Original Research

A Comparison of Obstetric Maneuvers for the Acute Management of Shoulder Dystocia

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OBJECTIVE: To assess the efficacy of obstetric maneuvers for resolving shoulder dystocia and the effect that these maneuvers have on neonatal injury when shoulder dystocia occurs.

METHODS: Using an electronic database encompassing 206,969 deliveries, we identified all women with a vertex fetus beyond 34 0/7 weeks of gestation who incurred a shoulder dystocia during the process of delivery. Women whose fetuses had a congenital anomaly and women with an antepartum stillbirth were excluded. Medical records of all cases were reviewed by trained abstractors. Cases involving neonatal injury (defined as brachial plexus injury, clavicular or humerus fracture, or hypoxic–ischemic encephalopathy or intrapartum neonatal death attributed to the shoulder dystocia) were compared with those without injury.

RESULTS: Among 132,098 women who delivered a term cephalic liveborn fetus vaginally, 2,018 incurred a shoulder dystocia (1.5%), and 101 (5.2%) of these incurred a neonatal injury. Delivery of the posterior shoulder was associated with the highest rate of delivery when compared with other maneuvers (84.4% compared with 24.3–72.0% for other maneuvers; $P<.005$ to $P<.001$) and similar rates of neonatal injury (8.4% compared with 6.1–14.0%; $P=.23$ to $P=.7$). The total number of maneuvers performed significantly correlated with the rate of neonatal injury ($P<.001$).

CONCLUSION: Delivery of the posterior shoulder should be considered following the McRoberts maneuver and suprapubic pressure in the management of shoulder dystocia. The need for additional maneuvers was associated with higher rates of neonatal injury.

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Shoulder dystocia remains an important cause of neonatal and maternal injury with a reported incidence between 0.6% and 1.4% of vaginal births.[1] Maternal injuries include a higher rate of postpartum hemorrhage and fourth-degree lacerations.[2] Major neonatal injuries attributed to shoulder dystocia include brachial plexus palsies, fractures of the clavicle and humerus, hypoxic–ischemic encephalopathy and, in rare cases, neonatal death.[1] Fortunately, only a minority of shoulder dystocias result in neonatal injury with reported rates of injury ranging from 4% to 40% of cases.[1] Nonetheless, shoulder dystocia remains a challenge to birth attendants because shoulder dystocia is among the

four largest causes of monetary awards for obstetric tort cases in the United States.[3]

Efforts to address shoulder dystocia have focused mainly on training in the acute management of shoulder dystocia and developing risk strategies to identify women at risk for shoulder dystocia so that a prophylactic cesarean delivery could be considered. Although numerous attempts to identify women at risk for shoulder dystocia have been made, the sensitivity and specificity of these efforts have been poor.[4–6] Thus, the large number of prophylactic cesarean deliveries that would be needed to avoid a single[7] case of shoulder dystocia resulting in a permanent neonatal injury poses a prohibitive financial cost and would result in substantial maternal morbidity.[6]

Physician and nurse training in the acute management of shoulder dystocia has been widely accepted despite there being little objective evidence that this training affects neonatal and maternal injuries.[7] This may be in part attributable to the fact that the maneuvers used and the order in which they are performed are largely based on provider preference, expert opinion, and theoretical models[8,9] Little objective study of the different maneuvers and their effect on neonatal injury has been performed. The objective of this study was to estimate the efficacy obstetric maneuvers for resolving shoulder dystocia and the effect that these maneuvers have on neonatal injury when shoulder dystocia occurs by examining a large cohort of women and their neonates in whom shoulder dystocia was encountered.

MATERIALS AND METHODS

The Consortium on Safe Labor was formed in response to a request issued by the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development. Members of this group were selected based on numerous criteria, including a history of archiving data from hospital-based electronic medical records and geographic representation from the nine American College of Obstetricians and Gynecologists (College) districts. The 12 centers in the consortium were able to retrospectively aggregate maternal and neonatal outcomes from 228,668 women who delivered 233,844 newborns during the time period of 2002–2008. Institutional review board approval was obtained from all 12 centers, the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development, and the EMMES Corporation before the initiation of the project. Among women who had sequential births during the time course of the study, information was only collected from their first delivery.

