



www.figo.org

Contents lists available at ScienceDirect

International Journal of Gynecology and Obstetrics

journal homepage: www.elsevier.com/locate/ijgo



CLINICAL ARTICLE

Inadequate identification of small-for-gestational-age fetuses at an urban teaching hospital

Kathleen Powell Mattioli^a, Maureen Sanderson^b, Suneet P. Chauhan^{c,*}^a Aurora Health Care, West Allis, Wisconsin, USA^b Department of Obstetrics and Gynecology, Meharry Medical College, Nashville, Tennessee, USA^c Aurora Sinai Medical Center, Milwaukee, Wisconsin, USA

ARTICLE INFO

Article history:

Received 29 September 2009

Received in revised form 20 November 2009

Accepted 22 December 2009

Keywords:

Clinical estimate of fetal weight

Intrauterine growth restriction

Small for gestational age

Sonographic estimate of fetal weight

Symphyseal fundal height

ABSTRACT

Objective: To ascertain the likelihood of identifying small for gestational age (SGA) neonates prenatally (below the 10th percentile for gestational age). **Methods:** On admission for delivery, the charts of singletons with reliable gestational age (GA) were reviewed to determine whether intrauterine growth restriction (IUGR) was suspected, clinically or sonographically. Multiple logistic regression analysis was used with the accurate identification of SGA as the dependent variable and 13 independent variables. **Results:** Over 10 months, 1502 pregnant women met the inclusion criteria and 16% of neonates were born SGA. Before delivery, only 10% (95% confidence interval 6%–14%) of newborns identified as SGA were detected, and 7% weighed below the 5th percentile. Multiple logistic regression analysis identified 4 factors that made a significant independent contribution to the detection of SGA: younger maternal age, size less than date, sonographic examination within 4 weeks of delivery, and a history of substance abuse. **Conclusions:** Because we failed to identify 90% of SGA with fundal height measurements, the likelihood of detecting most growth-restricted fetuses clinically is low. If other investigators confirm these findings, a paradigm shift is warranted to improve the detection of IUGR.

© 2010 International Federation of Gynecology and Obstetrics. Published by Elsevier Ireland Ltd. All rights reserved.

1. Introduction

Intrauterine growth restriction (IUGR)—a prenatal indication that the newborn will be small for gestational age (actual weight below the 10th percentile for gestational age)—is considered by the American College of Obstetricians and Gynecologists (ACOG) to be one of the most common and complex problems in modern obstetrics. IUGR is linked to an increased rate of stillbirth, perinatal morbidity (oligohydramnios, umbilical arterial pH <7.00, seizures, and sepsis), and mortality [1].

Identification of small for gestational age (SGA) fetuses is important because it can influence the location of delivery [2], and prenatal testing may decrease perinatal mortality [1]. According to the guideline on SGA from the Royal College of Obstetricians and Gynaecologists (RCOG), these newborns should be born at a facility with optimal neonatal expertise, where a skilled resuscitator is present. ACOG noted that for suspected SGA neonates managed with a serial biophysical profile, the corrected perinatal mortality was 8.4 per 1000 live births, whereas for unsuspected SGA neonates the perimortality was 21.3 per 1000 live births [1].

The ACOG practice bulletin on IUGR notes that, “unfortunately, approximately half of growth-restricted fetuses are not diagnosed until delivery” [1]. Our experience suggested otherwise [3,4]. The aim of the present retrospective study was to determine the proportion of SGA neonates that were identified prenatally and to ascertain the factors that influence the accuracy of this identification.

2. Materials and methods

The inclusion criteria were non-anomalous singletons, born to mothers with either a reliable known last menstrual period date with regular, normal menstrual cycle plus ultrasound examination in the second trimester confirming the gestational age (GA) or an ultrasound examination before 20 weeks [5]. Approval for the study was obtained from the Institutional Review Board. The charts of all patients admitted for delivery from October 2006 to July 2007 were reviewed. Because this was a retrospective study, informed consent was not obtained.

From the prenatal records, we obtained the maternal demographics, the accuracy of the dating, risk factors for growth restriction, and the report of any ultrasound examination within 4 weeks of admission. We also reviewed the antepartum charts to determine whether the clinicians considered fundal height to be less than expected for GA (size less than date). After delivery, we extracted the data on the intrapartum course and birth weight.

* Corresponding author. Aurora Sinai Medical Center, 945 N 12th Street, OHC Room Number 3099, PO Box 342, Milwaukee, WI 53201, USA. Tel.: +1 414 328 6941; fax: +1 414 328 6928.

