The Accuracy of Gestation-Adjusted Projection Method in Estimating Birth Weight by Sonographic Fetal Measurements in the Third Trimester

Sukit Sritippayawan MD*,
Wisude Anansakunwat MD*, Chotima Suthantikorn*

** Department of Obstetrics and Gynecology, Charoenkrung Pracharuk Hospital*

Objectives: *1. To assess the accuracy of the gestation-adjusted projection method in estimating birth weight in Thai pregnant women.*

2. To determine the efficiency of the gestation-adjusted projection method for the detection of low actual birth weight, normal birth weight, and large fetus groups.

Study design: *Diagnostic clinical trial.*

Material and Method: *The present study was conducted on 328 uncomplicated pregnancies that were monitored at the Department of Obstetrics and Gynecology, Charoenkrung Pracharuk Hospital during the period of August 1 to November 30, 2006. The fetal biometry was measured by ultrasound at 34 weeks' gestation or after. Fetal weight was calculated according to Hadlock's formula. The extrapolation technique is based on the gestation-adjusted projection (GAP) method. The accuracy of the method was assessed by analyzing the weight predictions in relation to the actual birth weight (ABW). Main outcome measurements were simple error, absolute error, absolute percentage error and accuracy within 10% of ABW.*

Results: *The accuracy within 10% of ABW was 76.5% (95% CI 71.9, 81.1). The estimation tended to be underestimated (-134.5 ± 235.2 grams). The mean of absolute error and of absolute percentage error were 226.2 ± 148.8 grams and 7.2 ± 4.5% respectively. The smallest observed mean difference was obtained in the large fetus group (birth weight > 4,000 grams) and the largest one was obtained in the normal birth weight group (birth weight 2,500-4,000 grams). The accuracy amongst possible contributing factors were compared and analyzed. The sensitivity and specificity for prediction of birth weight (BW) lower than 2,500 grams (g); 2,500-4,000 g and more than 4,000 g were 60% and 93.8%; 92.5% and 56.5%; 33.3% and 98.8%, respectively. The positive predictive value (PPV) and negative predictive value (NPV) of each BW group were 38.7% and 97.3%; 96.6% and 36.1%; 20% and 99.4%, respectively. The post-test likelihood when the test is negative of each BW group was 2.7%, 63.9%, and 0.6%, respectively. The likelihood ratio of a positive result (LR+) and negative result (LR-) of each BW group were 10 and 0.4; 2.1 and 0.1; 33 and 0.8, respectively. The test efficiency (TE) of each BW group was 91.7%, 89.9%, and 98.2%, respectively.*

Conclusion: *The GAP of estimated fetal weight (EFW) is able to accomplish the prediction of BW in Thai pregnant women with good accuracy. The diagnostic performance of this method for detection of low birth weight (LBW) and large fetus group are acceptable because of its high specificity, high NPV, high LR+, and low post-test likelihood ratio when the test is negative.*

Keywords: *Gestation-adjusted projection method, Sonographic estimation of fetal weight, Birth weight*

J Med Assoc Thai 2007; 90 (6): 1058-67
Full text. e-Journal: *http://www.medassocthai.org/journal*

Abnorm alities of labor and neonatal complications may be associated with different size of birth weight (BW)[1]. Strategies for antepartum and intrapartum care may be influenced by prospective estimation of fetal weight. For example, intrapartum management of fetuses presenting as breech and pre-term labor will be influenced greatly by the estimated fetal weight (EFW)[1].

Correspondence to : Sritippayawan S, Department of Obstetrics and Gynecology, Charoenkrung Pracharuk Hospital, Bangkok 10120, Thailand.

The two main methods for predicting BW in obstetric practice are clinical estimation and sonographic fetal measurements[2-4]. Direct comparisons of clinical and sonographic estimates of BW have found ultrasound techniques to be superior for preterm infants, clinical assessment to be superior for infants between 2,500 and 4,000 g and both techniques to have similar accuracy (or inaccuracy) over 4,000 g[2,3].

Clinical estimation of fetal weight by palpation is generally unreliable, particularly if the woman is obese[5]. Many studies assessing the accuracy of sonography in estimating BW have used sonograms performed in early labor. Although this approach eliminates the potential effects of fetal growth on the estimation of weight, it possesses several inherent flaws. First, as delivery approaches, the fetal head descends into the pelvis, making accurate measurements of the fetal head (BPD, HC) difficult. Second, decreasing amniotic fluid volume at term can limit the accuracy of all measurements. Finally, particularly with large fetuses, inability of the transducer to capture the entire cross section of the head or fetal abdomen can lead to inaccuracies of these measurements (BPD, HC, AC)[6-14].

