OBSTETRICS

Accuracy of Intrapartum Birth Weight Estimation by Clinical Equation in Low Risk Thai Term Pregnant Women

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ABSTRACT

Objectives: To assess the accuracy of clinical equation in estimation of birth weight in Thai term pregnant women and to compare with abdominal palpation method.

Materials and Methods: This cross-sectional study was conducted in 335 term pregnant Thai women who were admitted for delivery at Siriraj Hospital during February 2015 to December 2015. Singleton vertex presented pregnancies were estimated for fetal weight using abdominal palpation and Buchmann, et al. equation [100 x (symphysis-fundal height (cm) - 5)] plus 100 if head engaged. After delivery, the accuracy within ten percent of actual birth weight was calculated and compared between two methods.

Results: Overall accuracy within ten percent of actual birth weight was similar between methods. The accuracy of Buchmann equation and abdominal palpation method were 64.6% and 60.3% (p = 0.218) and the mean absolute percentage errors were 8.7 ± 7.0 and 9.3 ± 6.8 respectively. In the normal birthweight group (2,500-3,999g), Buchmann equation was more accurate than abdominal palpation method (p = 0.045). In detecting macrosomia, abdominal palpation method had higher sensitivity than Buchmann equation, but without statistical significance (83.3% vs. 33.0%; p = 0.079) using 3,500g cut-off value.

Conclusion: Overall accuracy between Buchmann equation and abdominal palpation method was similar. Thus, practitioners who are lack of skills can use Buchmann equation to gain experience. Although Buchmann equation demonstrated better accuracy in the normal birth weight group, it was shown to be less accurate in extreme birthweights. Therefore, other methods for estimation of fetal weight are useful for prediction in extreme groups.

Keywords: Intrapartum birth weight estimation, clinical equation, abdominal palpation, symphysis fundal height

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ความแม่นยำของการคะเนน้ำหนักทารกในระยะคลอด ด้วยสมการทางคลินิกสำหรับสตรีตั้งครรภ์ชาวไทยกลุ่มเสี่ยงต่ำที่มีอายุครรภ์ครบกำหนด

จิรเมธ พรหมจิรโชติ, เพียงบุหรัน ยาปาน

บทคัดย่อ

วัตถุประสงค์: เพื่อศึกษาความแม่นยำของการคะเนน้ำหนักทารกในระยะคลอดด้วยสมการทางคลินิก และเปรียบเทียบกับการคะเนด้วยวิธีการคลำทางหน้าท้อง ในสตรีตั้งครรภ์ชาวไทยกลุ่มเสี่ยงต่ำที่มีอายุครรภ์ครบกำหนด

วัสดุและวิธีการศึกษา: ศึกษาในสตรีตั้งครรภ์ชาวไทยที่มีอายุครรภ์ครบกำหนดจำนวน 335 คนที่รับไว้เป็นผู้ป่วยในเพื่อรอคลอดในห้องคลอด โรงพยาบาลศิริราช ระหว่างเดือนกุมภาพันธ์ ถึง เดือนธันวาคม ปี พ.ศ.2558 โดยสตรีตั้งครรภ์เดี่ยวที่มีส่วนนำเป็นศีรษะจะได้รับการคะเนน้ำหนักทารกในครรภ์ด้วยวิธีการคลำทางหน้าท้องและสมการทางคลินิกของ Buchmann และคณะ =[100 x (ระดับยอดมดลูก(ซม.)-5)] + 100 เมื่อส่วนนำผ่านเข้าช่องเชิงกราน ภายหลังคลอดความแม่นยำในการคะเนน้ำหนักทารกจะได้รับการคำนวณและเปรียบเทียบระหว่างสองวิธี

ผลการศึกษา: ความแม่นยำโดยรวมของการคะเนน้ำหนักทารกไม่แตกต่างกันระหว่างสองวิธี ความแม่นยำของสมการทางคลินิกและการคลำทางหน้าท้องคือ ร้อยละ 64.6 และร้อยละ 60.3 (p=0.218) ค่าเฉลี่ยของค่าสัมบูรณ์ของร้อยละของความคลาดเคลื่อนคือ 8.7±7.0 และ 9.3±6.8 ตามลำดับ ในกลุ่มน้ำหนักทารกปกติ (2,500-3,999 กรัม) สมการทางคลินิก ของ Buchmann และคณะ มีความแม่นยำกว่าวิธีการคลำทางหน้าท้อง (p=0.045) ในการคะเนน้ำหนักทารกที่มีขนาดโตกว่าปกติโดยใช้ค่าเกณฑ์ตัดสิน 3,500 กรัม พบว่า วิธีการคลำทางหน้าท้องมีความไวมากกว่าสมการทางคลินิกแต่ไม่มีนัยสำคัญทางสถิติ (ร้อยละ 83.3 และร้อยละ 33.0; p=0.079)

