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ORIGINAL ARTICLE



Long-term outcomes of twins based on the intended mode of delivery*

Nathan S. Fox^{a,b}, Natalie Cohen^b, Elizabeth Odom^b, Simi Gupta^a, Jennifer Lam-Rachlin^a, Daniel H. Saltzman^a and Andrei Rebarber^a

^aMaternal Fetal Medicine Associates, PLLC, New York, NY, USA; ^bDepartment of Obstetrics, Gynecology and Reproductive Science, Icahn School of Medicine at Mount Sinai, New York, NY, USA

ABSTRACT

Objective: Recent studies have shown that for twin pregnancies with a cephalic presenting first twin, planned vaginal delivery is not associated with adverse short-term neonatal outcomes, as compared to planned cesarean delivery. Our objective was to compare long-term outcomes in twins, based on planned mode of delivery.

Study design: This was a prospective, observational cohort of twin pregnancies delivered by a single MFM practice. All the patients with a twin pregnancy >34 weeks delivered from 2005–2014 were surveyed regarding pediatric outcomes at or after 2 years of life. The survey was mail-based, with phone follow-up for nonresponses or for clarification of answers. Using chi-square, Student's *t*-tests, and regression analysis we compared outcomes between women who planned a vaginal (with active management of the second stage) versus cesarean delivery. The main outcome measures were: (1) a composite of major adverse outcomes (death, cerebral palsy, necrotizing enterocolitis, chronic renal, heart, or lung disease); (2) a composite of minor adverse outcomes (learning disability, speech therapy, occupational therapy, physical therapy).

Results: Five hundred and thirty-two women met inclusion criteria and 354 (66.5%) responded. 178 (50.3%) women planned to have a cesarean delivery (100% of whom had a cesarean delivery) and 176 (49.7%) women planned to have a vaginal delivery (83% of whom had a vaginal delivery). The average age of the children at the time of the survey was 5.9 years. There were no differences in any pediatric outcomes between the two groups. After controlling for maternal age, IVF, obesity, and preeclampsia, the planned mode of delivery was not associated with a composite of major adverse outcomes (aOR 0.673, 95% CI 0.228, 1.985), nor a composite of minor adverse outcomes (aOR 0.767, 95% CI 0.496, 1.188).

Conclusions: Planned vaginal delivery with active management of the second stage of labor in twin pregnancies >34 weeks is not associated with adverse childhood outcomes.

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Introduction

Twin births now account for 3.4% of all live births in the USA [1]. Most twins in the USA are delivered by cesarean delivery, with reported cesarean rates as high as 75% [2]. Reasons for cesarean delivery in twins include breech presentation of the first or second twin, as there is fear of short or long-term injury due to a breech extraction. A recent, large, randomized trial of planned cesarean versus vaginal delivery in twins with a cephalic-presenting first twin demonstrated no difference in outcomes at 28 days of life based on planned mode of delivery [3]. In this study, delivering providers were comfortable with breech extraction of the second twin. Follow-up at 2 years of life confirmed no long-term differences as well [4].

Active management of the second stage of labor in twins includes breech extraction of the breech or transverse second twin, as well as internal podalic version and breech extraction of a cephalic second twin, as necessary [5,6]. The goal of active management of the second stage of labor is to reduce the incidence of cesarean delivery and decrease the time between delivery of the first and second twin. We reported no difference in short-term neonatal outcomes between women with twin pregnancies planning cesarean delivery as compared to those planning vaginal delivery with active management of the second stage of labor [6]. However, long-term outcome data twins delivered with active management of the second stage are limited. The objective of this study was to report long-term outcomes for twins born to women

CONTACT Nathan S. Fox  nfox@mfmnyc.com  Maternal Fetal Medicine Associates, PLLC, New York, NY, USA

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planning vaginal delivery with active management of the second stage of labor.

Materials and methods

We surveyed all the patients with twin pregnancies delivered by one Maternal Fetal Medicine practice from June 2005 (when our electronic database was created) to March 2014. The survey was mail-based and sent to patients in April 2016. All nonresponders were contacted by phone or email if the contact information in our records was current. Anyone who expressed that she did not want to participate was not contacted again. Surveys were returned by mail or email and responders were contacted by phone or email if clarification of any response was needed. The survey questions chosen were intentionally designed to be answerable by parents, and the questions asked were considered practically relevant to parents considering long-term outcomes for their twins. A copy of the survey can be found in supplementary Figure S1.

For this analysis, we only included women who delivered at 34 weeks or greater, in order to control for gestational age at delivery, which would be expected to have the greatest impact on long-term outcomes. We also excluded women with monochorionic-monoamniotic twins, twins with major fetal anomalies or genetic abnormalities discovered before or after birth, and anyone with an intrauterine fetal death of either twin.