Mongelli and Gardosi proposed the gestation-adjusted projection (GAP) method of predicting fetal weight from sonographic measurements of fetal ultrasound parameters remote from term[15]. The clinical value of this model is suggested in many primary health care centers, where the equipment or expertise is unavailable. This extrapolation technique is based on the assumption that normal fetuses do not cross percentiles on growth curves. This implies that in the third trimester of pregnancy, the ratio between the EFW at the time of the ultrasound examination and the median fetal weight at that gestational age will be the same as the ratio between estimated BW and the median BW for gestational age at delivery[15]. However, there is no data about the performance of this model in Thai pregnant women.

The purpose of the present study was to assess the accuracy of GAP method for prediction BW in Thai pregnant women and to determine the efficiency of the GAP method for the detection of low ABW (BW < 2,500 g), normal BW (BW 2,500-4,000 g), and large fetus groups (BW > 4,000 g).

Material and Method

The present study was conducted between August 1 and November 30, 2006. The population sample included 328 low-risk mothers with singleton pregnancies recruited in the antenatal clinics at booking, Department of Obstetrics and Gynecology, Charoenkrung Pracharuk Hospital, with the approval of the institutional ethic committee. Pregnant women included in the present study met the following criteria: 1) the pregnancy was a singleton gestation 2) accurate gestational dating 3) gestational age at least 34 complete weeks 4) the infant was live born 5) all neonates were weighted within 30 minutes after delivery on the same metric scale and infant weight was recorded to the nearest grams 6) absence of medical and pregnancy complications that may have independent effects on fetal growth 7) data on the outcome of delivery were available. The exclusion criteria were 1) intrauterine fetal death 2) known fetal anomaly 3) pregnancy with uterine or adnexal pathology. After the patients were enrolled, their characteristic data were recorded on a research card. Standard sonographic measurement of BPD, HC, AC and FL, using GE model LOGIQ 3 PRO fitted with a 3.5 MHz convex probe, was performed by one of the authors (SS and WA). Two measurements were made of each variable and the mean for each were recorded. The inter-observer and intra-observer variation were computed on a subset of 10 cases selected at random within the same clinics. The measurements were taken twice by the same observer and repeated by another observer. Differences were expressed in millimeters and the variation computed in terms of median differences, standard deviations and 95% confidence intervals. Measurements for the AC and HC were taken by using the built-in ellipse function in the ultrasound machine. The EFW was computed according to the Hadlock's formula for multiple parameters using BPD, HC, AC and FL. ($Log_{10}weight = 1.3596 - 0.00386AC \times FL + 0.0064HC + 0.00061BPD \times AC + 0.042AC + 0.174FL$).

Data were collected on maternal age, parity, body mass index (BMI), last menstrual period, estimated date of delivery, gestational age at sonogram, fetal biometry and EFW, gestational age at delivery, time interval between the ultrasound weight estimate and time of delivery, fetal sex, and actual birth weight (ABW). At the time of delivery, if there were fetal anomalies or stillbirth, the patient was excluded from the present study. Birth weight was predicted from each sonogram using the GAP method and Thailand Standard curves for intrauterine growth (From Department of Obstetrics and Gynecology, Faculty of Medicine, Chulalongkorn University)[16].

The GAP method originates from the hypothesis that the ratio of the weight of the normal fetus to the population median remains constant in the third trimester[15]. This value is the antenatal equivalent of the birth weight ratio, and is closely related to the weight for gestation percentile. It implies that in normal fetuses, growth curves do not cross percentile cut-off lines to any significant degree.

If *Median* is the growth function describing the median curve, *EFW* the ultrasound fetal weight estimation, *u* the gestational age at ultrasound examination and d the gestational age at delivery, the following relationship applies:

EFWu: Median(u) = EFWd: Median(d)
∴ Projected fetal weight at delivery:
EFWd = Median(d) x [EFWu/Median(u)]
= Median(d) x Fetal Weight Ratio

Statistical analysis

The GAP- predicted BW was compared with the ABW with respect to the following: 1) mean of simple error (EFW-ABW), 2) mean of absolute error (absolute value of [EFW - ABW]), 3) mean of absolute percentage error (%) (absolute value of [EFW-ABW] x 100/ABW), and 4) ratio (%) of estimates within 10% of ABW (true when absolute percentage error was not more than 10%). One-way ANOVA was performed to compare the mean of error between groups. The accuracy of the GAP-method of predicting BW then was assessed by calculating these outcomes. The accuracy within 10% of ABW was calculated for each subset of possible contributing factors in GAP- predicted BW (BMI, fetal sex, gestational age at delivery, GAP of EFW, ABW, and latency interval) and compared by using Chi Square test. The effects of latency until delivery and ABW on the absolute percentage error were assessed using Pearson correlation coefficient. The authors also determined the correlation coefficient (Pearson's) of ABW versus GAP- predicted BW. $p < 0.05$ was considered statistically significant.