สรุป: ความแม่นยำโดยรวมของสมการทางคลินิกของ Buchmann กับการคลำทางหน้าท้องไม่แตกต่างกัน ดังนั้น สมการของ Buchmann จึงมีประโยชน์สำหรับนักศึกษาที่ขาดประสบการณ์ในการคะเนน้ำหนักทารกโดยการคลำทางหน้าท้อง แต่พบว่าสมการของ Buchmann มีความแม่นยำน้อยในทารกที่น้ำหนักแรกเกิดน้อยหรือมากกว่าปกติ ดังนั้นจึงควรคะเนน้ำหนักทารกโดยวิธีอื่นร่วมด้วย

คำสำคัญ: การคะเนน้ำหนักทารก, สมการทางคลินิก, การคลำทางหน้าท้อง, ระดับยอดมดลูก

Introduction

It is widely acknowledged that abnormal fetal growth and intrauterine fetal abnormalities are associated with adverse perinatal outcomes. Failure to detect of these abnormalities may further increase risk to both mother and fetus[1, 2]. For example, low birth weight and excessive fetal weight both increase perinatal complications[3]. Pregnant women who deliver a fetus weighing more than 4,000 g may experience delivery-related complications, including postpartum hemorrhage, pelvic floor injury, and birth canal injury. Fetal risks in this setting include shoulder dystocia, brachial plexus injury, and intra-partum asphyxia[4-6].

Reliable estimation of fetal weight, in part, facilitates choice of decision between allowing labor with intent of vaginal delivery or opting for cesarean delivery in patients with suboptimal clinical parameters. Moreover, estimation of fetal weight also provides the clinician with insight relative to cephalo-pelvic disproportion when there is a failure to progress during labor[6, 7]. Various methods for intrapartum birth weight estimation have been proposed, with prediction rates that vary from 53.5% to 84.1% (Table 1)[6, 8-11].

Table 1. Accuracy within 10% of various birth weight estimation methods.

Methods	Prediction within 10% of actual birth weight
Abdominal palpation	55-75 %[8, 9]
Clinical equations	
1. EFW(g)= SFH x AG	53.5%[6]
2. EFW (g) = – 3198 – (122.3 x presentation) + (94.9 x GA (weeks)) + (93.5 x SFH(cm)) – (97.4 x sex) + (87.1 x parity)	61.6%[9]
3. EFW (g) = 100 ([SFH(cm)] -5) plus 100 if head engaged	68.1%[8]
4. EFW (g) = 1485.61 + (SFH(cm) x 23.37) + (11.62 (cm) x mAC) + [BMI x (-6.81)] + (parity (0 = nulliparous, 1 = multiparous) x 72.25)	72.7%[9]

Abbreviations: EFW: estimated fetal weight,

SFH: symphysis-fundal height,

AG: abdominal girth,

GA: gestational age,

mAC: maternal abdominal circumference,
BMI: body mass index
*Difference in inclusion criteria and the formula used to estimate fetal weight

Estimation of birth weight by abdominal palpation method yields a wide range of prediction reliability, with estimation accuracy being associated with clinical on experience[8]. There is also a statistics-based approach to birth weight estimation that is based on quantitative assessment of maternal characteristics and pregnancy-specific factors, including coefficients derived from gestational age, third trimester weight gain, maternal weight and height, parity, and fetal[12, 13]. Although ultrasonographic fetal weight estimation is considered to be a more accurate method for predicting birth weight, some studies have reported that clinical equations for estimating fetal weight are as accurate as ultrasound in the third trimester[11, 14-17].

Prediction of fetal weight using a clinical equation has the advantage of lower cost, higher applicability, acceptable validity, added convenience, and lower likelihood of potential harm[18]. Furthermore, a clinical equation could be easily and effortlessly applied by other practitioners who are inexperienced in using ultrasonography, such as midwives, general practitioners, and medical students. Clinical estimation of fetal weight using clinical equation is often overlooked, but its simplicity and usability across skill levels makes it a valuable tool in obstetric clinical practice[6]. Based on our review of the literature, relatively few studies have investigated the accuracy of these clinical equations and none of these studies have been conducted among Thai women.

Accordingly, the primary objective of this study was to assess the accuracy of Buchmann equation within 10% of actual birth weight[8]. The secondary objective was to compare accuracy between Buchmann equation and abdominal palpation method.