Women who incurred a shoulder dystocia during the process of vaginal delivery were identified among this cohort. Cases were initially identified by examining direct physician, nursing entry, or both in the medical record or International Classification of Diseases, 9th Revision codes, depending on the individual center's use of electronic medical records. Identified cases were included if they required either an additional obstetric maneuver or had a documented delivery of head to body time of 60 seconds or greater. Women were included if they delivered a singleton, vertex fetus beyond 34 0/7 weeks of gestation. Cases of major fetal anomalies and fetal death before the onset of the second stage of labor were excluded. Women who had a cesarean delivery after cephalic replacement (Zavanelli maneuver) were included. After initial identification, all cases of shoulder dystocia were confirmed and the entire medical records of both the mother and her newborn were reviewed by trained obstetric abstractors using a common abstraction form.

Our two primary outcomes of interest were successful use of a maneuver leading to delivery of the neonate and development of a neonatal injury attributable to the management of the shoulder dystocia. For the purposes of this analysis, neonatal injury was strictly defined as a brachial plexus injury (Erb's palsy or Klumpke's palsy), nonintentional fracture of the clavicle or humerus diagnosed by radiography, hypoxic–ischemic encephalopathy or neonatal death, or all of these attributable to the management of the shoulder dystocia. Brachial plexus injuries were deemed present if they were assessed by an attending physician and attributed in the final diagnosis. Rule-out diagnoses were not included. Cases of hypoxic–ischemic encephalopathy were initially identified through chart abstraction if they had an Apgar score less than 4 at 5 minutes. Cases of hypoxic–ischemic encephalopathy also needed to have an umbilical cord pH less than 7.0, base deficit more than 12 mmol, and neurologic sequelae (seizures, coma, hypotonicity within 72 hours of birth) or multiple organ involvement (kidneys, lung, heart) Bruising, cephalohematomas, or other soft tissue injuries that might have resulted from the management of the shoulder dystocia were not classified as neonatal injuries. Because of the retrospective nature of our study, we attributed success of a maneuver if it was clearly described as the last or only maneuver that relieved the shoulder dystocia. If the nature of the documentation was such that the multiple maneuvers were used and the final maneuver culminating in delivery could not be determined, then we excluded these

deliveries in our analysis of success. Our primary exposure of interest was the maneuvers that were used to relieve the shoulder dystocia. For the purpose of classification, these were divided into the following categories: McRoberts maneuver, suprapubic pressure, Rubin maneuver, delivery of the posterior shoulder, Woods corkscrew maneuver, Gaskin maneuver (delivery in the maternal knee–chest position), Zavanelli maneuver, and fundal pressure. We did not differentiate use of "prophylactic" maneuvers such as McRoberts from therapeutic maneuvers. Primary management was attributed to the attending physician, midwife, or resident who delivered the neonate and thus initiated the maneuvers. Other variables in the acute obstetric management of these patients were also garnered from the chart.

Categorical variables were evaluated using a chi-square test or Fisher's exact test when appropriate. Continuous variables were analyzed using a Student's *t* test with unequal variance or Wilcoxon rank-sum test if indicated. The Cochran-Armitage test for trend was used where appropriate.

It was recognized that a potential bias of attributing a fetal injury to a specific maneuver might occur as a result of the nonrandom way in which they were used in clinical practice. In other studies, secondary maneuvers (ie, delivery of the posterior shoulder, Woods corkscrew, and Rubin's maneuver) were more likely to be used in more difficult cases after primary maneuvers (McRoberts maneuver and suprapubic pressure) had been unsuccessful.[1] Moreover, neonates could be exposed to multiple maneuvers confounding attribution of an injury to a specific maneuver. We thus took two approaches to examining this issue. One approach was to compare the rate of fetal injury by the maneuver that successfully relieved the shoulder dystocia. Multivariate logistic regression was used to examine the association between maneuver type, potential exposure to multiple maneuvers, and successful delivery and neonatal injury adjusting for site, maternal age, maternal race, parity, and birth weight. Because a successful vaginal delivery occurred in all cases save one excluded case, we chose to perform a repeated measures analysis using GENMOD controlling for these same variables. Statistical analysis was performed by the EMMES Corporation, which served as the data coordinating center for this project using SAS 9.1 and STATA 10.0.