Efficiency of GAP of EFW in prediction of BW (Sensitivity, Specificity, False positive rate, False negative rate, PPV, NPV, Post-test likelihood when the test is negative, LR of a positive test result, LR of a negative test result and TE) were calculated for the following conditions: 1) among parturients with a GAP-estimation of BW less than 2,500 g to detect accurately a newborn weighing 2,499 g or less. 2) among parturients with a GAP- estimation of BW between 2,500-4,000 g to detect accurately a newborn weighting between 2,500-4,000 g, 3) among parturients with a GAP-estimation of BW exceeding 4,000 g to actually predict a newborn with an ABW of more than 4,000 g.

Results

Three hundred and twenty-eight pregnant women participated in this study. The characteristics of the patients and their infants were shown in Table 1. The mean age was 26.5 ± 6.6 years and ranged from 15 to 47 years.

The parous and non-parous groups were found in the similar number. The mean BMI was 26.9 ± 3.7, the percentages of underweight (BMI < 19.8), normal weight (BMI 19.8-26), over weight (BMI 26.1-29.0), and obese groups (BMI > 29) were 0.3, 51.2, 26.8, and 21.7 percent respectively. The mean gestational age was 39.4 ± 1.6 weeks and 93.9 percent of cases were term pregnancy. The mean ABW was 3,091 ± 410.7 g (range 1,930-4,800 g) and 93% were within normal BW range. The mean time interval from ultrasound to delivery was 16.9 ± 12.6 days (range 1-60 days). There were only three cases when latency exceeded 49 days. The majority (51.5%) of fetal sex was female.

The mean GAP - predicted BW, 2,957.5 ± 379.4 g compared favorably to the mean ABW, 3,091 ± 410.7 grams. The authors classified the ABW into three groups as follows: 1) less than 2,500 g: 20 cases, 2) 2,500-4,000 g: 305 cases, and 3) more than 4,000 g: 3 cases.

The mean predicted simple BW errors, absolute BW errors, and absolute percentage errors for the entire study population are shown in Table 2. These were categorized according to whether the GAP - predicted BW was less than 2,500 g; 2,500-4,000 g or more than 4,000 g. It was found that the mean of simple error was -134.5 ± 235.2 g [range (-138.8 ± 240.7 g) – 146 ± 94.2 g]. It meant that the estimation seemed to be in the underestimated direction (negative value). It was noted that the mean simple errors were more likely to overestimate the BW of larger fetuses (BW more than 4,000 g) and underestimate the BW of smaller fetuses (BW < 2,500 g) and normal birth weight fetuses (BW 2,500-4,000 g). These differences were statistically significant ($p = 0.026$). The mean absolute error was 226.2 ± 148.8 g, ranged from 146 ± 94.2 g (fetal weight > 4,000 g) to 233 ± 150.9 g (fetal weight 2,500- 4,000 g). The mean of absolute percentage error was 7.2 ± 4.5%, ranged from 3.7 ± 2.5% (fetal weight > 4,000 g) to 7.3 ± 4.5% (fetal weight 2,500-4,000 g.) The accuracy within 10% of ABW was 76.5%, ranged from 75.7% (fetal weight 2,500-4,000 g) to 100% (fetal weight > 4,000 g). There were no statistically significant in the absolute error, the absolute percentage error and the accuracy within 10% of ABW in each fetal weight strata (p = 0.053, 0.177 and 0.379, respectively).

Although there were many possible contributing factors affecting the accuracy within 10% of ABW (Table 1), factors such as BMI, fetal sex, gestational age at delivery, GAP of estimated fetal weight, latency interval and ABW were not statistically significant (p = 0.128, 0.932, 0.477, 0.379, 0.324 and 0.196, respectively).

The authors tested the GAP method across the range of lapse time in seven-day intervals as shown in Table 3. The mean of simple errors in seven-day segments of lapse time ranged from -294.5 ± 219.9 g (latency interval 57-63 days) to 386 g (latency interval 50-56 days). Analysis of variance failed to support a difference among segmental means of absolute error (p = 0.173) and absolute percentage error (p = 0.415) but a difference among segmental means for simple error was statistically significant (p = 0.027). Deterioration of accuracy occurred when latency exceeded 49 days.

Table 1. The demographic data of studying population and the accuracy within 10% of actual birth weight in subset of possible contributing factors in GAP of estimated fetal weight

