

Association of Fetal Abdominal–Head Circumference Size Difference With Shoulder Dystocia: A Multicenter Study

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Abstract

Objective This study aims to determine if shoulder dystocia is associated with a difference in the fetal abdominal (AC) to head circumference (HC) of 50 mm or more noted on antenatal ultrasound.

Study Design A multicenter matched case–control study was performed comparing women who had shoulder dystocia to controls who did not. Women with vaginal births of live born nonanomalous singletons ≥ 36 weeks of gestation with an antenatal ultrasound within 4 weeks of delivery were included. Controls were matched for gestational age, route of delivery, and diabetes status.

Results We identified 181 matched pairs. Only 5% of the fetuses had an AC to HC of ≥ 50 mm. The proportion of AC to HC difference of ≥ 50 mm was significantly higher in shoulder dystocia cases (8%) than controls (1%, $p = 0.002$). With multivariate regression, the three significant factors associated with shoulder dystocia were AC to HC ≥ 50 mm (odds ratio [OR], 7.3; confidence interval [CI], 1.6–33.3; $p = 0.010$), femur length (OR, 1.1; CI, 1.0–1.2; $p = 0.002$), and induced labor (OR, 1.8; CI, 1.1–3.1; $p = 0.027$).

Conclusion A prenatal ultrasound finding of a difference in AC to HC of ≥ 50 mm while uncommon is associated with shoulder dystocia.

Keywords

- ▶ ultrasound
- ▶ abdominal circumference
- ▶ head circumference
- ▶ shoulder dystocia

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Shoulder dystocia, an obstetric emergency, is defined as the need for ancillary maneuvers when gentle downward traction of the head is insufficient to affect the delivery of the fetal shoulders. It occurs in approximately 0.6 to 1.4% of vaginal deliveries.¹ The potential morbidities include neonatal brachial plexus palsy (NBPP), clavicular or humeral fractures, hypoxic brain injury, and neonatal death. For the parturient, there is an associated risk of extensive lacerations and postpartum hemorrhage.¹

Known risk factors for shoulder dystocia include maternal obesity, diabetes, fetal macrosomia, operative vaginal births, and previous shoulder dystocia.²⁻¹⁴ Fetal macrosomia has one of the highest known associations with shoulder dystocia. Acker et al, for example, reported that shoulder dystocia occurred in 1% of infants weighing < 4,000 g versus 10% of infants between 4,000 and 4,499 g and 23% in infants over 4,500 g.¹⁵ But as the majority shoulder dystocia cases occur in nonmacrosomic newborns and over 50% of shoulder dystocia cases have no identifiable risk factors before delivery,^{1,13,16} additional methods of predicting shoulder dystocia would be useful.

Sonographic measurements of biometric parameters to identify cases of shoulder dystocia have been disappointing¹⁷⁻²³ because of a small sample sizes and wide variation in ability to identify those that will have an impacted shoulder. However, a large difference in the abdominal circumference compared with the head circumference being related to shoulder dystocia has biologic plausibility. We initially performed a small single center study evaluating the finding on antenatal ultrasound in 46 subjects with shoulder dystocia. We found that the larger the fetal abdominal (AC) to head circumference (HC) difference, the higher the likelihood of shoulder dystocia. All the women with a fetal AC to HC ≥ 50 mm on antenatal ultrasound then experienced a shoulder dystocia. The data were presented at the Central Association of Obstetricians and Gynecologists (CAOG) Annual Meeting in October 2011. We sought to confirm this association in a larger study.

The primary objective of this retrospective multicenter study was to determine if a difference in AC and HC is linked with shoulder dystocia. The secondary objective was to ascertain if the association was also applicable in shoulder dystocia cases complicated by NBPP.

Materials and Methods

A multicenter retrospective case-control study was undertaken at six participating centers (NorthShore University HealthSystem, University of Cincinnati Medical Center, Aurora Sinai Medical Center, Rush University Medical Center, Good Samaritan Hospital in Cincinnati, and University of Arkansas Medical School) as part of the CAOG Fellows and Residents (FAR) Research Network. Institutional review board approval was obtained from each of the institutions.

At each center, delivery and nursery logs were used to identify cases, which were patients who delivered vaginally a nonanomalous singleton live born at > 36 weeks of gestation and whose delivery was complicated by shoulder dystocia with or without NBPP. All the deliveries occurred between January 1, 2009, and December 31, 2011. Controls were

matched by gestational age, route of delivery (vaginal), and diabetes status. The delivery had to have occurred within 2 weeks of the case. Diabetes status was matched for to minimize its confounding effect and to evaluate AC to HC ≥ 50 mm as an independent association with shoulder dystocia. Cases and controls were required to have had an antenatal ultrasound with biometric parameters within 4 weeks of delivery.