E-mail address: suneet.chauhan@aurora.org (S.P. Chauhan).

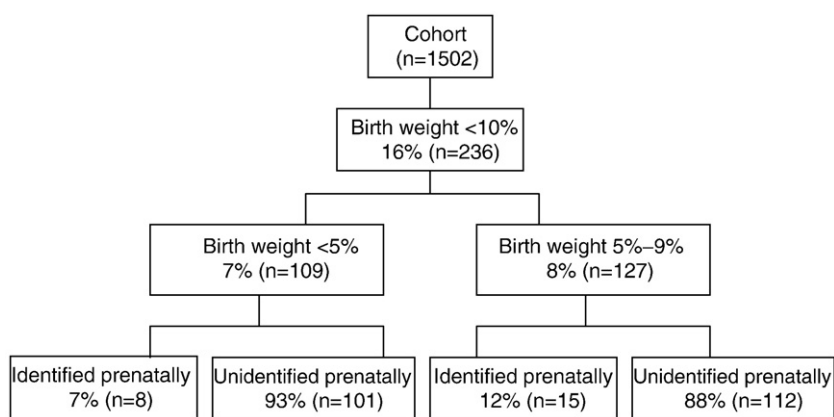


Fig. 1. Detection of small for gestational age neonates.

A neonate was considered to be SGA if its birth weight was at or below the 10th percentile for GA, according to the nomograms proposed by Alexander et al. [6]. A fetus was considered to have IUGR if the clinicians managing the pregnancy noted this in the prenatal chart or the admission history and physical examination. The suspicion of IUGR could be derived clinically, or with sonographic measurements of biometric parameters. The regression equations developed by Hadlock et al. [7] were used; if the abdominal circumference alone or the sonographically estimated fetal weight (SEFW) was 10% or less, then the fetus was considered to have IUGR. Some of the examinations were performed by registered diagnostic medical sonographers (RDMS) under the supervision of a maternal–fetal medicine subspecialist; others were performed by residents on labor and delivery wards or obstetricians in private practice. At our institute patients are managed and delivered by midwives, family practice and obstetrics–gynecology residents, under the supervision of their faculty, and by private ACOG fellows. On the basis of ACOG advice [1], all pregnancies were screened for abnormal growth with serial fundal height measurements during the prenatal visits, and ultrasound examination was reserved for those with risk factors or lagging growth.

Odds ratios (OR) with 95% confidence intervals (CI) were calculated. Multiple logistic regression analysis was used with correct identification of SGA as the dependent variable and the following 15 independent variables, which are known to be linked with growth restriction: (1) maternal age (<19 years vs 20 years or more); (2) ethnicity (African American, Hispanic, white, other); (3) nulliparity (yes or no); (4) ultrasound examination before 20 weeks (yes or no); (5) SEFW within 4 weeks of birth (yes or no); (6) abnormal maternal serum screen (quadruple or triple screen; yes or no); (7) asthma (yes or no); (8) second or third trimester bleeding (yes or no); (9) cigarette smoker (yes or no); (10) medical illness, including pregestational diabetes, renal disease, or sickle cell disease (yes or no); (11) hypertensive disease of pregnancy, including pregnancy-induced hypertension, pre-eclampsia, chronic hypertension (yes or no); (12) placenta previa or abruption (yes or no); (13) substance abuse (yes or no; either acknowledged by the patient or after a positive urine test for amphetamine, barbiturates, benzodiazepine, cannabinoids, cocaine, methadone, opiates, phencyclidine or propoxyphene); and

(14) GA at delivery (<37.0 weeks vs \geq 37.0 weeks). The 15th variable in the analysis was size less than date (a difference between symphyseal fundal height in centimeters and gestational age in weeks, as ascertained by the clinician managing the patient), which is a predictor of SGA neonates [1]. In the correctly identified SGA group there were no patients with placenta previa/abruption or medical illness. Therefore, these two variables were excluded from the final multiple logistic regression leaving 13 variables in the analysis. To determine which variables made a significant contribution to the correct identification of SGA neonates, we compared the full model with a simpler model omitting the least significant variable one at a time. A variable was considered a significant predictor if $P < 0.05$.

3. Results

Over 10 months, there were 1793 births at our centers and among them 1502 (84%) pregnant women met the inclusion criteria for the study. The mean \pm SD maternal age of the cohort was 24.2 ± 5.9 years, and the mean GA was 38.5 ± 2.4 weeks. Of the participants, 64% were African American, 15% were Hispanic, 11% were white, and 9% were of other ethnicity. Almost half of the patients (47%) did not have any of the risk factors for IUGR; 39% had one risk factor; 11% had 2 factors; and 2% had 3 risk factors. The 3 most common risk factors were teenage pregnancy (23%), cigarette smoking (11%), and advanced maternal age (35 years or more) (6%).