	Mean (SD)	Range	Group	Numbers	%	Accuracy within 10% of actual BW (%)	p-value
Age (years)	26.5 (6.6)	15-47	≤17	28	8.5		
			18-34	259	78.9		
			≥35	41	12.6		
Parity	0.7 (0.9)	0-4	0	162	49.4		
			≥1	166	50.6		
BMI	26.9 (3.7)	18.9-46.9	<19.8	1	0.3	0	0.128
			19.8-26.0	168	51.2	73.8	
			26.1-29.0	88	26.8	67.3	
			>29	71	21.7	54.3	
GA (weeks)	39.4 (1.6)	34.4-43.3	<37	20	6.1	70	0.477
			≥37	308	93.9	76.9	
Actual Birth weight (grams)	3,091 (410.7)	1,930-4,800	<2,500	20	6.1	80	0.196
			2,500-4,000	305	93	76.7	
			>4,000	3	0.9	33.3	
GAP of estimated fetal weight (grams)	2,957.5 (379.4)	1,922-4,857	<2,500	31	9.5	80.6	0.379
			2,500-4,000	292	89	75.7	
			>4,000	5	1.5	100	
Latency interval (days)	16.9 (12.6)	1-60	1-7	95	28.9	77.9	0.324
			8-14	64	19.5	82.8	
			15-21	59	17.9	78.0	
			22-28	41	12.5	75.6	
			29-35	39	11.9	64.1	
			36-42	20	6.2	80.0	
			43-49	7	2.2	71.4	
			50-56	1	0.3	0	
			57-63	2	0.6	50	
Fetal sex			Male	159	48.5	76.7	0.932
			Female	169	51.5	76.3	

SD indicates standard deviation; GAP indicates gestation-adjusted projection

The simple error and absolute percentage error were not statistically significant correlated with lapse time (r = -0.089, p = 0.109 and r = 0.099, p = 0.074 respectively). The absolute percentage error was statistically significant weak inverse correlation with the GAP - predicted BW (r = - 0.116, p = 0.036).

The absolute percentage error was also statistically significant correlation with the ABW (r = 0.185, P = 0.001, correlation is significant at the 0.01 level, 2-tailed). The coefficient of correlation between GAP predicted BW and the ABW was 0.824 (p value < 0.001; correlation is significant at the 0.01 levels, 2-tailed) (Fig. 1).

Table 4 lists the sensitivity, specificity, false positive rate (FP), false negative rate (FN), positive predictive value (PPV), negative predictive value (NPV), post-test likelihood when the test is negative, likelihood ratio of a positive test result (LR+), likelihood ratio of a negative test result (LR-) and efficiency of test (TE) for the GAP method to identify accurately a newborn with BW less than 2,500 g, 2,500-4,000 g, or more than 4,000 g.

Table 2. Accuracy of weight prediction classified by GAP of estimated fetal weight (n = 328 cases)

	Mean error (SD) [95% confidence interval]				p-value
	< 2,500 g (n = 31)	2,500-4,000 g (n = 292)	> 4,000 g (n = 5)	Total (n = 328)	
Simple error (grams)	-139.9 (161.7) [(-199.2)-(-80.6)]	-138.8 (240.7) [(-166.5)-(-111.1)]	146 (94.2) [29.1-262.9]	-134.5 (235.2) [(-160.1)-(-109)]	0.026
Absolute error (grams)	174.2 (122.5) [129.3-219.2]	233 (150.9) [215.7-250.4]	146 (94.2) [29.1-262.9]	226.2 (148.8) [209.9-242.3]	0.053
Absolute percentage error (%)	6.8 (4.5) [5.1-8.4]	7.3 (4.5) [6.8-7.8]	3.7 (2.5) [0.6-6.9]	7.2 (4.5) [6.7-7.7]	0.177
Accuracy within 10% of Actual BW (%)	80.6 [66.7-94.5]	75.7 [70.8-80.6]	100	76.5 [71.9-81.1]	0.379

g indicates gram; SD indicates standard deviation

Table 3. Accuracy of weight prediction within segments of lapse time

Latency interval (days)	Numbers	Simple error (grams) Mean (SD)	Absolute error (grams) Mean (SD)	Absolute percentage error (%) Mean (SD)	Accuracy within 10% of actual birth weight (%)
1-7	95	-138.6 (203.9)	199.4 (144.2)	6.5 (4.6)	77.9
8-14	64	-68.5 (231.4)	208.4 (119.1)	6.9 (3.9)	82.8
15-21	59	-138.5 (254.9)	244.3 (154.3)	7.8 (4.7)	78.0
22-28	41	-138.9 (241.8)	230.7 (153.8)	7.2 (4.5)	75.6
29-35	39	-228.3 (225.7)	279.5 (155.7)	8.4 (4.2)	64.1
36-42	20	-137.0 (259.7)	230.2 (177.2)	7.3 (4.9)	80
43-49	7	-124.9 (281.7)	220.6 (201.9)	6.3 (5.5)	71.4
50-56	1	386	386	13.2	0
57-63	2	-294.5 (219.9)	294.5 (219.9)	8.1 (6)	50
Total	328	-134.5 (235.1)	226.2 (148.8)	7.2 (4.5)	76.5
p-value		0.027	0.173	0.415	0.324

Table 4. Comparison of result of predicting birth weight. Efficiency of GAP of estimated fetal weight in prediction of birth weight