We compared outcomes based on the intended mode of delivery at the time of presentation to labor and delivery. In our practice, the protocol for twin delivery has been previously described [6]. Briefly, women are considered candidates for vaginal delivery if the first twin is cephalic presentation. If the second twin is noncephalic, the estimated fetal weight for the second twin must be ≥ 1500 g and the estimated fetal weight discordancy must be $< 20\%$. There must be no other contraindications to labor. Women who are eligible for vaginal delivery may elect to have a cesarean delivery and they were considered to be in the planned cesarean delivery group. In our practice, we utilize active management of the second stage for twin deliveries that includes breech extraction of the noncephalic second twin, as well as internal podalic version and breech extraction of a cephalic but unengaged second twin.

There were two primary outcomes for this study: a composite of major adverse outcomes (death, cerebral palsy, necrotizing enterocolitis, chronic renal, heart, or lung disease), and a composite of minor adverse outcomes (learning disability, speech therapy,

occupational therapy, physical therapy). We also analyzed each individual outcome on the survey. Outcomes were per mother, not per child. Therefore, if either twin had an outcome, the outcome was considered to be present. For the questions that asked about the age in months at which the child crawled, walked, and spoke, since we only included deliveries > 34 weeks, we did not adjust the responses for gestational age at delivery.

Baseline pregnancy and delivery characteristics were obtained from our computerized medical record. Gestational age at delivery was determined by last menstrual period and confirmed by ultrasound in all the patients. The pregnancy was redated if there was a > 5 -day discrepancy up to 14 weeks or a > 7 -day discrepancy after 14 weeks. If the pregnancy was the result of *in vitro* fertilization (IVF), gestational age was determined from IVF dating.

Chi square, Fisher's exact, and Student's *t*-test were used to compare groups, as appropriate (IBM SPSS for Windows 22.0, Armonk, New York, 2013). A *p*-value of $\leq .05$ was considered significant. A planned regression analysis for the primary outcomes was performed including all variables with differences at baseline with a significance of $p < .10$. We also analyzed the primary outcomes based on the actual mode of delivery (cesarean, vaginal cephalic, vaginal breech). For this analysis, the outcomes were per child, not per mother. Power analysis was done *post-hoc* as the plan was to survey all patients with twin deliveries in our practice.

Results

Over the course of the study period, there were 532 women with twin deliveries > 34 weeks who met inclusion criteria. Of these, 354 returned completed surveys for a response rate of 66.5%. There were no significant differences between responders and nonresponders in regards to maternal age, maternal race, prepregnancy body mass index, gestational age at delivery, birthweight of the larger or smaller twins, or steroid exposure (data not shown). However, the age of the children of responders was younger than nonresponders (5.9 versus 6.7 years, $p < .001$), which was not unexpected given the greater difficulty in reaching women via survey who delivered longer ago.

Among the 354 responders, 178 (50.3%) women planned to have a cesarean delivery (100% of whom had a cesarean delivery of both twins) and 176 (49.7%) women planned to have a vaginal delivery (83% of whom had a vaginal delivery of both twins, 17% had a cesarean delivery of both twins, 0% had a combined vaginal-cesarean delivery).

Table 1. Baseline characteristics of twin pregnancies, based on maternal planned mode of delivery.

	Planned caesarean N = 178	Planned vaginal N = 176	p
Advanced maternal age	51.1%	35.2%	.003
Chorionicity			.902
Dichorionic	87.6%	88.1%	
Monochorionic	12.4%	11.9%	
<i>In-vitro</i> fertilization	71.9%	58.5%	.008
Multifetal pregnancy reduction	5.1%	6.3%	.627
White race	89.3%	90.9%	.618
Maternal prepregnancy obesity	11.8%	6.3%	.069
Antenatal corticosteroid exposure in pregnancy	28.2%	21.6%	.156
Either twin birthweight <10%-ile	56.7%	59.7%	.578
Either twin birthweight <5%-ile	31.5%	32.4%	.852
Gestational diabetes	10.2%	9.2%	.758
Preeclampsia	15.7%	8.6%	.042
Gestational age at delivery	36.7 ± 1.1	36.8 ± 1.1	.128
Child age at time of survey	5.8 ± 2.3	6.0 ± 2.4	.395
Genders			.426
Male–Male	25.3%	31.4%	
Female–Female	28.1%	26.9%	
Female–Male	46.6%	41.7%	

Baseline characteristics of the two groups are shown in Table 1. The planned cesarean delivery patients were older, had higher rates of IVF, and had a higher incidence of preeclampsia. Otherwise, there were no significant differences between the groups at baseline. The mean age of the children at the time of follow-up was approximately 6 years old (range 2.1–10.8 years). The gender distribution was similar between the two groups as was the proportion of women exposed to antenatal corticosteroids.