Shoulder dystocia and/or NBPP were defined as the presence of the complication documented in the medical record by the delivering birth attendant. Information on maternal demographics, sonographic examination, and peripartum outcomes was collected. The primary factor of interest in this study was AC to HC difference of 50 mm or more.

McNemar test for categorical variables and paired *t*-tests for continuous variables were used to identify potential predictors for shoulder dystocia. For the matched case-control samples, conditional logistic regression was used to identify significant risk factors for SD. All predictors with $p < 0.25$ in the univariate analysis were included in the next step variable selection and backward elimination was used to remove nonsignificant covariates sequentially from the multivariable model. Analyses were performed on SAS 9.3 (Cary, NC) platform. The $p < 0.05$ indicates a statistically significant difference.

Results

During the 36 months of the study period, there were a total of 76,986 deliveries at the six participating institutions with 66% (50,921) being vaginal births. There were 368 cases of SD with a rate of 0.7%. Only 49% (181) of SD had an ultrasound within 4 weeks of delivery and they were compared with their specific-matched controls (→Fig. 1).

Among 181 matched cases and the controls, there were no significant differences in maternal age, ethnicity, gestational age

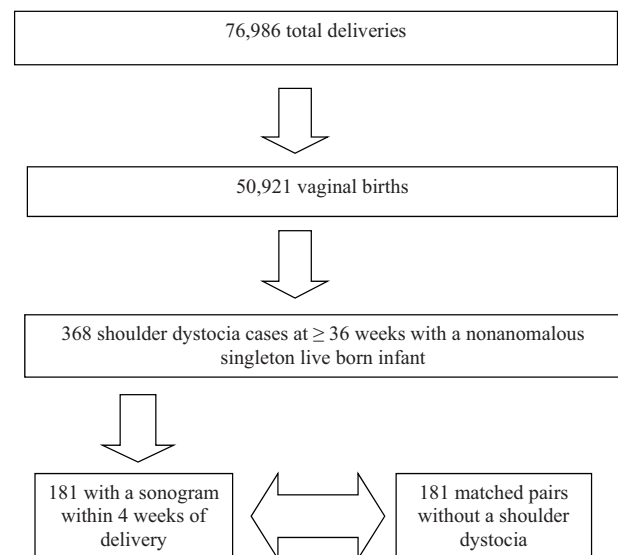


Fig. 1 Flowchart of the selected cases and controls.

at delivery, or the actual birth weight. NBPP occurred in 8% (14) of cases of shoulder dystocia and none of controls (► **Table 1**).

Sonographic examination with biometric parameters for the 181 matched pairs was notable for the AC, as well as AC to HC, being significantly greater between cases than controls. The likelihood of AC to HC \geq 50 mm was significantly more common among SD cases (8%) than the controls (1%) (unadjusted odds ratio [OR] = 7.5; confidence interval [CI], 1.7–33.3; $p = 0.002$). An estimated fetal weight of over 4,000 g occurred more frequently among shoulder dystocia cases than controls (8 vs. 2%, $p = 0.008$) (► **Table 2**). In the multivariable conditional logistic regression model, the three significant associations with shoulder dystocia were AC to HC \geq 50 mm (OR, 7.3; CI, 1.6–33.3; $p = 0.010$), femur length (OR, 1.1; CI, 1.0–1.2; $p = 0.002$), and induced labor (OR, 1.8; CI, 1.1–3.1; $p = 0.027$).

AC to HC \geq 50 mm occurred in 5% of sonograms done within 4 weeks of delivery. When the primary risk factor of AC to HC \geq 50 mm was compared with fetuses without the finding on ultrasound, it was more common in larger fetuses with an estimated fetal weight of greater than 4,000 g or 4,500 g ($p < 0.001$). However, in 35% (6 of 17) of fetuses with an AC to HC \geq 50 mm, the estimated fetal weight was $<$ 4,000 g (► **Table 3**). Also, when the finding was present on sonogram, 88% (15 vs. 2, $p < 0.001$) later experienced a shoulder dystocia with the birth. When AC to HC \geq 50 mm

occurred, there was an association with shoulder dystocia complicated by NBPP (18 vs. 3%, $p = 0.026$).

Comment

The primary finding of the study is that shoulder dystocia with or without NBPP is significantly more common among those fetuses with an AC to HC difference of 50 mm or more on antenatal ultrasound. There is plausibility for our findings because the actual measurements of newborns with shoulder dystocia differ from those without. Investigators from Kuwait as well as the United States have noted that the head circumference of newborns that had shoulder dystocia were disproportionately smaller than controls that did not.^{24,25} Measurement of abdominal circumference alone is a predictor of macrosomia,^{23,26} and an acknowledged risk factor for shoulder dystocia.^{1,2,4–6} Thus, it is plausible that the difference between AC and HC would identify deliveries complicated by shoulder dystocia versus those that are not.