Materials and Methods

This cross-sectional study was conducted in 335 term pregnant Thai women who were admitted for delivery at the Department of Obstetrics and Gynecology, Faculty of Medicine Siriraj Hospital, Mahidol University during the February 2015 to December 2015. Siriraj Hospital is Thailand's largest university-based tertiary referral. The protocol for this study was approved by Siriraj Institutional Review Board (SIRB).

Regarding routine care of patients who admitted to the labor ward, externs and residents who were on duty performed history taking, physical examination, and abdominal palpation by Leopold's maneuvers[11]. Estimation of birthweight was performed with individual experiences using Leopold's maneuvers. The estimation had been doing routinely in clinical practice. Patients who had singleton pregnancy with vertex presentation and engagement, admission for planned delivery, 37 to 42 weeks of gestation, and who were in first stage of labor were included. Pregnant women who had intrauterine fetal death and high-risk pregnancy, including gestational diabetes, oligo-polyhydramnios, hypertension in pregnancy, preeclampsia, fetal chromosome abnormalities, or uterine and/or ovarian tumors were excluded. Included patients were verbally counseled regarding the study protocol and written informed consent was obtained from all subjects prior to participation. Demographic, clinical, and obstetric-specific data were collected, including maternal age, weight, height, gestational age, status of membranes, cervical dilatation, and effacement. One researcher used a reverse-side up flexible plastic tape to measure symphysis- fundal height (SFH) from the highest point on the uterine fundus to mid-point of upper border of the symphysis pubis passing the umbilicus with no uterine contraction and empty bladder[19]. Participants were positioned in the supine position. SFH was recorded to the nearest 1 centimeter. Researcher was blinded from clinical information and results of each method.

Data were analyzed using PASW Statistics version 18 (SPSS, Inc., Chicago, IL, USA). Categorical data were expressed as absolute numbers and percentage. Continuous data were described using mean ± standard deviation (SD). Estimated fetal weight (EFW) by equation method and abdominal palpation method were compared with the actual birth weight (BW) using Students' t-test with respect to the mean of absolute error (absolute value of [EFW-BW]), and mean of absolute percentage error (absolute value of [EFW-BW x 100/BW]). McNemar's test was used to compare accuracy of fetal weight estimation between methods. A $p<0.05$ was considered statistically significant.

Results

Three hundred and thirty-five term pregnant Thai women were included into the study. Demographic, clinical and obstetric characteristics are shown in Table 2. Mean age of patients was 26.7±0.7 years, with a mean gestational age of 38.8±1.1weeks.

Table 2. Distribution of demographic and obstetric characteristics (N=335).

Parameter	Mean±SD	Range	Group	N (%)
Age (years)	26.7±5.7	18-43	< 21	43 (12.8)
			21-34	254 (75.8)
			> 34	38 (11.3)
Parity	0.6±0.8	0-4	0	180 (53.7)
			≥ 1	155 (46.3)
GA (weeks)	38.8±1.1	37-42	< 40	252 (75.2)
			≥ 40	83 (24.8)
BMI (kg/m²)	22.1±4.3	14.7-42.6	< 18.5	61 (18.2)
			18.5-22.9	151 (45.1)
			23-27.4	87 (26.0)
			≥ 27.5	36 (10.7)
Dilatation (cm)	3.3±1.7	0-9	0-2	86 (25.7)
			3-5	219 (65.4)
			6-10	30 (9.0)
Station			< 0	283 (84.5)
			≥ 0	52 (15.5)
Membranes			Intact	132 (39.4)
			ruptured	203 (60.6)
Gender			Male	188 (56.1)
			Female	147 (43.9)
BW (g)	3,124.2±383.9	2,150-4,370	< 2500	20 (6)
			2500-3999	309 (92)
			≥ 4000	6 (1.8)
SFH (cm)	35±3.1	25-45	< 30	14 (4.2)
			30-40	308 (91.9)
			≥ 40	13 (3.9)

GA: gestational age, BMI: body mass index, BW: birth weight, SFH: symphysis- fundal height

Mean percentage error, mean absolute percentage error, and accuracy within 10% of actual birth weight for each method and divided into 3 different weight groups are given in Table 3. Overall accuracy of Buchman equation and abdominal palpation method was 64.6% and 60.3%, respectively. Although overall accuracy between two methods was not statistically significant (p=0.218), statistical significance was observed in the 2,500-3,999 g actual birth weight category (p=0.045). The mean absolute percentage error for Buchmann equation was lower than abdominal palpation method in the 2,500-3,999 g group, but higher

in the < 2,500 g and ≥ 4,000 g group. Distribution of the power of Buchmann equation and abdominal palpation method for predicting fetal macrosomia (> 4,000 g) using 3,500 g cut off value is presented in Table 4.