RESULTS

Among the total cohort of 228,668 women, 206,969 had either a single birth or first birth included in the analyzed cohort. Of this group, 132,098 delivered a singleton vertex liveborn fetus vaginally and a single neonate underwent cephalic replacement with cesarean delivery (Zavanelli maneuver) beyond 34 0/7 weeks of gestation; thus, the total population included 132,098 deliveries. A total of 2,018 cases of shoulder dystocia were reported (average, 1.5%; institutional range, 0.2–3.0%). Information regarding neonatal injury was unavailable in 62 of these 2,018 neonates. A total of 101 neonates incurred a neonatal injury (5.2%; 95% confidence interval [CI] 4.1–6.2%), 1,855 did not have an injury, and in 62, no information was available (Fig. 1). The types and natures of the neonatal injuries are presented in Table 1. The most common neonatal injury was an Erb's palsy (59.4%, 95% CI 49.6–69.1%) followed by a clavicular fracture (38.6%, 95% CI 29.3–48.7%). A total of eight fetuses incurred multiple injuries. No cases of neonatal death attributable to shoulder dystocia occurred, although 6 of 101 (5.9%, 95% CI 1.2–10.7%) had hypoxic–ischemic encephalopathy.

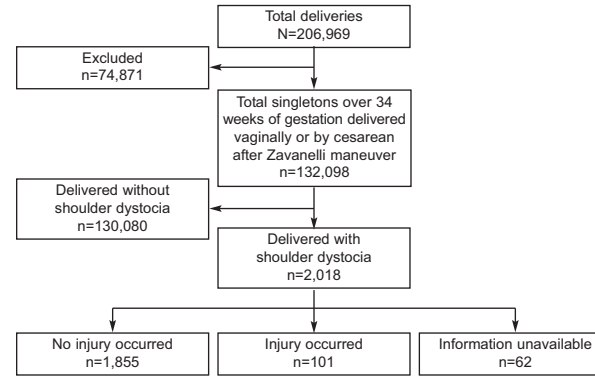

Fig. 1. Flow of participants through the study.
Hoffman. Dystocia Management and Neonatal Injury. Obstet Gynecol 2011.

Maternal and neonatal demographics are presented in Table 2. Women whose fetuses incurred a neonatal injury tended to be younger, African American and non-Hispanic, and less parous. As would be anticipated, the mean weight of the neonates with

Table 1. Neonatal Injuries (n=101)

Type of Injury	n	Percentage*
Erb's palsy	60	59.4
Klumpke's palsy	4	4.0
Clavicular fracture	39	38.6
Humerus fracture	2	2.0
Hypoxic–ischemic encephalopathy	6	5.9
Neonatal death	0	0.0

* Ten fetuses incurred multiple injuries.

Table 2. Maternal and Neonatal Variables

Variable	With Neonatal Injury	Without Neonatal Injury	*P*
Maternal age (y)	25.9	27.8	.002
Maternal race			<.001
White, non-Hispanic	44.1	54.5	
African American, non-Hispanic	38.7	22.4	
Hispanic	17.2	19.8	
Asian or Pacific Islander	0.0	3.2	
Gravidity	2.3	2.8	.01
Parity	0.8	1.2	.002
Body mass index (kg/m^2) at admission	35.6	32.3	<.001
Pregestational diabetes	9.70	4.5	.02
Gestational diabetes	6.80	6	.74
Regional anesthesia	95.8	87.1	.1
Mean newborn birth weight (g)	3,944	3,852	.04
Second stage of labor (min)	0.569	57.9	.9

Data are mean or % unless otherwise specified.

injuries was greater; however, the mean difference in the two groups was only 92 g.

Obstetric management is detailed in Table 3. No significant differences were seen in injury rates when the shoulder dystocia was primarily managed by resident physicians compared with midwives or attending physicians (rate of injury: attending physicians 5.2%, midwives 2.9%, resident physicians 7.4%; *P*=.099). Shoulder dystocia cases occurring after an operative vacuum vaginal delivery were more likely to incur a neonatal injury compared with those when the head delivered spontaneously (22.8% compared with 14.5%, respectively; *P*=.031). A similar trend was not seen with forceps, although the small numbers of forceps deliveries precludes meaningful comment on this issue. Although a statistically significant difference in the type of operative vaginal delivery (mid, low, outlet, not recorded) was noted, this mostly reflects the higher rate of "not recorded" seen in patients without neonatal injury. In cases involving a neonatal injury, it would be anticipated that documentation would be more complete, which may explain this finding. When a vacuum-assisted vaginal delivery was performed, neither the number of "popoffs" nor duration of vacuum use reported differed between women whose neonates incurred an injury and those who did not.

