

1 **Management of Fetal Malposition in the Second Stage of Labor: A Propensity**
2 **Score Analysis**

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29 **Condensation:** After stratifying cases of persistent malposition on variables

30 determining decision to attempt rotation, rotational instrumental delivery was not

31 associated with worse outcomes than cesarean delivery.

32

33 **Short Version of Article Title:** Managing fetal malposition in second stage

34 **Abstract**

35 **Objective:** To determine the factors associated with selection of rotational
36 instrumental versus cesarean delivery to manage persistent fetal malposition, and to
37 assess differences in adverse neonatal and maternal outcomes following delivery by
38 rotational instruments versus cesarean section.

39 **Study Design:** We conducted a retrospective cohort study over a 5-year period in a
40 tertiary UK obstetrics center. 868 women with vertex-presenting, single, live-born
41 infants at term with persistent malposition in the second stage of labor were included.
42 Propensity-score stratification was used to control for selection bias: the possibility
43 that obstetricians may systematically select more difficult cases for cesarean section.
44 Linear and logistic regression models were used to compare maternal and neonatal
45 outcomes for delivery by rotational forceps or ventouse versus cesarean section,
46 adjusting for propensity scores.

47 **Results:** Increased likelihood of rotational instrumental delivery was associated with
48 lower maternal age (OR= 0.95 p<0.01), lower BMI (OR=0.94 p<0.001), lower birth-
49 weight (OR=0.95 p<0.01), no evidence of fetal compromise at the time of delivery
50 (OR=0.31 p<0.001), delivery during the daytime (OR= 1.45, P<0.05), and delivery by
51 a more experienced obstetrician (OR=7.21 p<0.001). Following propensity score
52 stratification, there was no difference by delivery method in the rates of delayed
53 neonatal respiration, reported critical incidents, or low fetal arterial pH. Maternal
54 blood loss was higher in the cesarean group (295.8± 48ml p<0.001).

55 **Conclusions:** Rotational instrumental delivery is often regarded as unsafe. However,
56 we find that neonatal outcomes are no worse once selection bias is accounted for, and
57 that the likelihood of severe obstetric hemorrhage is reduced. More widespread

58 training of obstetricians in rotational instrumental delivery should be considered,
59 particularly in light of rising cesarean section rates.

60

61 **Key Words:** cesarean section; operative vaginal delivery; fetal malposition; delivery;
62 intra-partum care

63

64 **Introduction**

65 Fetal head malposition in the second stage of labor is a significant risk factor for
66 adverse maternal and neonatal outcomes, and is associated with high rates of both
67 instrumental delivery and cesarean section [1]. While some women will
68 spontaneously deliver a malpositioned fetus, most require obstetric intervention [2].
69 In cases of persistent malposition, the obstetrician must choose between a potentially
70 difficult rotational instrumental delivery and a second-stage cesarean section.

71

72 Instrumental rotation of the fetal head has fallen out of favor in modern obstetric
73 practice in much of the world, despite data showing low complication rates [3, 4]. It
74 has recently been demonstrated that, while the majority of obstetricians considered
75 rotation of the fetal head to be an acceptable intervention (97%), less than half (41%)
76 had performed it within the previous year [5]. Second-stage cesarean section is an
77 increasingly common alternative [6], but carries a significant burden of maternal
78 morbidity [7, 8].

79

80 A small number of studies have compared the morbidity associated with different
81 instruments used to effect rotational delivery, and have found low prevalence of
82 adverse maternal and neonatal outcomes, as well as increased risk of some adverse
83 events with emergency cesarean section [9-11]. However, any comparison of delivery
84 outcomes by rotational instruments versus second-stage cesarean section must
85 confront the possibility that obstetricians systematically select more difficult cases for
86 cesarean section, thereby introducing a selection bias. This study has two main
87 objectives: first, to illuminate the factors that make an attempt at rotational
88 instrumental delivery more likely, by modeling the obstetrician's decision-making

89 process; and second, to use propensity-score stratification to create comparable
90 groups that allow differences in maternal and fetal outcomes by delivery type to be
91 tested reliably.