	Prevalence (%)	Sensitivity (%)	Specificity (%)	FP (%)	FN (%)	Post-test likelihood, when the test is negative (%)	PPV (%)	NPV (%)	LR (+)	LR (-)	TE (%)
GAP-EBW & ABW < 2,500 g	6.1	60.0	93.8	6.2	40.0	2.7	38.7	97.3	10.0	0.4	91.7
GAP-EBW & ABW 2,500-4,000 g	93.0	92.5	56.5	43.5	7.5	63.9	96.6	36.1	2.1	0.1	89.9
GAP-EBW & ABW > 4,000 g	0.9	33.3	98.8	1.2	66.7	0.6	20.0	99.4	33.0	0.8	98.2

FP indicates false-positive rate; FN indicate false-negative rate; LR+ indicates likelihood ratio of a positive result, LR- indicates likelihood ratio of a negative result; PPV indicates positive predictive value; NPV indicates negative predictive value; TE indicates test efficiency; GAP-EBW indicates gestation - adjusted projection of estimated birth weight; ABW indicates actual birth weight; g indicates grams

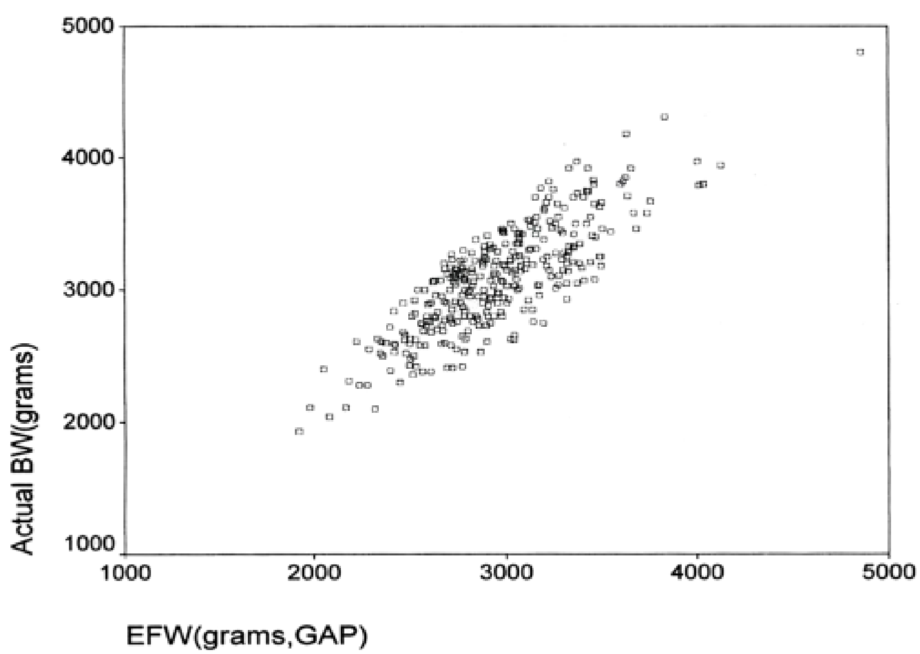

Fig. 1 Scatter plot of the relationship of GAP-estimated to actual birth weight (in grams) observed during trial

Discussion

An accurate estimation of BW could decrease the morbidity and mortality associated with birth trauma and perinatal asphyxia[1,17]. The present study was conducted to determine the accuracy of GAP method in predicting the fetal BW. By applying the GAP method on the date of delivery, using data obtained from an ultrasound examination at 34 weeks' gestation or after, BW can be predicted with a mean absolute percentage error of 7.2% which was lower than those in the study of Mongelli and Spinnato[15,18] (9.93% and 11.98% respectively). The difference might be from the variation of the study population.

The prediction of BW seemed to be underestimated (the mean of simple error = -134.5 ± 235.2 g). The GAP method tended to underestimate the small fetus (fetal weight < 2,500 g: the mean of simple error = -139.9 ± 161.7 g) and the normal birth weight fetus (fetal weight 2,500-4,000 g; the mean of simple error = -138.8 ± 240.7 g) but overestimate the large fetus (fetal weight > 4,000 g: the mean of simple error = 146 ± 94.2 g).

The results of the present study revealed the accuracy within 10% of ABW was 76.5% and the mean absolute error was 226.2 ± 148.8 g, which is better than many studies[15, 18, 19]. Therefore, it may conclude that the GAP method can improve the prediction of BW in Thai pregnant women. The smallest observed mean difference was obtained in the large fetus group (BW > 4,000 g) and the largest observed mean difference was obtained in the normal BW group (BW 2,500-4,000 g) [absolute error 146 ± 94.2 and 233 ± 150.9 g; absolute percentage error 3.7 ± 2.5% and 7.3 ± 4.5% respectively].

The possible factors that may affect the accuracy of EFW e.g. BMI, latency interval, fetal sex, ABW, and gestational age at delivery were insignificant factors that affected the accuracy within 10% of ABW (Table 1).