Table 3. Obstetric Interventions

Category	With Fetal Injury	Without Fetal Injury	*P**
Labor and delivery performed by			.099
Attending	72 (71.3)	1,318 (71.2)	
Resident	21 (20.8)	262 (14.2)	
Nurse midwife	8 (7.9)	269 (14.5)	
Medical student	0 (0.0)	2 (0.1)	
Vacuum	22 (22.8)	264 (14.4)	.025
Forceps	3 (3.0)	54 (2.9)	.928
Type of forceps or vacuum or forceps			<.006
Mid	1 (4.0)	4 (1.3)	
Low	7 (28.0)	127 (39.9)	
Outlet	13 (52.0)	68 (21.4)	
Not recorded	4 (16.0)	119 (37.4)	
Duration of operative delivery (min)	3.08	3.46	<.691
Recorded no. of "popoffs"	0.88	0.98	<.728
Episiotomy	42 (42.0)	472 (26.0)	<.001

Data are n (%) unless otherwise specified.
* Note the unit of analysis is by maneuver attempted because women who underwent multiple maneuvers can appear in multiple columns.

In terms of obstetric maneuvers to relieve shoulder dystocia, a total of 3,751 maneuvers was performed in 2,016 of the 2,018 cases (average number of maneuvers per case, 1.86). The maneuvers used to relieve the shoulder dystocia are presented in Table 4. As a result of their low rate of use, the Gaskin maneuver (performed 22 times with one neonatal injury), Zavanelli maneuver (performed one time), and fundal pressure (used in three cases) are not presented in Table 4. In 65.7% of cases, the order in which the maneuver was used could be determined. Reporting ranges were noted to be similar among the measures ranging from 58.1% to 70.2%.

When examining the number of deliveries that included the different maneuver types, irrespective of order, 84.4% of deliveries had successful resolution of the shoulder dystocia when delivery of the posterior shoulder was attempted. This was higher than the other maneuvers, which ranged from 24.3% (McRoberts) to 72.0% (Woods corkscrew) (Table 4). Recognizing that McRoberts and suprapubic pressure are the primary maneuvers recommended by the College, we chose to examine women who had already undergone these maneuvers and examine only the third maneuver after McRoberts and suprapubic pressure had failed. Given the potential for biases resulting from differences in maternal age, maternal race, parity, neonatal birth weight, and site of care, we chose to control for these potential confounders using logistic regression. When compared with delivery of the posterior shoulder, we found that Rubin's maneuver

Table 4. Outcomes of Obstetric Maneuvers

Maneuver	Total No.	No. (%) With Order Documented	First	Second	Third	Fourth	Fifth or More	*P*	Overall	*P*
Rate of success with a particular maneuver										
McRoberts	1,679	1,123 (66.9)	213/918 (23.2)	49/186 (26.3)	11/19 (57.9)	—	—	<.007	273/1,123 (24.3)	<.001
Suprapubic pressure	1,386	875 (63.1)	58/116 (50.0)	406/635 (63.9)	74/116 (63.8)	6/8 (75.0)	—	<.001	544/875 (62.2)	<.001
Delivery of posterior shoulder	262	179 (68.3)	7/8 (87.5)	28/32 (87.5)	55/73 (75.3)	40/45 (88.9)	21/21 (100.0)	<.465	151/179 (84.4)	Referent
Rubin maneuver	86	50 (58.1)	4/6 (66.7)	4/5 (80.0)	16/27 (59.3)	9/12 (75.0)	—	<.776	33/50 (66.0)	<.005
Woods corkscrew	315	221 (70.2)	14/19 (73.7)	27/34 (79.4)	78/114 (68.4)	35/49 (71.4)	5/5 (100.0)	<.704	159/221 (72.0)	<.005
Rate of injury with attempted maneuver										
McRoberts	1,679	1,123 (66.9)	51/918 (5.6)	15/186 (8.1)	2/19 (10.5)	—	—	.15	68/1,123 (6.1)	.25
Suprapubic pressure	1,386	875 (63.1)	6/116 (5.17)	39/635 (6.1)	10/116 (8.6)	1/8 (12.5)	—	.26	56/875 (6.4)	.34
Delivery of posterior shoulder	262	179 (68.3)	0/8 (0.0)	0/32 (0.0)	2/73 (2.7)	8/45 (17.78)	5/21 (23.8)	<.001	15/179 (8.4)	Referent
Rubin maneuver	86	50 (58.1)	0/6 (0.0)	0/5 (0.0)	5/27 (18.5)	2/12 (16.7)	—	.27	7/50 (14.0)	.23
Woods corkscrew	315	221 (70.2)	0/19 (0.0)	0/34 (0.0)	13/114 (11.4)	7/49 (14.3)	1/5 (20.0)	.01	21/221 (9.5)	.7