Our findings are consistent with other investigators who used sonographic measurements of fetal parts to identify deliveries complicated by shoulder dystocia. Using the difference between abdominal and biparietal diameter of 2.6 cm or more, three groups of investigators^{18,20,21} reported that shoulder dystocia occurred in 25 to 100% of the cases. With

Table 1 Peripartum characteristics for 181 shoulder dystocia cases versus matched controls

	SD (N = 181)	Controls (N = 181)	p Value
Age (y)	26.9 \pm 6.5	27.1 \pm 6.7	0.862
Ethnicity			
Caucasian	36.7% (66)	33.9% (61)	0.604
African American	43.3% (78)	40% (40)	
Others	20% (36)	26.1% (47)	
Gravidity	2.18 \pm 1.64	2.83 \pm 1.84	0.323
Prior SD or NBPP	3.2% (5)	0	–
Diabetes ^a	30% (54)	30% (54)	Matched
GA at ultrasound (wks)	37.1 \pm 1.6	37 \pm 1.9	0.999
GA at delivery (wks)	39.1 \pm 1.1	39.1 \pm 1.3	Matched
Induced labor ^b	47% (85)	34.5% (60)	0.017
SVD ^c	88.8% (159)	85.1% (154)	0.273
Birth weight (g)	3720 \pm 440	3260 \pm 493	$<$ 0.001
\geq 4,000	27.8% (50)	7.2% (13)	$<$ 0.001
5 Minute Apgar \leq 6	6.7% (12)	0	–
Female neonatal gender	51.7% (93)	48.6% (87)	0.596
Fracture of clavicle or humerus	2.8% (5)	0	–
Blood transfusion	0.6% (1)	0	–
NBPP	7.7% (14)	0	–

Abbreviations: NBPP, neonatal brachial plexus palsy; SD, shoulder dystocia; SVD, spontaneous vaginal delivery.

Note: Data are presented as % (n) or mean \pm standard deviation.

^aPregestational or gestational diabetes.

^bThe remainder of the labor was spontaneous or augmented.

^cThe remainder of the deliveries was operative (vacuum or forceps) vaginal births.

Table 2 Sonographic parameters for 181 shoulder dystocia cases versus matched controls

	SD (N = 181)	Controls (N = 181)	p Value	OR (95% CI)
Biparietal diameter	88.9 ± 4.1	89.4 ± 4.3	0.333	
HC	325.4 ± 13.7	326.1 ± 13.8	0.627	
AC	343.1 ± 24.5	328.9 ± 22.6	< 0.001	
AC–HC	17.6 ± 20.3	2.6 ± 18.3	< 0.001	7.52 (1.72–33.33)
≥ 50 mm	8% (15)	1% (2)		
Femur length	72.3 ± 4.1	70.4 ± 5.9	< 0.001	
Estimated fetal weight (g)	3,278 ± 473	3,012 ± 476	< 0.001	4.67 (1.34–16.13)
≥ 4,000	7.7% (14)	1.7% (3)	< 0.001	

Abbreviations: AC, abdominal circumference; CI, confidence intervals; HC, head circumference; OR, odds ratio; SD, shoulder dystocia.
Note: Data presented as mean ± standard deviation or % (n). Biometric parameters are in mm.

Table 3 Abdominal and head circumference difference and shoulder dystocia

	AC–HC ≥ 50 mm (N = 17)	AC–HC < 50 mm (N = 345)	p Value
Age (y)	26.88 ± 7.66	27.01 ± 6.55	0.827
Race			
Caucasian	50% (8)	34.6% (119)	0.385
African American	37.5% (6)	41.9% (144)	
Other	12.5% (2)	23.6% (81)	
Nulliparous	29.4% (5)	33.6% (116)	0.513
Diabetes			
Yes	35.3% (6)	29.6% (102)	0.614
No	64.7% (11)	70.4% (243)	
History of SD			
Yes	0% (0)	1.6% (5)	–
No	100% (16)	98.4% (315)	
History of NBPP			
Yes	0% (0)	0% (0)	–
No	100% (16)	100% (320)	
Gestational age at U/S	39.59 ± 1.2	39.11 ± 1.2	0.119
Estimated fetal weight > 4,000 g			
Yes	35.3% (6)	3.2% (11)	< 0.001
No	64.7% (11)	96.8% (334)	
Estimated fetal weight > 45,00 g			
Yes	11.8% (2)	0% (0)	–
No	88.2% (15)	100% (345)	
Gestational age at delivery			
≥40 wks	47.1 (8)	29% (100)	0.112
< 40 wks	52.9 (9)	71% (245)	
Shoulder dystocia			
Yes	88.2% (15)	48.1% (166)	< 0.001
No	11.8% (2)	51.9% (179)	
NBPP	17.6% (3)	2.9% (10)	0.026