92

93 **Materials and Methods**

94 A cohort of 25,886 women with vertex-presenting, single, live-born infants at term
95 (37 – 42 completed weeks of gestation), aiming for vaginal delivery was identified
96 over a 5-year period (Jan 2008- Oct 2013) in a single tertiary obstetrics center in the
97 UK. A sub-cohort of 868 women was identified with a confirmed cephalic fetal
98 malposition in the second stage of labor. Of these, 833 underwent either cesarean
99 section (n=534) or successful instrumental delivery (n=299), and 35 underwent failed
100 instrumental delivery, followed by second-stage cesarean section.

101

102 Fetal malposition was defined as any cephalic position greater than 45 degrees from
103 direct occipito-anterior [12], and was diagnosed by digital examination. The rate of
104 malpositions delivered by each method did not vary significantly across the study
105 years. Deliveries where the obstetrician performed manual rotation of the fetal head
106 followed by direct instrumental delivery were not considered to be cases of persistent
107 fetal malposition, and were not included in the analysis. The indications and
108 procedures for instrumental delivery in our center are defined in the operative vaginal
109 delivery guidance from the Royal College of Obstetricians and Gynaecologists
110 (RCOG, UK) [12]. The classification of and indications for operative vaginal delivery
111 are materially identical to the American College of Obstetricians and Gynecologists
112 (ACOG) Practice Bulletin Number 17 on operative vaginal delivery [13].

113

114 Rotational instrumental delivery was carried out with either Kielland's forceps or
115 ventouse. Ventouse devices available in the unit include posterior and rotational metal
116 cups, silastic cups, and Kiwi Omnicups. Of the 334 successful instrumental deliveries,
117 62.0% (n=207) were conducted with Kielland's forceps and 38.0% (n=127) using
118 ventouse.

119

120 Data regarding each woman's pregnancy, labor, and delivery were recorded by
121 midwives shortly after birth, and were subsequently obtained from the hospital's
122 Protos data-recording system. The database is regularly validated by a rolling
123 program of audits where the original case notes are checked against the information
124 recorded in the database. No patient-identifiable data were accessed during this
125 research, which was performed as part of a provision-of-service study for the
126 obstetrics center. Individual medical records were not accessed at any stage.
127 Institutional Review Board approval was therefore not required.

128

129 Characteristics of the materno-fetal dyad were extracted from the database, including
130 maternal age (at time of delivery), BMI (at first-trimester prenatal booking), parity
131 (prior to delivery), ethnicity, and birth-weight to the nearest gram. Also recorded were
132 the time between diagnosis of second stage and delivery (time fully dilated), and the
133 instrument selected. Gestational age (measured by crown-rump length at first-
134 trimester ultrasound) was recorded to the nearest week. Only cases where birth
135 occurred within the interval 37-42 weeks' completed gestation were included. No
136 adjustment was made for infants found to be small or large for gestational age. The
137 indication for delivery was also classified into those where there was evidence of fetal
138 compromise (including pathological fetal-heart tracing, abnormal fetal-blood

139 sampling result, evidence of sepsis) and those where delivery was undertaken on other
140 grounds (including failure to progress in second stage and maternal exhaustion).

141 Deliveries were conducted under regional anesthesia (epidural or spinal), excepting a
142 small number who required general anesthetic because of time constraints or failure
143 of regional anesthesia during the procedure.