Data are n/N (%) unless otherwise specified.
Cochran-Armitage for trend delivery of posterior shoulder used as a referent.

was clearly less successful (odds ratio 0.33, 95% CI 0.11–0.98, $P<.05$). Using this methodology, Woods corkscrew was not less successful (odds ratio 0.58, 95% CI 0.26–1.3, $P=.20$), although this may reflect the small numbers of patients who underwent this maneuver as the third maneuver. None of the maneuvers demonstrated a loss of efficacy when examined as to which order they were used and in fact both McRoberts and suprapubic pressure became more effective the later they were used. This suggests strongly that all maneuvers have potential benefit regardless of whether one has attempted prior maneuvers.

In regard to neonatal injury, as expected, managing shoulder dystocia that included the primary maneuvers of McRoberts and suprapubic pressure resulted in the lowest percent of neonates with an injury (6.1–14.0%). Both delivery of the posterior shoulder and the Woods corkscrew maneuver demonstrated a significant trend toward fetal injury if they were successful as the fourth or fifth maneuver. This trend could not be confirmed in neonates who were delivered by either the McRoberts maneuver or suprapubic pressure, although these maneuvers were used sparingly beyond the second maneuver. Likewise, Rubin's maneuver was not affected by its timing, but it was only performed in a limited number of cases (n=50). As anticipated, when examined from the perspective of only how many maneuvers were performed rather than the specific maneuvers used, a strong association with the number of maneuvers and the risk of neonatal injury was demonstrated (Fig. 2). This was particularly true on use of a fourth maneuver.

We likewise examined the risk of being exposed to specific maneuvers and their association with neonatal injury through multiple logistic regression after adjusting for maternal age, maternal race, parity, birth weight, and site (Table 5). Because of this method, we were able to include use of all maneuvers and not just those that had clear documentation leading to successful delivery. Use of the Rubin and Woods corkscrew maneuvers were associated with a significantly higher risk of neonatal injury; although interestingly,

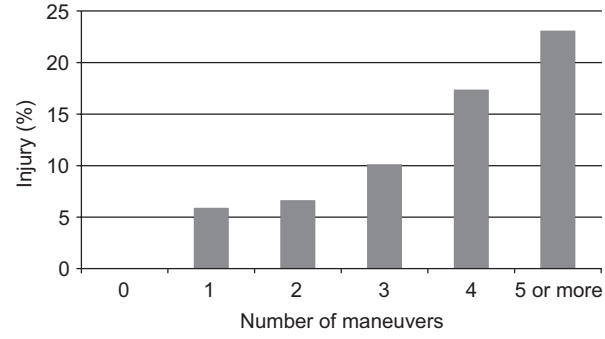

Fig. 2. Percentage with injury by number of maneuvers.
Hoffman. Dystocia Management and Neonatal Injury. Obstet Gynecol 2011.

Table 5. Multiple Logistic Regression of Neonatal Injury Based on Exposure to Obstetric Maneuvers*

Maneuver	Odds Ratio (95% CI)	*P*
MacRoberts (n=1,176)	1.43 (0.53–3.86)	.48
Suprapubic pressure (n=927)	0.98 (0.51–1.88)	.95
Woods corkscrew (n=240)	2.22 (1.22–4.04)	.009
Rubin maneuver (n=51)	1.54 (0.83–2.85)	.17
Delivery of posterior shoulder (n=192)	1.36 (0.71–2.61)	.358

CI, confidence interval.
* Adjusted for parity, maternal age, maternal race, site of care, and birth weight.

the only secondary maneuver not associated with injury was delivery of the posterior shoulder. This once again mostly likely reflects that these two maneuvers were used as secondary maneuvers and therefore in more difficult cases.