Abbreviations: AC, abdominal circumference; HC, head circumference (both in mm); NBPP, neonatal brachial plexus palsy; SD, shoulder dystocia.
Note: Data are presented as mean ± standard deviation or % (n).

varying success, others have measured chest circumference, postulated macrosomia score or used sonographic estimated fetal weight to identify women who will have shoulder dystocia.¹⁷⁻²³ But unlike previous publications, our threshold of AC to HC ≥ 50 mm was able to identify newborns that will have shoulder dystocia and NBPP (**Table 3**).

Despite the increased likelihood of shoulder dystocia in cases where the difference in AC to HC is 50 mm or more, at present, we do not recommend clinicians alter obstetric management by performing an induction or cesarean delivery. A prospective cohort study is needed to confirm the link between AC to HC ≥ 50 mm and shoulder dystocia and to determine the positive predictive value of the finding. The interventions of induction or cesarean delivery are not without morbidity.²⁷⁻³⁰ It is worth noting that induction of labor for suspected macrosomia may paradoxically increase the risk of shoulder dystocia.²³ Gonen et al³¹ randomized 273 women with estimated fetal weight of 4,000 or 4,500 g to induction or expectant management. They reported that induction did not improve neonatal outcomes. Thus, when intervention for macrosomia, an acknowledged risk factor for shoulder dystocia and NBPP,^{2,5,10,31} has not diminished morbidity, it is possible that altering obstetric care for differences in AC and HC may not improve neonatal outcomes.

While awaiting further studies, clinicians may choose to use the results of this study by taking into consideration additional risk factors for shoulder dystocia in addition to AC to HC ≥ 50 mm. Clinicians may opt to avoid induction and operative vaginal delivery, to have extra personnel be available at the birth, and to notify the nursery of the possible increased risk for shoulder dystocia.

The limitations of this retrospective multicenter study should be acknowledged. The definition of shoulder dystocia and its management was not standardized at all centers. Although there is variation in the definition and management of shoulder dystocia,³²⁻³⁴ the fact that our rate of impacted shoulder and NBPP were similar to published reports^{1,33,35,36} indicate that at the participating centers there was some conformity in the diagnosis and management. We included results of sonographic examinations if done within 4 weeks of delivery and during that time interval fetal growth could have altered the measurement of biometric parameters. Our reason for including sonographic examination within 4 weeks is the American Congress of Obstetricians and Gynecologists recommendation of repeating ultrasounds every 2 to 4 weeks when abnormalities of fetal growth are suspected.³⁷ A shortcoming of a diagnostic test to identify shoulder dystocia and NBPP is that over 40% of brachial plexus palsies occur without concomitant impaction of either shoulder.^{1,32} Thus, NBPP without shoulder dystocia would neither be identified nor prevented with measurements of AC and HC. We did not have sufficient follow-up of newborns with brachial palsy to determine if the difference in AC to HC can identify permanent NBPP, which is a major morbidity of shoulder dystocia and the main reason for litigation.^{38,39}

The strengths of this observational study are noteworthy. Unlike the seven previous publications on this topic,¹⁷⁻²³ our study is a multicenter study and has the largest number

of shoulder dystocia events. Thus, the findings are more generalizable. In contrast to the previous seven reports,¹⁷⁻²³ we determined if sonographic measurements can identify newborns with dystocia and NBPP. Several publications⁴⁰⁻⁴³ have reported that antepartum risk factors fail to identify newborns that will or will not have concomitant NBPP with shoulder dystocia. If our findings are confirmed, then the difference in the AC to HC may be a useful risk factor. Grimes and Schulz⁴⁴ advocated that with observational studies, the OR should exceed four for associations to be considered credible. The OR for AC to HC ≥ 50 mm to identify shoulder dystocia with NBPP was 6.09 (95% CI, 1.2-24.4).

In summary, a prenatal ultrasound finding of a difference in AC to HC of ≥ 50 mm while uncommon is associated with shoulder dystocia with or without NBPP.

Note

The study was an oral presentation at the Central Association of Obstetricians and Gynecologists 2013 Annual Meeting at Napa, California from October 16 to 19, 2013. Reprints will not be available.

Conflicts of Interest

None of the authors have a conflict of interest.

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