144

145 The level of experience of the obstetrician attempting delivery and the time at which
146 the delivery took place were also recorded. Obstetricians were classified into three
147 types using years of training as a proxy for experience. Type-1 and Type-2

148 obstetricians have 3-5 years and 5-10 years of obstetric training, respectively. Type 3
149 obstetricians typically have >10 years of clinical obstetric experience. Our study was

150 conducted in a unit where 2 obstetricians are available to perform instrumental

151 deliveries or cesarean sections at any time. The first is typically a type-1 obstetrician,

152 and is always supported by an immediately available doctor with >5 years obstetric

153 training: a type-3 obstetrician during the day, or type-2 overnight. All obstetricians

154 had training in at least one method of rotational instrumental delivery, in line with

155 RCOG training requirements.

156

157 Delay in neonatal respiration was recorded where spontaneous respiration was not

158 achieved within 1 minute of delivery. Umbilical cord blood was obtained immediately

159 following delivery, and the arterial pH recorded. Correlation between arterial and

160 venous pH was checked to confirm accuracy of the measurements. Arterial pH was

161 categorized as ≥ 7.1 or < 7.1 [14]. A critical-incident form was generated at delivery

162 in the case of any obstetric or neonatal emergency, including neonatal resuscitation,

163 post-partum hemorrhage, shoulder dystocia, severe perineal trauma, maternal visceral

164 injury, or any other event generating an obstetric emergency call. Maternal blood loss
165 was measured by operating-room staff immediately after delivery, using suction blood
166 collection and weighing of swabs and other pads. Blood loss was treated as a
167 numerical variable to the nearest milliliter, and also categorized as minor ($<1500\text{ml}$)
168 or major ($\geq 1500\text{ml}$). Severe perineal trauma was defined as any disruption to the
169 anal sphincter complex. Simple groupwise comparisons of these outcomes for women
170 undergoing rotational instrumental versus cesarean delivery were carried out using
171 either Student's t-test or the Mann-Whitney test for numerical data, and Pearson's chi-
172 squared test for categorical data.

173

174 Any rigorous attempt to compare outcomes for the rotational-instrumental and
175 cesarean-section groups is complicated by the fact that obstetricians may
176 systematically select more difficult cases for cesarean section. This selection bias may
177 involve physicians' own training and experience, their immediate concern for fetal
178 well-being, and anticipated fetal weight. An extensive set of these assignment-related
179 variables are available in our data set, allowing us to explicitly model the
180 obstetrician's decision-making process. This allows us to use propensity-score
181 stratification to adjust for factors that influence the decision to move towards cesarean
182 section. Propensity-score stratification involves two stages. First, we build a
183 statistical model for the treatment assignment (instrumental versus cesarean delivery),
184 given a suitable set of predictors. The propensity score is the predicted probability of
185 receiving the treatment derived from this first model. We then build a second set of
186 models to estimate the effect of the treatment on each clinical outcome of interest,
187 conditional on subjects' propensity scores. This approach generates a balanced cohort
188 of subjects whose baseline characteristics will be statistically similar, regardless of

189 treatment status. For the purpose of estimating treatment effects, it is typically more
190 robust than standard regression modeling, and may be formally justified under the
191 potential-outcomes framework for causal inference [15]. The effect of the covariates
192 themselves on the clinical outcome is captured by the propensity score, and is never
193 explicitly modeled.

194

195 For the purpose of estimating propensity scores, the 35 failed instrumental deliveries
196 were included in the instrumental group, as the goal of this first-stage analysis was to
197 model the physician's initial treatment decision. For the purpose of estimating
198 treatment effects, we ran two sets of second-stage analyses: one set with the 35 failed
199 instrumental deliveries included, and one with them excluded.

200

201 Propensity scores were generated using a logistic-regression model predicting
202 assignment to the instrumental-delivery group (the "treatment"). The regression
203 model included seven covariates found to be significantly different between women
204 undergoing rotational instrumental and cesarean section, and which were thought to
205 be clinically relevant: maternal age, maternal BMI, parity, birth-weight, evidence of
206 fetal compromise, time of delivery, and degree of experience of the delivering
207 obstetrician. Although birth-weight is unknown before delivery, it has been included
208 because it plausibly may be anticipated by the physician and it strongly predicts the
209 decision to move to cesarean delivery.