Before delivery, only 79 (5%) of the women were suspected of having IUGR. For 50 of these patients (63%), the suspicion was based on clinical examination; for 19 patients (24%) it was based on ultrasound examination; and for 10 patients (13%) it was based on both. Of the 1502 newborns, 236 (16%) were SGA: 109 (7%) were below the 5th percentile for GA and 127 (8%) were between the 5th and 10th percentile for GA. Before birth, only 10% (95% CI, 6%–14%; 23 out of 236) of the SGA neonates were suspected of abnormal growth. Of these, detection of newborns weighing below the 5th percentile for GA was similar to those weighing between the 5th and 10th percentile (7% vs 12%; OR 0.57; 95% CI, 0.24–1.45) (Fig. 1).

Table 1 provides the prevalence of and detection of SGA under various clinical scenarios. Table 2 provides the overall predictive

Table 1
Prevalence and detection of small-for-gestational age neonates.

	EDD based on US	EDD based on LMP	OR (95% CI)	Complicated pregnancy	Uncomplicated pregnancy	OR (95% CI)	US within 4 weeks of delivery	No US within 4 weeks of delivery	OR (95% CI)
Number	781	721	–	789	713	–	360	1142	–
SGA	15%	16%	0.96 (0.73–1.27)	19%	12%	1.5 (1.17–2.01)	22%	14%	1.72 (1.27–2.33)
Detection of SGA	7%	12%	0.57 (0.24–1.39)	14%	3%	4.5 (1.30–15.67)	26%	2%	17.82 (5.10–62.23)

Abbreviations: EDD, estimated date of delivery; US, ultrasound; LMP, last menstrual period; OR, odds ratio; CI, confidence interval; SGA, small for gestational age.

Table 2
Predictive accuracy of intrauterine growth restriction for identifying small-for-gestational age neonates.

	Rate SGA, %	Likelihood ratio (95% CI)	Sensitivity, % (95% CI)	Specificity, % (95% CI)	Positive predictive value, % (95% CI)	Negative predictive value, % (95% CI)
All patients (n = 1502)	16	2.2 (1.3–3.5)	10 (6–14)	95 (94–96)	29 (19–40)	85 (83–86)
SEFW within 4 weeks of birth (n = 360)	22	2.1 (1.3–3.5)	26 (16–37)	88 (83–91)	37 (24–51)	81 (76–85)
No SEFW within 4 weeks of birth (n = 1142)	14	0.8 (0.2–2.8)	2 (0.3–5)	98 (97–99)	12 (2–31)	86 (84–88)

Abbreviations: SGA, small for gestational age (birth weight below 10th percentile for gestational age, using Alexander et al. [6] nomograms); SEFW, sonographic estimated fetal weight; CI, confidence interval.

accuracy of IUGR to detect SGA neonates, together with the number of patients that had SEFW within 4 weeks of birth and those that did not. Table 3 differentiates between SGA neonates that were identified before birth and those that were not. Results of multiple logistic regression analysis indicate that 4 factors made a significant independent contribution to the detection of SGA: younger maternal age; history of substance abuse; size less than date; and SEFW within 4 weeks of delivery in increasing order of importance (Table 3). Although the odds ratios were statistically significant, the findings were based on small numbers and should be interpreted with caution.

4. Discussion

Prenatal identification of SGA neonates is important because it can reduce perinatal mortality, influence the location of delivery, and mitigate neonatal complications. Although the ACOG practice bulletin on IUGR notes that approximately half of SGA newborns are diagnosed before birth [1], the bulletin on ultrasonography in pregnancy [8] cites 6 publications that had a detection rate of 25%–94%. We needed to determine our accuracy in predicting SGA neonates for two reasons: (1) the high likelihood of abnormal fetal growth in our population, due to the maternal demographics and use of tobacco during pregnancy; and (2) we thought that our detection rate for SGA was higher than the ACOG estimate [3,4].