The GAP method, as originally described, was applied when the latency between sonographic measurements and delivery was 35 days or less[15]. This was because the GAP method was being compared with the Spinnato method[18], which reported unacceptable deterioration of accuracy when latency exceeds 35 days. However, the presented data included sonograms performed between 1 and 60 days before delivery. Deterioration of accuracy occurred when latency exceeded 49 days. Interestingly, sonograms performed within 1 or 2 weeks before delivery were more likely to obtain less absolute error. However, the difference among segmental means of absolute error was not statistically significant (p = 0.173). Since Mongelli[15] reported no significant correlation between the prediction errors and latency interval, the authors' assumption was that this increase in latency period would not significantly affect the present result. This assumption was supported by the presented data, which did not show a correlation between latency and the prediction errors (Simple error and absolute percentage error; r = -0.089, p = 0.109 and r = 0.099, p = 0.074 respectively). In the presented study, low BW (BW < 2,500 g) and large fetus groups (BW > 4,000 g) affected up to 6.1% and 0.9% of newborn infants and were the clinical conditions that are most often associated with adverse peripartum outcomes, it was of practical interest to quantify the usefulness of GAP method for the prediction of BW of less than 2,500 g and more than 4,000 g. Efficiencies for detection of low ABW (BW < 2,500 g) and large fetus (BW > 4,000 g) were different. Low ABW group has more percentages of sensitivity than the large fetus group (60% and 33.3% respectively) but similar high specificity (93.8% vs. 98.8%) and high NPV (97.3% vs. 99.4%). It means that GAP-estimation in screening for low ABW is better than the large fetus group. High negative predictive value in low ABW and the large fetus group means that in cases of estimated fetal weight more than 2,500 g, the chance of delivery of infants with BW more than 2,500 g is 97.3% and in cases of estimated fetal weight less than 4,000 g, the chance of delivery of infants with BW less than 4,000 g is 99.4%. The post-test likelihood when the test is negative in low ABW group was 2.7%. It means that in cases of estimated fetal weight more than 2,500 g, the chance of delivery of infants with BW less than 2,500 g is only 2.7%. Similarly, the post-test likelihood when the test is negative in large fetus group (BW > 4,000 g) was only 0.6%. It means that in cases of estimated fetal weight less than 4,000 g, the chance of delivery of infants with BW more than 4,000 g is only 0.6%. The LR+ in low ABW and large fetus groups were 10 and 33 respectively. These are significant because a LR of ≥ 5.0 is widely considered to be the threshold at which a test can be considered useful for clinical decision making, where as a test with a LR < 5.0 is felt to have either limited or absent utility[20].

The present study, therefore, validates the concept of GAP method. However, external validation appears necessary before this model can be widely endorsed. Regarding the small number of subjects in the low BW (BW < 2,500 g) and large fetus groups (BW > 4,000 g), further study should be focused on low BW and large fetuses who are the high-risk groups for perinatal morbidity and mortality[1,17,21].

Conclusion

GAP method is good enough for BW prediction in Thai pregnant women [accuracy within 10% of ABW = 76.5% (95% CI 71.9, 81.1)]. The diagnostic performance of this method for detection of low BW (BW < 2,500 g) and large fetuses (BW > 4,000 g) are acceptable because of its high specificity, high NPV, high LR+, and low post-test likelihood when the test is negative. The authors, therefore, advocate that the GAP method might be the promising and practical method for predicting BW in Thai pregnant women. Its clinical value is suggested in many primary health care centers where the equipment and expertise are unavailable and is helpful in planning of management, counseling on the likelihood of survival, optimal route of delivery, or level of hospital where the delivery should occur.

Acknowledgements

The authors wish to thank Dr. Sarawut Sonthikaew, Director of Charoenkrung Pracharak Hospital, for allowing the authors to complete the study. The authors also wish to thank Prof. Emeritus Wiboonpan Thitadilok for her kindness in reviewing this article.