210

211 The resulting propensity scores were then stratified by quintile [16], and the balance
212 of covariates between cases of rotational instrumental delivery and cesarean section
213 delivery checked within each quintile to verify that no significant differences

214 remained. Adverse maternal and fetal outcomes were then modeled using linear and
215 binary logistic regression, including the type of delivery and dummy variables for the
216 propensity score quintiles as predictors. Findings were considered statistically
217 significant at an alpha level of 0.05. Power calculations were performed by Monte
218 Carlo simulation. All data analysis was conducted using the R statistical software
219 package version 2.14.1.

220

221 **Results**

222 868 women with confirmed fetal malpositions in the second stage of labor were
223 identified. 534 (61.5%) were delivered directly by second-stage cesarean section; and
224 334 (38.5%) had an attempted rotational instrumental delivery, 299 of which resulted
225 in successful delivery, and 35 of which were converted to second-stage cesarean
226 section. Characteristics of the maternal-fetal dyad were compared between the
227 instrumental-delivery and cesarean-section groups (Table 1). Women in the cesarean-
228 section group were more likely to be older ($p<0.01$), to have higher BMI ($p<0.001$),
229 and to have babies with higher birth-weights ($p<0.01$). In terms of events surrounding
230 delivery, women in the cesarean-section group were more likely to have had a
231 delivery involving evidence of fetal compromise ($p<0.001$), to have been delivered
232 during the night ($p<0.01$), and to have been delivered by a less experienced
233 obstetrician ($p<0.001$).

234

235 Table 2 shows the results of the logistic regression predicting assignment to rotational
236 instrumental delivery (the “treatment”). Lower birth-weight ($p<0.01$), lower maternal
237 age ($p<0.01$), lower maternal BMI, ($p<0.001$), higher parity ($p<0.1$), absence of
238 evidence of fetal compromise ($p<0.001$), delivery during the daytime ($p<0.05$), and

239 increased experience of obstetrician ($p < 0.001$) are all significant predictors of
240 assignment to rotational instrumental delivery.

241

242 The balance of covariates between the two groups was then checked within each
243 propensity-score quintile. There were no significant differences between the groups
244 on any covariates in any of the quintiles. The results for the fourth quintile are shown
245 as an example (Table 3); note that the propensity score quintiles are based on the
246 combined groups. The characteristics of the materno-fetal dyad are now much more
247 similar across the two groups than they were before stratification (c.f. Table 1).

248

249 Unadjusted comparison of delivery outcomes (Table 4) showed that a higher
250 percentage of deliveries in the cesarean-section group was associated with a critical
251 incident at the time of delivery ($p < 0.01$) and increased estimated blood loss (491.6ml
252 v. 792.5ml, $p < 0.001$). As expected, there were a number of infants with shoulder
253 dystocia (2.7%) and severe maternal perineal trauma (3-4th degree tears; 6%) in the
254 rotational-instrumental group. In the cesarean-section group, 9.4% required
255 administration of general anesthesia.

256

257 Table 5 shows the associations between mode of delivery and adverse maternal and
258 neonatal outcomes following propensity-score adjustment. As a robustness check,
259 results are shown both with and without the failed instrumental deliveries included in
260 the rotational-instrumental cohort, and are very similar in both cases. There were no
261 differences between deliveries performed by rotational instruments versus cesarean
262 section in the time to neonatal respiration, reported critical incidents associated with
263 the delivery, or likelihood of fetal umbilical arterial pH of ≤ 7.1 . The estimated

264 blood loss was higher in the cesarean group by $295.8 \pm 48\text{ml}$ ($p < 0.001$). In addition,
265 the likelihood of sustaining $>1500\text{ml}$ estimated blood loss was lower in the
266 instrumental group (OR 0.24, $p < 0.01$). Power calculations showed that, at a Type-I
267 error rate of 5%, we have at least 80% power to detect odds ratios outside the interval
268 (0.54, 1.85) for binary outcomes, and to detect blood-loss effect sizes of at least 135
269 milliliters.