Recognizing both the rarity and importance of hypoxic–ischemic encephalopathy as a complication of shoulder dystocia, we chose to examine factors associated with our six cases. Among these cases, the mean time of delivery between delivery of the head and the remainder of the body was 10.75 minutes (range, 3–20 minutes) with all cases reporting more than five maneuvers. Among these six cases, only one woman had diabetes and only one underwent a vacuum delivery. The mean birth weight of these neonates was 4,246 g.

An issue of concern secondary to the nature of the study is the heterogenous nature of the populations and approaches taken by the various centers. Statistically different rates of shoulder dystocia ($P<.001$) and fetal injury ($P<.001$) are reported by different centers within our study. We believe that these differences can largely be attributed to differences in important causes of shoulder dystocia that also differ between centers (eg, birth weight, diabetes, and body mass index; all $P<.001$). Nonetheless, the clinical approach to these patients, which is the primary focus of this investigation, remains relatively consistent with 10 of 12 centers using McRoberts and suprapubic pressure as the primary maneuvers in 100% of cases and the remaining two centers using them in 94.9% and 98.0% of cases.

DISCUSSION

Our analysis validates that McRoberts maneuver and suprapubic pressure are widely practiced as the primary steps to relieve shoulder dystocia and that these maneuvers are associated with low rates of neonatal injury. Our study also demonstrates that delivery of the posterior shoulder had the highest overall rate of success when compared with all other maneuvers. Because quick resolution of shoulder dystocia is the primary goal, delivery of the posterior shoulder after the less technically demanding maneuvers of McRoberts and suprapubic pressure would be an appropriate approach. Likewise, we were able to demonstrate that the risk of neonatal injury did increase with the number of maneuvers performed, a finding consistent with other investigations.[10] This finding further strengthens the argument for using the most effective maneuver (delivery of the posterior shoulder) earlier in the approach to cases of shoulder dystocia. Interestingly, our study did not demonstrate a loss of efficacy of any maneuver regardless of its timing. This would suggest that at no point in the acute management of shoulder dystocia should any maneuver be completely abandoned.

Few others have investigated success rates of particular maneuvers and their relationship to birth injury. Our findings are similar to those of Chauhan et al[10] who were likewise unable to identify any particular maneuver associated with a lower risk of neonatal injury. A Cochrane Review of prophylactic McRoberts maneuvers suggested that its use decreased the risk of shoulder dystocia; however, this study did not demonstrate the more important outcome of whether prophylactic use of this maneuver minimizes neonatal injury.[11] Poggi et al[12] were able to demonstrate that delivery of the posterior shoulder was associated with a marked decrease in the degree of obstruction in a geometric analysis. Likewise, in a computer model, Grimm et al[13] determined that delivery of the posterior arm led to a 71% decrease in anterior nerve stretch and an 80% reduction in delivery force. We were able to validate these models in clinical practice by demonstrating that delivery of the posterior shoulder was the most effective maneuver for the acute resolution of shoulder dystocia.

Although our study did not show differences based on experience, recently two studies have been able to demonstrate lower rates of neonatal injury after implementation of drill-based training,[14] although this finding has not been universal.[7] We believe that these drills should emphasize delivery of the posterior shoulder as the third maneuver to allow providers to become more facile and comfortable with its performance.

Our study also demonstrated that hypoxic–ischemic encephalopathy is a very rare complication of shoulder dystocia with only six instances in 2,018 cases. All of these cases required five or more maneu-

vers to resolve the shoulder dystocia and were associated with a mean prolonged delivery time of 10.75 minutes. The rarity of this complication coupled with the need for multiple maneuvers and prolonged time of delivery highlight the extreme degree of difficulty in resolving these cases. Nonetheless, the small number of cases precludes meaningful comment on optimal management or prediction of these rare cases.

Some of the strengths of this study include the fact that it includes a large cohort of women delivered in multiple hospitals that are geographically diverse. Moreover, we included the entire cohort of eligible cases at each of the 12 institutions during the study period. Moreover, data were abstracted by trained research personnel who followed a common abstraction form with consistent definitions.

Limitations of the study include the operational definition of shoulder dystocia rather than objective parameters, a weakness of virtually all shoulder dystocia studies. Nonetheless, virtually all of our cases (2,016 of 2,018) had documentation of the use of maneuvers beyond gentle downward traction, which is in keeping with the definition provided by the College.[1] The remaining two patients were documented to have a head-to-body delivery time of greater than 60 seconds. Although all cases of shoulder dystocia used in the study were confirmed as actual cases, the method to initially identify cases varied in different centers; some used International Classification of Diseases, 9th Revision coding information, whereas others obtained this directly from their electronic medical record. Thus, there may have been differences in the sensitivity of our screening between centers.

