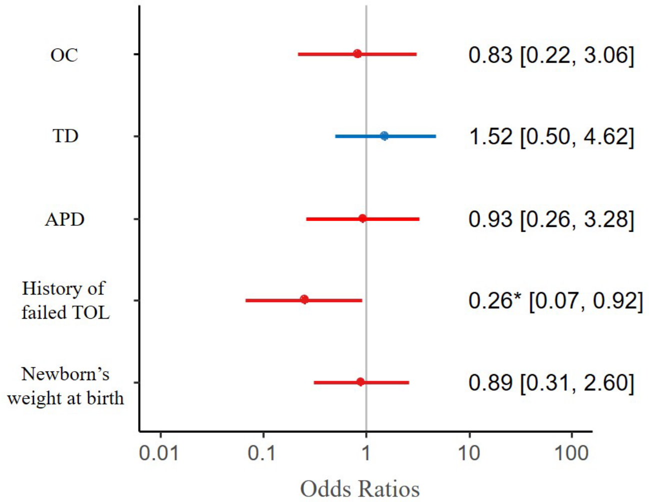

Figure 4.
Forest plot. Data represent odds ratio with 95% confidence interval.
OC, obstetric conjugate; TD, transverse diameter of the pelvic inlet; APD, anteroposterior diameter of the pelvic inlet; TOL, trial of labor. *p < 0.05.

DISCUSSION

In the present study, we investigated the contribution of pelvic size and morphological data obtained from X-ray pelvimetry to the first successful TOLAC. We found that X-ray pelvimetry parameters, specifically OC, TD, and APD, were not significantly different between the successful and unsuccessful TOLAC groups nor were they associated with the success or failure of TOLAC. Few studies have examined the relationship between pelvic size and the success or failure of TOLAC (8–11), and no clear evidence has emerged thus far. Lao et al. reported that although the mean OC and TD were 1.6–2.0 mm greater in the successful TOLAC group, they were not the factors that contributed to the success of TOLAC [8]. The study by Lao et al. differs significantly from our cohort in that 48% of pregnant women in the success group in their study had a history of previous successful vaginal delivery. In our study, we excluded 35 patients with a history of successful VBAC to examine the success or failure of the first TOLAC. Sibony et al. found that among women who attempted TOLAC, 81% delivered vaginally if the TD was >12 cm, whereas only 58% delivered vaginally if the TD was <11.5 cm (9). Similarly, Gowri et al. found that several pelvic diameters measured by magnetic resonance imaging were significantly larger in the successful TOLAC group than in the failed group (10). Notably, these two studies included a significant number of cases of CS before the onset of labor, i.e., elective CS in the failed TOLAC groups. More recently, in a retrospective observational study by Roux et al., pelvimetry was performed on 2,474 women who underwent TOLAC, and abnormal pelvic dimensions were defined as an OC of <10.5 cm and/or TD of <12 cm (11). They reported that the CS rate was significantly higher in the abnormal pelvic dimension group (35.3% vs. 15.2%, $p < 0.001$), but they did not mention any differences in pelvic measurement data between the successful and failed TOLAC groups (11). When their pelvimetry criteria were applied to our cohort, there was no statistically significant difference in the CS rate between the abnormal and normal pelvic dimension groups (25% vs. 21%, $p = 0.85$). This discrepancy in results between the two studies may be attributed to the decision-making policy for CS. Nevertheless, our study is novel in that it revealed no difference in the actual pelvic size between the successful and unsuccessful TOLAC groups.

The X-ray pelvimetry on pregnant women undergoing TOLAC at our institution until 2021 was primarily aimed at assessing the presence of a narrow pelvis that may potentially require CS. Harper et al. performed X-ray pelvimetry after delivery regardless of vaginal delivery or CS, and the readers were blinded to the outcomes. As a result, the rate of CS among women with an APD of >9.5 cm was 21%, in contrast to a 98% rate observed among women with an APD <9.5 cm (12). Consequently, antepartum X-ray pelvimetry might be significant at least in women with an APD <9.5 cm who are not eligible for TOLAC. However, we recently performed precise pelvimetry using three-dimensional computed tomography images in 1,263 non-pregnant Japanese women and revealed that mean OC and TD were 12.70 cm and 12.68 cm, which were 1.18 cm and 0.43 cm larger, respectively, than those in the 1972 large-scale survey (13). Moreover, only 0.7% of women had an OC, almost equal to the APD, <10.5 cm, and even fewer (0.08%) had an OC <9.5 cm (13). Given the low prevalence of a narrow pelvis, X-ray pelvimetry for women attempting TOLAC is of little significance.

To our knowledge, this study is the first to show that the shape of the pelvic inlet does not affect the success or failure of TOLAC. Caldwell and Moloy classified the female bony pelvis into four types and proposed that each type is linked to different birth outcomes: the anthropoid type is favorable for occiput posterior delivery, or platypelloid type is prone to cephalopelvic disproportion (6). Although this concept appears theoretically plausible and intriguing, no empirical studies have substantiated a correlation between pelvic type and distinct delivery outcomes as of the present (14).

In the present study, a history of failed labor trials was identified as a factor contributing to the success or failure of TOLAC using generalized linear model analysis; this has been acknowledged in previous studies (2, 4). Additionally, although the difference was not statistically significant, all women with a history of vaginal delivery prior to CS had a successful TOLAC, suggesting that prior vaginal delivery positively influences the likelihood of VBAC (2, 4, 15). In contrast, our generalized linear model revealed that pelvic measurements obtained using X-ray pelvimetry were not significant contributing factors to the success or failure of TOLAC. While prior investigations have identified various determinants affecting the outcomes of TOLAC, the role of pelvic size and shape, whether conducive or obstructive, remains unclear. This gap in the literature can be attributed to the limited number of studies that have investigated the correlation between pelvimetry and TOLAC. Hence, our study is significant because it addresses this lacuna in the existing research.

Our study was limited by its retrospective nature and small number of patients. The absence of reliable data on pelvic size and vaginal delivery success rates in previous studies precluded the calculation of a statistically valid sample size for this study. Nevertheless, the strength and uniqueness of this study is that it excluded women with a previous successful VBAC. Through a comprehensive analysis of the clinical history and pelvic measurements exclusively among women who underwent initial TOLAC, we enhanced the precision of discerning the determinants influencing the success or failure of TOLAC.

In conclusion, our results showed that the pelvic size and morphological findings obtained by X-ray pelvimetry had no discernible impact on the outcomes of TOLAC. The universal application of X-ray pelvimetry in all women attempting TOLAC may not have significant clinical relevance.

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