270

271 **Comment**

272 After propensity-score adjustment, instrumental delivery does not appear to be
273 associated with worse maternal and neonatal outcomes. If anything, it offers a
274 significantly lower risk than cesarean section of postpartum hemorrhage. We found
275 no difference in delay to neonatal respiration following instrumental delivery, and no
276 clinically significant difference in the risk of a low fetal arterial pH. We also
277 demonstrate systematic differences between women who are assigned by obstetricians
278 to rotational instrumental delivery versus second-stage cesarean section. These
279 differences include lower birth-weight, lower maternal age, lower BMI and higher
280 parity. Obstetricians are also more likely to undertake rotational instrumental delivery
281 when they have more experience and when working during daylight hours (which
282 may reflect the availability of immediate back-up from more experienced colleagues).

283

284 Our results are in general agreement with previous studies examining the maternal
285 and neonatal risks of rotational instrumental delivery [9-11]. In addition to the
286 outcomes reported here, these studies are reassuring regarding maternal outcomes,
287 including duration of hospital stay [17] and obstetric anal sphincter injury [11]; and
288 neonatal outcomes, including fetal injury [9, 10, 18]. Although we did not specifically

289 examine it here, even in cases where instrumental deliveries are not successful, the
290 outcomes of such attempts do not appear to be worse outcomes than proceeding
291 directly to cesarean section [19].

292

293 The main strength of our study is its methodological robustness in addressing
294 selection bias. Systematic differences between delivery groups are likely to affect any
295 observational study, complicating any attempt to compare maternal and neonatal
296 outcomes using standard regression analysis. The use of propensity-score
297 stratification, a technique that is becoming more widely used in obstetrics [20, 21],
298 offers major advantages in this context. In particular, as long as the covariates can be
299 shown to be properly balanced after stratification, the subsequent estimate of the
300 treatment effect does not rely upon the precise mathematical relationship between the
301 outcome and the covariates. This stands in strong contrast to standard regression
302 analysis: when the covariates are heavily imbalanced between the groups, as they are
303 in our data set, all treatment effects estimated by regression depend upon the specific
304 form of the model, and are not robust to violations of standard assumptions, such as
305 linearity, separability of covariate effects, and homoscedasticity [22, 23].

306

307 The main limitations of our study include the inability to distinguish between
308 different fetal malpositions (occipito-posterior, occipito-transverse etc.), and the lack
309 of sub-division of the cohort to distinguish between deliveries conducted using
310 rotational forceps and ventouse. While these data are available, a further sub-cohort
311 analysis has not been performed, as sample sizes would be insufficiently large to
312 allow adequate propensity-score stratification between groups. Additionally, we did
313 not have information about attempts at manual rotation, as these are not routinely

314 recorded in our database. Another limitation is the lack of information about caput,
315 molding, and station. We were thus unable to account for the influence of these
316 subjective but important variables in the decision-making process. We were also
317 unable to control for the presence of maternal diabetes. Our study documents adverse
318 maternal and neonatal outcomes at birth; however, we lack the follow-up data to
319 ensure that there is no excess of late adverse outcomes in either group. Existing data
320 suggest that there is no evidence of increased adverse neurodevelopmental outcomes
321 in neonates following instrumental delivery [24]. Additionally, data are collected
322 shortly after delivery, and therefore do not include information on length of stay in
323 hospital, either for the mother or the neonate.

324

325 The association we demonstrate between obstetrician experience and likelihood of
326 proceeding to instrumental delivery likely reflects the difficulty of such deliveries and
327 the experience required to undertake them with confidence. Indeed, others have noted
328 the importance of operator experience in the safe use of Kielland's forceps [25] and
329 that junior obstetricians are relatively more likely to use rotational ventouse rather
330 than forceps [26]. We have shown elsewhere that obstetricians in their first 5 years of
331 training are more likely to have unsuccessful instrumental deliveries than more
332 experienced obstetricians [27]. Our findings imply that increased training and
333 experience for trainee obstetricians is important, especially in light of rising cesarean
334 section rates. Other studies have also recognized a need for improved training in
335 instrumental delivery techniques [28]. While 'real-life' experience is desirable,
336 simulator-based training has been developed and may help fulfill some learning needs
337 [29].