Likewise, as a result of the retrospective nature of the study, we are unable to assess site differences (eg, training in shoulder dystocia, nursing response) that may have influenced both the clinical approach to shoulder dystocia and in turn the avoidance of fetal injury. Nonetheless, we were able to demonstrate that for the overwhelming majority of patients, the currently College-recommended approach of McRoberts maneuver and suprapubic pressure is widely adhered to, suggesting some uniformity in approach at the site level.

Another limitation of our study is that our definition of neonatal injury did not differentiate those injuries that were permanent from those that spontaneously resolved. The majority of cases of brachial plexus injury (our most common injury) will resolve, suggesting that our study overestimates the rate of permanent fetal injury associated with the treatment of shoulder dystocia. Lastly, we recognize that abstracted clinical documentation can vary in its accuracy.

In summary, we were able to clearly demonstrate that delivery of the posterior shoulder was superior to other maneuvers in the acute management of shoulder dystocia with a comparable rate of neonatal injury. Based on our data, we strongly encourage the early use of maneuvers to deliver the posterior shoulder when a shoulder dystocia is encountered.

REFERENCES

1. Clinical management guidelines for obstetrician–gynecologists. ACOG Practice Bulletin No. 40. American College of Obstetricians and Gynecologists. Obstet Gynecol 2002;100:1045–50.
2. Gherman RB, Goodwin TM, Souter I, Neumann K, Ouzounian JG, Paul RH. The McRoberts' maneuver for the alleviation of shoulder dystocia: how successful is it? Am J Obstet Gynecol 1997;176:656–61.
3. Mavroforou A, Koumantakis E, Michalodimitrakis E. Physicians' liability in obstetric and gynecology practice. Med Law 2005;24:1–9.
4. Lewis DF, Edwards MS, Asrat T, Adair CD, Brooks G, London S. Can shoulder dystocia be predicted? Preconceptive and prenatal factors. J Reprod Med 1998;43:654–8.
5. Mazouni C, Porcu G, Cohen-Solal E, Heckenroth H, Guidicelli B, Bonnier P, et al. Maternal and anthropomorphic risk factors for shoulder dystocia. Acta Obstet Gynecol Scand 2006;85:567–70.
6. Rouse DJ, Owen J. Prophylactic cesarean delivery for fetal macrosomia diagnosed by means of ultrasonography–a Faustian bargain? Am J Obstet Gynecol 1999;181:332–8.
7. MacKenzie IZ, Shah M, Lean K, Dutton S, Newdick H, Tucker DE. Management of shoulder dystocia: trends in incidence and maternal and neonatal morbidity. Obstet Gynecol 2007;110:1059–68.
8. Gonik B, Zhang N, Grimm MJ. Prediction of brachial plexus stretching during shoulder dystocia using a computer simulation model. Am J Obstet Gynecol 2003;189:1168–72.
9. Gherman RB, Chauhan S, Ouzounian JG, Lerner H, Gonik B, Goodwin TM. Shoulder dystocia: the unpreventable obstetric emergency with empiric management guidelines. Am J Obstet Gynecol 2006;195:657–72.
10. Chauhan SP, Christian B, Gherman RB, Magann EF, Kaluser CK, Morrison JC. Shoulder dystocia without versus with brachial plexus injury: a case–control study. J Matern Fetal Neonatal Med 2007;20:313–7.
11. Athukorala C, Middleton P, Crowther CA. Intrapartum interventions for preventing shoulder dystocia. The Cochrane Database of Systematic Reviews 2006, Issue 4. Art. No.: CD005543. DOI: 10.1002/14651858.CD005543.pub2.
12. Poggi SH, Spong CY, Allen RH. Prioritizing posterior arm delivery during severe shoulder dystocia. Obstet Gynecol 2003;101:1068–72.
13. Grimm MJ, Costello RE, Gonik B. Effect of clinician-applied maneuvers on brachial plexus stretch during a shoulder dystocia event: investigation using a computer simulation model. Am J Obstet Gynecol 2010;203:339.e1–5.
14. Grobman W, Miller DA, Burke C, Hornebogen A, Costello R. Clinical outcomes associated with implementation of a shoulder dystocia protocol. Am J Obstet Gynecol 2009;201:S125.