References

1. McIntire DD, Bloom SL, Casey BM, Leveno KJ. Birth weight in relation to morbidity and mortality among newborn infants. N Engl J Med 1999; 340: 1234-8.
2. Sherman DJ, Arieli S, Tovbin J, Siegel G, Caspi E, Bukovsky I. A comparison of clinical and ultrasonic estimation of fetal weight. Obstet Gynecol 1998; 91: 212-7.
3. Chauhan SP, Hendrix NW, Magann EF, Morrison JC, Kenney SP, Devoe LD. Limitations of clinical and sonographic estimates of birth weight: experience with 1034 parturients. Obstet Gynecol 1998; 91: 72-7.
4. Prechapanich J, Thitadilok W. Comparison of the Accuracy of Fetal Weight Estimation Using Clinical and Sonographic Methods. J Med Assoc Thai 2004; 87 (Suppl 3): S1-7.
5. Farrell T, Holmes R, Stone P. The effect of body mass index on three methods of fetal weight estimation. BJOG 2002; 109: 651-7.
6. Blann DW, Prien SD. Estimation of fetal weight before and after amniotomy in the laboring gravid woman. Am J Obstet Gynecol 2000; 182: 1117-20.
7. Mongelli M. Fetal weight estimation by symphysis-fundus height and gestational age. Gynecol Obstet Invest 1997; 43: 20-4.
8. Chien PF, Owen P, Khan KS. Validity of ultrasound estimation of fetal weight. Obstet Gynecol 2000; 95: 856-60.
9. Venkat A, Chinnaiya A, Gopal M, Mongelli JM. Sonographic fetal weight estimation in a south-east Asian population. J Obstet Gynaecol Res 2001; 27: 275-9.
10. Ratanasiri T, Jirapornkul S, Somboonporn W, Seejorn K, Patumnakul P. Comparison of the accuracy of ultrasonic fetal weight estimation by using the various equations. J Med Assoc Thai 2002; 85: 962-6.
11. Degani S. Fetal biometry: clinical, pathological, and technical considerations. Obstet Gynecol Surv 2001; 56: 159-67.
12. Barnhard Y, Bar-Hava I, Divon MY. Accuracy of intrapartum estimates of fetal weight. Effect of oligohydramnios. J Reprod Med 1996; 41: 907-10.
13. Nahum GG, Stanislaw H. Ultrasonographic prediction of term birth weight: how accurate is it? Am J Obstet Gynecol 2003; 188: 566-74.
14. Sabbagha RE, Minogue J, Tamura RK, Hungerford SA. Estimation of birth weight by use of ultrasonographic formulas targeted to large-, appropriate-, and small-for-gestational-age fetuses. Am J Obstet Gynecol 1989; 160: 854-60.
15. Mongelli M, Gardosi J. Gestation-adjusted projection of estimated fetal weight. Acta Obstet Gynecol Scand 1996; 75: 28-31.
16. Uerpairojkit B. Intrauterine Growth Restriction. In: Tannirandorn Y, editor. Maternal - fetal medicine. Bangkok: Sangsue and Usa; 2001: 90-100.
17. Smith-Bindman R, Chu PW, Ecker J, Feldstein VA, Filly RA, Bacchetti P. Adverse birth outcomes in relation to prenatal sonographic measurements of fetal size. J Ultrasound Med 2003; 22: 347-56.
18. Spinnato JA, Allen RD, Mendenhall HW. Birth weight prediction from remote ultrasound examination. Obstet Gynecol 1988; 71: 893-8.
19. Pressman EK, Bienstock JL, Blakemore KJ, Martin SA, Callan NA. Prediction of birth weight by ultrasound in the third trimester. Obstet Gynecol 2000; 95: 502-6.
20. Jacschke R, Guyatt GH, Sackett DL. Users' guides to the medical literature. III. How to use an article about a diagnostic test. B. What are the results and will they help me in caring for my patients? JAMA 1994; 271: 703-7.

21. Noumi G, Collado-Khoury F, Bombard A, Juliard K, Weiner Z. Clinical and sonographic estimation of fetal weight performed during labor by residents. Am J Obstet Gynecol 2005; 192: 1407-9.

ความถูกต้องในการคะเนน้ำหนักทารกแรกเกิดด้วยวิธี Gestation-adjusted projection โดยใช้เครื่องตรวจคลื่นเสียงความถี่สูงวัดขนาดของทารกในครรภ์ในไตรมาสที่สามของการตั้งครรภ์

สุกิจ ศรีทิพยวรรณ, วิสุทธิ์ อนันต์สกุลวัฒน์, โชติมา สุทันติกร

วัตถุประสงค์: *1. เพื่อประเมินความถูกต้องของวิธี Gestation-adjusted projection ในการคะเนน้ำหนักทารกแรกเกิดของหญิงไทยตั้งครรภ์*

2. เพื่อประเมินประสิทธิภาพของวิธี Gestation-adjusted projection ในการตรวจพบทารกแรกเกิดที่มีน้ำหนักน้อยกว่า 2,500 กรัม, 2,500-4,000 กรัม และมากกว่า 4,000 กรัม