There are 3 findings of the present study. First, despite that our rate of SGA neonates was 60% higher than expected (16% vs 10%), our detection rate was worse than any cited by ACOG practice bulletins [1,8]. With a high likelihood of abnormal fetal growth at our institute, we expected to have a better accuracy in predicting SGA neonates than the published reports, which had rates of IUGR of 4% to 13% [9–13]. The possible explanations for our poor performance are: clinical examination and Leopold maneuvers are poor techniques to detect SGA; the increase in the rate of maternal obesity [14] has rendered symphyseal–fundal

Table 3
Factors influencing identification of small-for-gestational-age neonates.^a

	Identified SGA (n = 23)	Unidentified SGA (n = 213)	OR (95% CI) ^b
Age, y	21.0 ± 4.2	24.1 ± 5.8	
≤19	12 (52)	49 (23)	5.06 (1.68–15.25)
≥20 ^c	11 (48)	164 (77)	1.0 (Referent)
Substance abuse ^d	4 (17)	12 (6)	6.59 (1.51–28.77)
Size < dates ^e	5 (22)	3 (1)	9.41 (1.54–57.53)
SEFW within 4 weeks of delivery	20 (87)	60 (28)	13.95 (3.78–51.52)

Abbreviations: SGA, small-for-gestational-age; OR, odds ratio; CI, confidence interval; SEFW, sonographic estimated fetal weight.

^a Data are presented as mean ± SD or number (percentage).

^b Adjusted for each of the other variables in the model.

^c In the identified SGA group there were no patients aged 35 years or more. Thus, we categorized maternal age into just 2 groups.

^d Either acknowledged by the patient or by positive urine test for amphetamine, barbiturates, benzodiazepine, cannabinoids, cocaine, methadone, opiates, phencyclidine and propoxyphene.

^e Disparity between symphyseal fundal height and gestational age.

measurement and clinical estimate of birth weight less useful [15]; multiple factors influence the accuracy of SEFW [16]; despite ACOG suggestions that SEFW does not have to be repeated for 2–4 weeks, its accuracy deteriorates over time [16]; and the threshold of what is below the 10th percentile for GA by Hadlock et al. [7] differs from that of Alexander et al. [6]. It is noteworthy that at a military teaching hospital [17], the detection of macrosomia was 11% (95% CI, 8%–14%). As in the current study, investigators at the military center reviewed the prenatal course when patients were admitted in labor and delivery and noted that 90% of newborns weighing 4000 g or more were undetected before birth [17].

The second finding is that even among the various subgroups, our detection of SGA ranged from 3% (those with no risk factors) to 26% (cohorts with SEFW within 4 weeks of delivery). It is alarming that 97% of abnormal growth in low-risk pregnancies is undetected; it is disappointing that despite ultrasound examination within a month of delivery 74% of SGA neonates were unidentified. The RCOG guideline on this topic [2] considers abdominal palpation and symphyseal fundal height measurements to have limited diagnostic accuracy to detect abnormal growth.

Our third finding focuses on the variables that improve the identification of SGA. Because the disparity between fundal height and GA increases the detection, as does SEFW within 4 weeks of birth, both should be used. The use of illicit drugs is associated with an incidence of SGA ranging from 30% to 50% [1]. Thus, it is understandable why detection of SGA was higher among patients that abused illicit drugs. Our finding of younger maternal age significantly enhancing detection of SGA needs verification and explanation. A PubMed search using several combinations of terms (“intrauterine growth restriction,” “small for gestational age,” “estimated fetal weight,” “accuracy,” “sensitivity,” “maternal age,” “teenage pregnancy”) yielded no article that explains improved detection with maternal age. An implication of the multiple logistic regression analysis is that to improve the detection of SGA, even patients with no risk factors for suboptimal growth and appropriate symphyseal fundal height should have an SEFW within 4 weeks of delivery.

The limitations of the present retrospective study should be acknowledged. Although there are inherent biases in non-randomized trials, we minimized these by including all patients that met the inclusion criteria. Our inability to detect 90% of SGA neonates suggests our bias was minimal. Our patients were managed by a variety of clinicians; therefore, the findings may not be applicable in all settings. However, our practice mirrors those of other teaching hospitals in urban settings, and our findings reflect daily clinical practice in the USA. There are multiple risk factors for SGA and although we selected several [18], we did not have an exhaustive list. A foreknowledge of all the risk factors for SGA may enhance our detection rates. Another limitation of our retrospective study is that we did not ascertain the type of clinician (midwives, residents, or ACOG fellows) that managed the patients prenatally and whether the SEFW was done by an RDMS or residents.

In conclusion, since 90% of SGA neonates are undetected at birth, a change [19,20] in obstetric practice is warranted to improve the detection of one of the most common and complex problems in

modern obstetrics. Consistent with the randomized clinical trial by McKenna et al. [18], we recommend routine ultrasound examination in the third trimester to decrease the rate of SGA. Lastly, based on the review of the literature on the accuracy of ultrasound estimation of fetal weight, whenever feasible the ultrasound examination should be performed by an RDMS [16].