338

339 The obstetrician's perception of the safety of the mother and fetus plays a major role
340 in the decision to perform rotational instrumental delivery in the face of persistent
341 malposition. Our analysis shows that higher maternal weight and age, the expectation
342 that the fetus is large, and the presence of fetal distress all make the choice of
343 cesarean section more likely. However, once we adjust for these factors, it does not
344 appear that rotational instrumental delivery is associated with a higher rate of adverse
345 outcomes. A risk of shoulder dystocia is inherent in vaginal deliveries, as is the risk of
346 severe perineal trauma. The obstetrician must carefully weigh these risks against the
347 increased risk of maternal hemorrhage and of requiring general anesthesia with
348 second-stage cesarean section. Rotational instrumental delivery, particularly by
349 Kielland's forceps, has been all but abandoned in many obstetric practices. Yet the
350 findings presented here suggest that there is room for further debate about the
351 inclusion of rotational instruments in the clinical toolkit of modern obstetricians,
352 especially in settings where cesarean section has become the default mode of delivery.

353

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443

444 **Table 1**—Characteristics of the Maternal-Fetal Dyad for the Full Sample and
 445 Stratified by Decision to Rotate
 446

Characteristic	All Patients (N=868)	Rotational Instrumental Delivery (n=334)	Second Stage Cesarean (n=534)
Maternal age (yrs)	30.5	29.8	31.0**
Maternal BMI (kg/m²)	25.5	24.4	26.2***
Gestation (wks)	39.9	39.9	39.8
Parity			
0	454 (52.3)	166 (49.7)	288 (53.9)
1+	414 (47.7)	168 (50.3)	246 (46.1)
Time fully dilated (min)	159.1	159.8	161.2
Epidural			
Yes	601 (69.2)	229 (68.6)	372 (69.7)
No	267 (30.8)	105 (31.4)	162 (30.3)
Obstetrician type			
1	405 (46.7)	104 (31.1)	301 (56.4)***
2	366 (42.2)	159 (47.6)	207 (38.8)
3	97 (11.2)	71 (21.3)	26 (4.9)
Birth weight (g)	3592	3532	3630**
Fetal Indication			
Yes	439 (50.6)	116 (34.7)	313 (58.6)***
No	429 (49.4)	218 (65.3)	221 (41.4)
Ethnicity			
White	784 (90.3)	303 (90.7)	481 (90.1)
Southeast Asian	53 (6.1)	21 (6.3)	32 (6.0)
Black	9 (1.0)	5 (1.5)	4 (0.7)
Chinese	8 (1.0)	1 (0.3)	7 (1.3)
Other	14 (1.6)	4 (1.2)	10 (1.9)
Time of Delivery			
Day	467 (53.8)	206 (61.7)	261 (48.9)
Night	401 (46.2)	128 (38.3)	273 (51.1)**

447
 448 Figures are means or n, percentages in parentheses

449 **p<0.01, ***p<0.001

450

451 **Table 2**—Factors Associated with Decision to Perform Rotational Instrumental

452 Delivery (N=868)

453

Variable	Odds Ratio (95% CI)	
Maternal Age (yrs)	0.95 ^{***}	(0.93-0.98)
Maternal BMI (kg/m²)	0.94 ^{***}	(0.91-0.97)
Parity		
0		ref
1+	1.36 [†]	(1.00-1.85)
Obstetrician Type		
1		ref
2	2.49 ^{***}	(1.79-3.48)
3	7.21 ^{***}	(4.22-12.64)
Birth Weight (per 100g)	0.95 ^{**}	(0.92-0.98)
Fetal Indication	0.31 ^{***}	(0.23-0.43)
Time of Delivery		
Night		ref
Day	1.45 [*]	(1.05-2.01)