ชนิดของการวิจัย: *การวิจัยทางคลินิกในเชิงการวินิจฉัย*

วัสดุและวิธีการ: *กลุ่มศึกษาคือหญิงไทยตั้งครรภ์ที่ไม่มีภาวะแทรกซ้อน จำนวน 328 ราย อายุครรภ์ตั้งแต่ 34 สัปดาห์เป็นต้นไป มาฝากครรภ์ที่ห้องฝากครรภ์ โรงพยาบาลเจริญกรุงประชารักษ์ ตั้งแต่วันที่ 1 สิงหาคม ถึง 30 พฤศจิกายน พ.ศ. 2549 โดยสตรีตั้งครรภ์เหล่านั้นจะได้รับการคะเนน้ำหนักทารกในครรภ์ โดยใช้เครื่องตรวจคลื่นเสียงความถี่สูงวัดขนาดทารกในครรภ์ คำนวณน้ำหนักโดยใช้สมการของ Hadlock และคะเนน้ำหนักทารกแรกเกิดโดยใช้วิธี Gestation-adjusted projection เปรียบเทียบน้ำหนักทารกแรกเกิดที่คำนวณได้กับน้ำหนักทารกแรกเกิดที่แท้จริง นำไปคำนวณหาค่ากลางความคลาดเคลื่อน ค่ากลางความคลาดเคลื่อนสมบูรณ์ ร้อยละของความคลาดเคลื่อนสมบูรณ์ และสัดส่วนของการคะเนน้ำหนักทารกในครรภ์ที่ถูกต้องภายในร้อยละ 10 ของน้ำหนักทารกแรกเกิด คำนวณค่าความไว ความจำเพาะ ผลบวกลวง ผลลบลวง ค่าการพยากรณ์บวก ค่าการพยากรณ์ลบ ค่าการประเมินโอกาสที่ผลลัพธ์ที่แท้จริงจะผิดปกติเมื่อผลการทดสอบปกติ, ค่าการประเมินว่าผลการทดสอบที่ผิดปกติ/ปกติ จะพบในกลุ่มคนที่ผิดปกติเป็นกี่เท่า ของกลุ่มที่ปกติ และประสิทธิภาพของวิธีการทดสอบ*

ผลการศึกษา: *การคะเนน้ำหนักทารกแรกเกิดด้วยวิธี Gestation-adjusted projection มีความถูกต้องร้อยละ 76.5 (ช่วงความเชื่อมั่น ร้อยละ 95 CI 71.9, 81.1) การคะเนน้ำหนักทารกแรกเกิดมีแนวโน้มที่จะคะเนต่ำกว่าน้ำหนักจริง โดยมีความคลาดเคลื่อนเฉลี่ย -134.5 ± 235.2 กรัม ค่าความคลาดเคลื่อนสมบูรณ์เฉลี่ย 226.2 ± 148.8 กรัม เทียบได้กับร้อยละ 7.2 ± 4.5 ของน้ำหนักทารกแรกเกิดที่แท้จริง ความคลาดเคลื่อนน้อยที่สุดพบในกลุ่มที่น้ำหนักมากกว่า 4,000 กรัม และความคลาดเคลื่อนมากที่สุดพบในกลุ่มที่มีน้ำหนัก 2,500-4,000 กรัม ความถูกต้องในการคะเนน้ำหนักทารกแรกเกิดในกลุ่มที่ต่ำกว่า 2,500 กรัม และมากกว่า 4,000 กรัม พบว่ามีความไวร้อยละ 60 และร้อยละ 33.3 ความจำเพาะร้อยละ 93.8 และร้อยละ 98.8 ค่าการพยากรณ์บวกร้อยละ 38.7 และร้อยละ 20 ค่าการพยากรณ์ลบร้อยละ 97.3 และร้อยละ 99.4 ตามลำดับ ค่าการประเมินเมื่อผลการทดสอบพบว่าทารกแรกเกิดมีน้ำหนักมากกว่า 2,500 กรัม โอกาสที่ทารกแรกเกิดจะมีน้ำหนักน้อยกว่า 2,500 กรัม เท่ากับร้อยละ 2.7 และเมื่อผลการทดสอบพบว่าทารกแรกเกิดมีน้ำหนักน้อยกว่า 4,000 กรัม โอกาสที่ทารกแรกเกิดจะมีน้ำหนักมากกว่า 4,000 กรัม เท่ากับร้อยละ 0.6 ประสิทธิภาพของวิธี Gestation-adjusted projection ในการคะเนน้ำหนักแรกเกิดได้ถูกต้องเท่ากับร้อยละ 91.7, 89.9 และ 98.2 สำหรับน้ำหนักแรกเกิดที่น้อยกว่า 2,500 กรัม, 2,500-4,000 กรัม และมากกว่า 4,000 กรัม ตามลำดับ*

สรุป: *วิธี Gestation-adjusted projection สามารถใช้คะเนน้ำหนักทารกแรกเกิดของหญิงไทยตั้งครรภ์ได้ โดยมีความถูกต้องที่ดี ขีดความสามารถในการวินิจฉัยของวิธีการนี้ในการคะเนน้ำหนักแรกเกิดในกลุ่มที่มีน้ำหนักแรกเกิดต่ำกว่า 2,500 กรัม และมากกว่า 4,000 กรัม อยู่ในเกณฑ์ที่ยอมรับได้ เนื่องจากมีค่าความจำเพาะ ค่าการพยากรณ์ลบ และค่า LR+ สูง และมีค่า Post-test likelihood เมื่อให้ผลมีค่าลบต่ำ*