Survey responses of long-term outcomes are shown in Table 2. There were no neonatal deaths in either group and there were no differences in the composite of major adverse outcomes nor in the composite of minor adverse outcomes. There were no differences in any of the individual outcomes queried including medical problems, speech, occupational or physical therapy, concerns of the pediatrician regarding height or weight, any operations, allergies, or medications, psychological or psychiatric evaluation, or the need for glasses. There were no differences in the reported ages at which the twins crawled, walked, and spoke their first word.

Regression analysis was performed to estimate the independent effect of planned mode of delivery on the primary outcomes and the results are shown in Table 3. Other variables included in this analysis were advanced maternal age, IVF, preeclampsia, and maternal prepregnancy obesity. Planned mode of delivery was not independently associated with either composite outcome.

We assessed the incidence of the primary outcomes per child, based on actual mode of delivery. There were 414 children delivered via cesarean, 186 children born vaginally in cephalic presentation and 108

children born vaginally by breech extraction. The outcomes for these three groups are shown in Table 4. The actual mode of delivery was not associated with either primary outcome.

A post-hoc power analysis was performed. Based on our sample size, we had 80% power (at an alpha error of 5%) to detect a difference in the primary outcomes from 5.1 to 10% (for the composite of major adverse outcomes) and from 56.7 to 66% (for the composite of minor adverse outcomes).

Comment

In this study, we found no differences in reported outcomes between twins who were planned to be delivered by cesarean and twins who were planned to be delivered vaginally including active management of the second stage of labor, which includes breech extraction of the second twin and internal podalic version of the second twin, as necessary. All the patients in the planned cesarean delivery group had a cesarean delivery and 83% of the patients in the planned vaginal delivery group had a vaginal delivery. When we examined outcomes per child based on the actual mode of delivery, the mode of delivery was still not associated with any adverse long-term outcomes. Our study supports and strengthens previous observational research showing no difference in short-term outcomes between similar groups [5,6].

A recent, large, randomized trial of twin pregnancies showed that planned mode of delivery was not associated with any adverse short- [3] or long-term [4] outcomes. In this randomized study, delivering providers were “experienced at vaginal twin delivery”, but no mention was made of the number of providers

Table 2. Childhood outcomes*** in twins, based on maternal planned mode of delivery.

	Planned Caesarean N = 176	Planned Vaginal N = 178	p
Neonatal death of either twin	0.0%	0.0%	.999
Composite of major adverse outcomes in either twin*	5.1%	3.4%	.442
Composite of minor adverse outcomes in either twin**	56.7%	50.0%	.204
Has either twin been diagnosed with or treated for			
Colic	12.9%	9.1%	.250
Asthma/Reactive airways	11.2%	15.9%	.199
Any other chronic lung disease	1.7%	1.1%	.662
Gastrointestinal reflux	25.8%	24.4%	.760
Kidney (renal) disease	0.6%	0.6%	.994
Heart (cardiac) disease	2.8%	1.7%	.485
Necrotizing enterocolitis (NEC)	0.0%	0.0%	.999
Cerebral palsy	0.6%	0.0%	.999
Any learning disability	12.4%	11.9%	.902
Difficulty with hearing	3.4%	5.7%	.295
Diabetes	0.0%	0.0%	.999
High blood pressure	0.0%	0.0%	.999
Has either child ever required			
Speech therapy	42.1%	37.5%	.373
Occupational therapy ("OT")	37.6%	29.0%	.084
Physical therapy ("PT")	33.1%	31.3%	.703
At or after the age of 2 years, has your pediatrician ever had any concerns regarding either child's			
Height (too short)	5.1%	6.3%	.627
Weight (too light)	9.0%	10.2%	.693
Weight (too heavy)	4.5%	2.3%	.248
Vision	16.3%	14.8%	.693
Hearing	3.4%	5.7%	.295
Motor skills	15.7%	10.8%	.171
Has either child undergone any operations	36.0%	27.8%	.102
Does either child take any medications	15.7%	11.9%	.301
Is either child allergic to any foods	11.2%	12.5%	.713
Has either child ever been evaluated or treated by a psychologist or psychiatrist?	19.7%	12.5%	.067
Does either child wear glasses?	14.6%	20.5%	.148
Age when both twins were crawling (months)	8.6 ± 2.2	8.5 ± 1.8	.620
Age when both twins were walking (months)	14.3 ± 2.8	14.1 ± 2.5	.482
Age when both twins said their first word (months)	13.8 ± 5.2	13.6 ± 4.9	.741

*Composite major outcome: Death, cerebral palsy, necrotizing enterocolitis, chronic renal, heart, or lung disease.

**Composite minor outcome: Learning disability, speech therapy, occupational therapy, physical therapy.

***Outcomes are per mother.

Table 3. Regression analysis.