454

455 Model coefficients are expressed as odds ratios and 95% confidence intervals (CI).

456 [†]p<0.1, *p<0.05, **p<0.01, ***p<0.001

457

458 **Table 3**—Balance of Matched Covariates after Propensity Score Stratification

459 (Fourth Quintile)

460

461

Characteristic	Rotational Instrumental Delivery (n=81)	Second Stage Cesarean (n=92)	P
Maternal age (yrs)	29.4	29.8	0.60
Maternal BMI (kg/m²)	23.8	24.0	0.69
Parity			
0	42 (51.9)	46 (50.0)	0.81
1+	39 (48.1)	46 (50.0)	
Obstetrician type			
1	27 (33.3)	31 (33.7)	0.96
2	45 (55.6)	58 (63.0)	
3	9 (11.1)	3 (3.3)	
Birth weight (g)	3531.7	3592.4	0.10
Fetal Indication			
Yes	58 (71.6)	68 (73.9)	0.73
No	23 (28.4)	24 (26.1)	
Time of Delivery			
Day	48 (59.3)	52 (56.5)	0.72
Night	33 (40.7)	40 (43.5)	

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463 Figures are means or n, percentages in parentheses

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484 **Table 4**—Maternal and Neonatal Outcomes for the Full Sample and Stratified by
 485 Decision to Rotate
 486

Characteristic	All Patients (N=868)	Rotational Instrumental Delivery (n=334)	Second Stage Cesarean (n=534)
Estimated Blood Loss (ml)	677.2	491.6	792.5 ^{***}
Delayed Neonatal Respiration	86 (9.9)	27 (8.1)	59 (11.0)
Critical Incident Reported	89 (10.3)	23 (6.9)	66 (12.4) ^{**}
Umbilical Arterial pH <7.1	43 (5.0)	14 (4.2)	29 (5.4)
Shoulder Dystocia	9 (1.0)	9 (2.7)	-
Severe Perineal Trauma	20 (2.3)	20 (6.0)	-
General Anesthesia	50 (5.8)	-	50 (9.4)

487
 488 Figures are means or n, percentages in parentheses

489 Failed Instrumentals included in rotational instrumental delivery group

490 ^{**}p<0.01, ^{***}p<0.001

491

492 **Table 5**—Associations Between Mode of Delivery and Adverse Maternal and
 493 Neonatal Outcomes for the Propensity Score Adjusted Sample
 494

Outcome	Failed Instrumental Deliveries Not Included (N=833)		Failed Instrumental Deliveries Included (N=868)	
	OR (95% C.I.)	P	OR (95% C.I.)	P
Time to Neonatal Respiration				
Cesarean Section	ref		ref	
Rotational Instrumental	0.77 (0.43-1.31)	0.35	0.77 (0.44-1.29)	0.31
Incidence of Critical Incident				
Cesarean Section	ref		ref	
Rotational Instrumental	1.52 (0.77-3.09)	0.24	1.66 (0.86-3.31)	0.14
Fetal Umbilical Arterial pH<7.1				
Cesarean Section	ref		ref	
Rotational Instrumental	0.63 (0.26-1.40)	0.27	0.77 (0.36-1.60)	0.49
Estimated Blood Loss >1.5L				
Cesarean Section	ref		ref	
Rotational Instrumental	0.20 (0.10 – 0.38)	<0.01 **	0.24 (0.13-0.43)	<0.01 **
		Coefficient (S.E.)	Coefficient (S.E.)	
Estimated Blood Loss (ml)				
Cesarean Section	ref		ref	
Rotational Instrumental	-333.4 (50.09)	<0.001 ***	-295.8 (47.98)	<0.001 ***

495

496 ** p<0.01, ***p<0.001

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