There were many contributing factors that affected the accuracy of fetal weight estimation. Table 5 shows the comparison of accuracy within 10% of actual birth weight between methods according to different contributing factors, including parity, BMI, cervical dilatation, station, membranes status, fetal gender, and symphysis-fundal height. The result showed no difference between methods relative to any contributing factors.

Table 3. Accuracy and differences between fetal weight estimation methods.

Actual birth weight (g)	Abdominal palpation	Buchmann equation	p value
Overall			
Mean absolute error (g)	293.5±216.8	270.0±216.2	0.082
Mean absolute percentage error (%)	9.3±6.8	8.7±7.0	0.144
Accuracy within 10% of actual birth weight (%)	60.3	64.6	0.218
< 2500			
Mean absolute error (g)	321.0±263.9	433.0±201.1	0.067
Mean absolute percentage error (%)	13.5±11.1	18.3±8.7	0.063
Accuracy within 10% of actual birth weight (%)	45	15	0.031*
2500-3999			
Mean absolute error (g)	286.2±209.3	248.8±196.3	0.007*
Mean absolute percentage error (%)	9.0±6.3	7.9±6.1	0.010*
Accuracy within 10% of actual birth weight (%)	62.8	69.3	0.045*
≥ 4000			
Mean absolute error (g)	578.3±270.4	818.3±315.1	0.115
Mean absolute percentage error (%)	14.1±6.7	20.0±8.0	0.116
Accuracy within 10% of actual birth weight (%)	33.3	0	-

* p < 0.05 indicates statistical significance

Table 4. Distribution of the power of Buchmann equation and abdominal palpation methods for predicting fetal macrosomia (≥ 4,000 g) using 3,500 gram cut off value.

Actual birth weight (g)	Abdominal palpation	Buchmann equation	p value
Sensitivity (%)	83.3	33.3	0.079
Specificity (%)	92.1	87.8	0.069
Positive predictive value (%)	16.1	4.8	0.103
Negative predictive value (%)	99.7	98.6	0.165

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Table 5. Comparison of accuracy within 10% of actual birth weight between methods relative to different contributing factors.

Parameter	Group	N	Accuracy within 10% of actual birth weight (%)		p value
			Abdominal palpation	Buchmann equation	
Parity	0	180	63.3	66.7	0.561
	≥ 1	155	56.8	62.6	0.281
BMI (kg/m²)	< 18.5	61	59.0	73.8	0.108
	18.5-22.9	151	56.3	62.3	0.306
	23-27.4	87	65.5	66.7	1.000
	≥ 27.5	36	66.7	55.6	0.424
Dilatation (cm)	0-2	86	68.6	70.9	0.851
	3-5	219	56.6	62.6	0.203
	6-10	30	63.3	63.3	1.000
Station	< 0	283	59.4	64.7	0.180
	≥ 0	52	65.4	65.4	1.000
Membranes	Intact	132	59.8	68.9	0.111
	Ruptured	203	60.6	62.1	0.824
Gender	Male	188	63.8	67.0	0.539
	Female	147	55.8	61.9	0.314
Symphysis fundal height (cm)	< 30	16	62.5	31.3	0.125
	30-44.9	318	60.4	66.6	0.085
	≥ 45	1	0.0	0.0	-

Discussion

There are various methods for intrapartum fetal weight estimation, including transabdominal ultrasonography, abdominal palpation, and clinical equation. Abdominal palpation method for estimation of fetal weight is fast, inexpensive, and easy to practice. But, it requires experience. Transabdominal ultrasonography is widely used because of its relatively high accuracy, but it is not suitable in many clinical setting due to the requirement of an ultrasound machine and an experienced operator. Given the requirements and limitations associated with these two methods, many studies have explored the applicability, accuracy, and reliability of clinical equation for estimation of fetal weight. Many equations have been proven, each with a different level of accuracy. For this study, Buchmann equation was selected because of its convenience and its similar accuracy to ultrasonography.

All participants were term pregnant women, with vertex presentation and head engagement. The subjects were low risk Thai pregnancy. Since many unexpected adverse events may arise even in low-risk pregnancy, it would be an added benefit to be able to identify and triage pregnancy with extreme birth weight. Close monitoring of this group would improve pregnancy outcomes.