	Composite major outcome* aOR (95% CI)	Composite minor outcome** aOR (95% CI)
Planned mode of delivery	0.673 (0.228, 1.985)	0.767 (0.496, 1.188)
Advanced maternal age	1.140 (0.391, 3.324)	0.658 (0.420, 1.029)
<i>In-vitro</i> fertilization	1.001 (0.324, 3.095)	1.402 (0.886, 2.220)
Preeclampsia	1.013 (0.216, 4.756)	1.606 (0.810, 3.187)
Maternal prepregnancy obesity	1.661 (0.352, 7.827)	0.986 (0.453, 2.145)

*Composite major outcome: Death, cerebral palsy, necrotizing enterocolitis, chronic renal, heart, or lung disease.

**Composite minor outcome: Learning disability, speech therapy, occupational therapy, physical therapy.

who were comfortable with, or routinely used, breech extraction or active management of the second stage including internal podalic version. It is likely that many providers were not using these maneuvers given that the combined vaginal-cesarean delivery rate was 4.2% in the planned vaginal delivery group. In centers comfortable with active management of the second stage, the combined vaginal-cesarean delivery rate appears to be <1% [5–7] (it was 0% in this cohort). Therefore, our study further supports the findings of Barrett et al. and Asztalos et al. that planned mode of delivery does not impact long-term neonatal outcomes, and our study also suggests that breech extraction and active

management of the second stage is also not associated with adverse long-term pediatric outcomes. This is important as recent guidelines from the American College of Obstetricians and Gynecologists and Society for Maternal Fetal Medicine state that vaginal delivery of twins with a cephalic-presenting first twin is a “reasonable option ... provided that an obstetrician with experience in internal podalic version and vaginal breech delivery is available” [8]. Our data supports this recommendation and provides additional outcome data as well.

Strengths of this study include the large sample size and that our long-term outcomes were

Table 4. Childhood outcomes*** in twins, based on actual mode of delivery.

	Caesarean N = 414	Vaginal cephalic N = 186	Vaginal breech N = 108	p
Neonatal death	0%	0%	0%	.999
Composite of major adverse outcomes*	2.9%	1.6%	0.0%	.151
Composite of minor adverse outcomes**	42.7%	36.9%	42.6%	.392

*Composite major outcome: Death, cerebral palsy, necrotizing enterocolitis, chronic renal, heart, or lung disease.

**Composite minor outcome: Learning disability, speech therapy, occupational therapy, physical therapy.

***Outcomes are per child.

ascertained at approximately 6 years, on average. Many relevant and important outcomes would not manifest at age two, particularly ones related to learning issues, vision, and hearing. Also, since the deliveries were all by one practice, there is minimal variation in regards to pregnancy and labor management. Finally, we were able to examine numerous baseline characteristics in the two groups that might also impact outcomes, and were able to control for variables that differed between the two groups.

Our study was mail-based, which has limitations. Our response rate of 66.5% is very good for this type of study; however, it is possible that there is an element of selection bias in our findings. However, we did not find any differences in baseline characteristics between responders and nonresponders. The vast majority of nonresponders were women we simply could not reach due to outdated contact information; only 14/532 (2.6%) specifically declined to participate, none of whom had a neonatal death. Unlike Asztalos et al., we did not actually examine the children, nor did we use a validated clinical tool for evaluation of the children. This limits the precision of our findings, but it also adds a new dimension to the findings of Asztalos et al., as we were able to report on several outcomes not typically studied by researchers that are clinically relevant to parents. For example, does your child wear glasses, has your child needed additional therapy, what age did your child walk, has your child been diagnosed with a learning disability are all questions that parents consider when considering the health of their children. Therefore, in addition to having the data from standardized testing at 2 years reported by Asztalos et al., obstetricians can use the results from this study to counsel pregnant patients regarding mode of delivery, using other outcomes that might be more understandable for many women.

Another limitation of the study is the relatively homogeneous nature of this population. Approximately 90% were white and all had private health insurance. This population might have more access to care, both obstetric and pediatric, than others, so outcomes in other populations might differ, but it is not clear in which direction. It could produce

more positive outcomes given the good access to care. Alternatively, this population's access to care may result in more postnatal diagnoses of learning issues as well as other minor morbidity variables given that follow-up to care may be more fastidious. Therefore, further studies would be needed to determine if our findings are generalizable to other populations as well. Currently, aside from this study and Asztalos et al., there are limited data regarding any long-term outcomes in twins based on mode of delivery as most studies focused on short-term outcomes only [5,6]. Long-term outcome studies are important as long-term neonatal outcomes may differ from short-term outcomes, as most short-term neonatal outcomes are either temporary or surrogate outcomes.

In conclusion, planned vaginal delivery with active management of the second stage of labor in twin pregnancies does not appear to be associated with adverse childhood outcomes. Obstetricians could use this information in counseling women with twin pregnancies regarding planned mode of delivery.

Disclosure statement

The authors report no conflicts of interest.

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