5. Conflict of interest

There is no conflict of interest.

References

- [1] American College of Obstetricians and Gynecologists. Intrauterine growth restriction. ACOG practice bulletin. Number 12, January 2000. *Int J Gynecol Obstet* 2001;72(1):85–96.
- [2] Royal College of Obstetricians and Gynaecologists. The investigation and management of the small-for-gestational-age fetus. Guideline No. 31. London: RCOG Press; 2002.
- [3] Chauhan SP, Parker D, Shields D, Sanderson M, Cole JH, Scardo JA. Sonographic estimate of birth weight among high-risk patients: feasibility and factors influencing accuracy. *Am J Obstet Gynecol* 2006;195(2):601–6.
- [4] Chauhan SP, Cole J, Sanderson M, Magann EF, Scardo JA. Suspicion of intrauterine growth restriction: Use of abdominal circumference alone or estimated fetal weight below 10%. *J Matern Fetal Med* 2006;19(9):557–62.
- [5] American College of Obstetricians and Gynecologists. Management of Postterm Pregnancy. ACOG practice bulletin. Number 55, September 2004. *Obstet Gynecol* 2004;104(3):639–46.
- [6] Alexander GR, Himes JH, Kaufman RB, Mor J, Kogan M. A United States national reference for fetal growth. *Obstet Gynecol* 1996;87(2):163–8.
- [7] Hadlock FP, Harrist RB, Sharman RS, Deter RL, Park SK. Estimation of fetal weight with the use of head, body, and femur measurements—a prospective study. *Am J Obstet Gynecol* 1985;151(3):333–7.
- [8] American College of Obstetricians and Gynecologists. Ultrasonography in Pregnancy. ACOG practice bulletin. Number 58. *Obstet Gynecol* 2004;104(6):1449–587.
- [9] Bakketeig LS, Eik-Nes SH, Jacobsen G, Ulstein MK, Brodtkorb CJ, Balstad P, et al. Randomised controlled trial of ultrasonographic screening in pregnancy. *Lancet* 1984;2(8396):207–11.
- [10] Neilson JP, Munjanja SP, Whitefield CR. Screening for small for dates fetuses: a controlled trial. *Br Med J (Clin Res Ed)* 1984;289(6453):1179–82.
- [11] Secher NJ, Kern Hansen P, Lenstrup C, Sindberg Eriksen P, Morsing G. A randomized study of fetal abdominal diameter and fetal weight estimation for detection of light-for-gestation infants in low-risk pregnancies. *Br J Obstet Gynaecol* 1987;94(2):105–9.
- [12] Larsen T, Larsen JF, Petersen S, Greisen G. Detection of small-for-gestational-age fetuses by ultrasound screening in a high risk population: a randomized controlled trial. *Br J Obstet Gynaecol* 1992;99(6):469–74.
- [13] Duff GB. A randomized controlled trial in a hospital population of ultrasound measurement screening for the small for dates baby. *Aust N Z J Obstet Gynaecol* 1993;33(4):374–8.
- [14] Ehrenberg HM, Dierker L, Milluzzi C, Mercer BM. Prevalence of maternal obesity in an urban center. *Am J Obstet Gynecol* 2002;187(5):1189–93.
- [15] Fox NS, Bhavsar V, Saltzman DH, Rebarber A, Chasen ST. Influence of maternal body mass index on the clinical estimation of fetal weight in term pregnancies. *Obstet Gynecol* 2009;113(3):641–5.
- [16] Chauhan SP, Hendrix NW, Magann EF, Morrison JC, Scardo JA, Berghella V. A review of sonographic estimate of fetal weight: vagaries of accuracy. *J Matern Fetal Neonatal Med* 2005;18(4):211–20.
- [17] Heywood RE, Magann EF, Rich DL, Chauhan SP. The detection of macrosomia at a teaching hospital. *Am J Perinatol* 2009;26(2):165–8.
- [18] Chauhan SP, Magann EF. Screening for fetal growth restriction. *Clin Obstet Gynecol* 2006;49(2):284–94.
- [19] McKenna D, Tharmaratnam S, Mahsud S, Bailie C, Harper A, Dorman J. A randomized trial using ultrasound to identify the high-risk fetus in a low-risk population. *Obstet Gynecol* 2003;101(4):626–32.
- [20] Bukowski R, Uchida T, Smith GC, Malone FD, Ball RH, Nyberg DA, et al. Individualized norms of optimal fetal growth: fetal growth potential. *Obstet Gynecol* 2008;111(5):1065–76.