The characteristics of the 335 participants in this study were slightly different from those of other studies. For example, Emmanuel, et al., and Prechapanich, et al., had 82% term pregnant women[6, 11]. Prechapanich et al. had 96% of participants with vertex presentation and 70.7% head engagement[11]. The present study had 39.4% with intact membranes, while Prechapanich, et al., had 75.1% of women with their membranes

intact[11].

Using Buchmann equation for Thai pregnancies, 64.6% of all birth weight estimations were correct to within 10% of actual birth weight, which was similar to the 65% reported in the validated study by Buchmann, et al., and non-significantly different from the palpation method in which 60.3% were correct to within 10% of actual birth weight (p = 0.218) (Table 3)[8]. Prechapanich et al. found accuracy within 10% of actual birth weight for abdominal palpation method and ultrasonography to be 66.7% and 65.3%, respectively (p = 0.77) which was similar to the result from E. Perengrine, et al., in which accuracy between palpation method and ultrasonography using Shepard formula were non-significantly different (71% and 62%, respectively; p=0.25)[11,20]. It can, thus, be concluded that intrapartum fetal weight can be estimated by using any of these three techniques, given that none of them was shown to be inferior to the others. The present study showed usefulness of Buchmann equation for practitioners such as midwives, general practitioners, and medical students to gain experience for estimation of fetal weight. Some practitioners lack of skills to use abdominal palpation method and ultrasonographic equipment. Thus, Buchmann equation is the other choice of method in estimation of fetal weight in the faculty of medicine or low resource hospitals.

The actual birth weight was divided into 3 groups for subgroup analysis along with the size of fetus for gestation age and routine practice include small for gestation age (< 2,500 g), appropriate for gestational age (2,500 - 3,999 g) and large for gestational age (> 4,000g). These were not the primary objective of this study but some points were interest when compare with other studies. In the 2,500-3,999g group (N = 92%), accuracy within 10% of actual birth weight using Buchmann equation was significantly higher than for that of abdominal palpation method (69.3% vs. 62.8%, respectively, p=0.045). These findings supported the advantage of Buchmann equation for practitioners to gain experience in estimation of fetal weight in generally patients.

Accuracy of abdominal palpation method in the < 2,500 g group was significantly superior to Buchmann equation (45% vs. 15%, respectively; p=0.031). A study by E. Perengrine et al. found that ultrasonography using either Shepard or Hadlock formula had higher accuracy for estimation of fetal birth weight than abdominal palpation (p=0.003 and p<0.001, respectively)[20]. Prechapanich, et al. reported that accuracy within 10% of actual birth weight in low birth weight group (< 2,500 g) using abdominal palpation was 48.6%, which was similar to this study; however, ultrasonography had an accuracy of 60.0% (p=0.424)[11]. The results of this study showed that Buchmann equation was least accurate in estimation of extreme birth weight. One possible reason for this finding was that this study excluded preterm participants, so there were a small number of participants in the low birth weight group. Additional ultrasonography would improve the accuracy in this birth weight group.

Only 6 out of 335 participants delivered babies that weighed more than 4,000 g and none of those 6 estimations were accurate within 10% of actual birth weight by Buchmann equation. Given the small sample size in this birth weight group, it cannot be concluded that palpation method was better than Buchmann equation. In detecting fetal macrosomia, abdominal palpation method had higher sensitivity than Buchmann equation, but without statistical significance (83.3% vs. 33.0%; p=0.079) using 3,500g cut-off value, while specificity and predictive values were comparable (Table 4). There were other ways to estimate birth weight in this extreme weight group. First, ultrasonography with either Shepard or Hadlock formula was significantly more accurate than abdominal palpation method according to E. Perengrine, et al. (p=0.001 and p=0.01, respectively)[20]. Second, the Emmanuel, et al., formula (EFW=SFHxAG) was more accurate than ultrasonography with Hadlock formula (p = 0.001)[6].

Conclusion

In conclusion, although Buchmann equation demonstrated better accuracy in the normal birth weight group, it was shown to be less accurate in extreme birth weights. Because the abdominal palpation method may be the three-dimension estimation while SFH in Buchmann equation may be the two-dimension

estimation.

The strength of this study was the methodology by which fetal weight was estimated by abdominal palpation by routine service physicians and SFH measurement was performed by one researcher who was blinded to the estimated fetal weight by palpation method. A mentionable limitation of this study was that only a single researcher measured SFH, which was different from variations that would likely be observed by measurement by different clinicians in routine clinical setting. Further studies should investigate intra-observer and/or inter-observer reliability and conceptualize the design an equation that may be more suitable for Thai pregnant women.

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Potential conflicts of interest

The authors declare no conflict of interest.

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