Comparison of perinatal outcomes for all modes of second stage delivery in obstetric theatres: a retrospective observational study

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Abstract

Objective To compare rates of vaginal delivery and adverse outcomes of instrumental delivery trials in obstetric theatre compared to primary emergency full dilatation Caesarean section Design Retrospective cohort study Setting University teaching hospital Population Women with singleton, non-anomalous, pregnancy undergoing instrumental delivery trial in obstetric theatre Methods Data was collected from consecutive cases during 2014 until 2018 using clinical records. Multivariate regression analysis was used comparing groups per first delivery attempt. Main Outcome Measures Primary outcome was completion of vaginal delivery between all methods of instrumental delivery. Secondary outcome was a composite of immediate perinatal adverse outcomes for instrumental delivery modes and primary full dilatation Caesarean section. Results From 971 deliveries analysed: ventouse delivery was significantly less likely to achieve vaginal delivery compared to Keilland's forceps delivery (OR 0.42, 95%CI 0.22-0.79). Once confounding factors were adjusted for, adverse outcome rates were less frequent in the Keilland's forceps group compared with primary full dilatation Caesarean section (OR 0.37, 95% CI: 0.16-0.81), however the receiver operating characteristic curve produced from this model demonstrated low predictive value (AUC 0.64). Conclusions Attempting instrumental delivery in delivery suite theatre, as an alternative to primary emergency full dilatation Caesarean section, is both reasonable and safe. Ventouse delivery in this situation may be associated with a higher chance of failure than other modes of instrumental delivery, thus making appropriate choice of delivery method of paramount importance according to each clinical situation. Funding None Keywords Caesarean section, Keilland's forceps, ventouse, trial of instrumental delivery

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Running title: Perinatal outcomes for second stage delivery

Abstract

Objective

To compare rates of vaginal delivery and adverse outcomes of instrumental delivery trials in obstetric theatre compared to primary emergency full dilatation Caesarean section

Design

Retrospective cohort study

Setting

University teaching hospital

Population

Women with singleton, non-anomalous, pregnancy undergoing instrumental delivery trial in obstetric theatre

Methods

Data was collected from consecutive cases during 2014 until 2018 using clinical records. Multivariate regression analysis was used comparing groups per first delivery attempt.

Main Outcome Measures

Primary outcome was completion of vaginal delivery between all methods of instrumental delivery. Secondary outcome was a composite of immediate perinatal adverse outcomes for instrumental delivery modes and primary full dilatation Caesarean section.

Results

From 971 deliveries analysed: ventouse delivery was significantly less likely to achieve vaginal delivery compared to Keilland's forceps delivery (OR 0.42, 95%CI 0.22-0.79). Once confounding factors were adjusted for, adverse outcome rates were less frequent in the Keilland's forceps group compared with primary full dilatation Caesarean section (OR 0.37, 95% CI: 0.16-0.81), however the receiver operating characteristic curve produced from this model demonstrated low predictive value (AUC 0.64).

Conclusions

Attempting instrumental delivery in delivery suite theatre, as an alternative to primary emergency full dilatation Caesarean section, is both reasonable and safe. Ventouse delivery in this situation may be associated with a higher chance of failure than other modes of instrumental delivery, thus making appropriate choice of delivery method of paramount importance according to each clinical situation.

Funding

None

Keywords

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Tweetable abstract

Instrumental delivery trials in theatre are safe but use of ventouse associated with higher rate of failure.

Introduction

Rates of Caesarean section are increasing progressively; a trend observed in both developed and developing countries [1]. As well as exposing women and babies to immediate surgical risks, a Caesarean section will characterise any subsequent pregnancy as higher risk: conveying on the mother novel pregnancy risks including complications such as placenta accreta or uterine scar rupture, and leading to a need for increased resources to manage such pregnancies[2]. Several health authorities including the World Health Organisation and medical colleges have prioritised efforts to reduce the rate of unnecessary Caesarean section and resulting harm to mothers [3, 4].

The use of instruments to aid vaginal delivery in the second stage of labour is common practice in many countries. Reasons for this include: a failure for birth to occur promptly, concern regarding fetal distress, maternal request for assistance or a need to shorten the second stage due to maternal illness [5]. A patient will be transferred from delivery suite room to obstetric theatre for a 'trial of instrumental delivery' if a more challenging delivery is anticipated, common reasons for transfer including fetal malposition, maternal obesity, or to optimise maternal analgesia [6]. Clinicians must choose the most appropriate method of delivery from the options of: Keilland's rotational forceps delivery (KFD), direct forceps delivery (DFD), initial rotation of a baby manually followed by non-rotational forceps delivery (MR+FD) or ventouse delivery (VD). If instrumental delivery is not deemed suitable or is unsuccessful, then recourse to delivery by primary emergency full dilatation Caesarean (pEmCS) section is required [7].

Internationally, rates of instrumental deliveries are declining due to concerns regarding associated complications such as neonatal injury or maternal perineal trauma, a decrease that becomes self-perpetuating as clinicians become less familiar and confident to perform such deliveries[8]. As a corollary, primary full dilatation Caesarean sections are increasing [9]; however, such deliveries are associated with high rates of maternal and neonatal morbidity[10] , and can increase the risk of preterm birth in a subsequent pregnancy [11].

Observational studies comparing outcomes of instrumental delivery in obstetric theatre have demonstrated that Keilland's forceps delivery may be associated with an increased chance of successful vaginal delivery compared to other forms of instrumentation without a significant increase in exposure to maternal or neonatal risks[12-14]. However, data is limited comparing immediate perinatal adverse outcomes from all four instrumental delivery types and many studies do not include primary emergency Caesarean section as a control group.

This study aimed to address this deficit by examining all obstetric theatre trials of second stage delivery over a 5-year period, in a university teaching hospital where all methods of instrumental delivery are routinely practised. The primary objective was to examine completion rates of vaginal delivery between all four forms of instrumental delivery (KFD, DFD, MR+FD, VD), taking possible confounding factors into account. The secondary objective was to compare immediate perinatal adverse outcomes between instrumental delivery groups and the pEmCS group.

Methods

Design

We conducted a retrospective cohort study examining all trials of operative vaginal delivery performed in Obstetric theatre at the James Cook University NHS Hospital over five years (2014-2018). The hospital is a consultant-led UK NHS maternity unit with between approximately 4500-5000 deliveries per year and level three neonatal intensive care facilities. Within the delivery unit there is consultant presence on labour ward from 0830-2200 every day with a senior registrar (doctor with minimum 5 years postgraduate obstetric training) present overnight. For all second stage of labour deliveries performed in obstetric theatre the unit policy recommends consultant attendance to supervise the delivery. Our study was granted ethical approval provided by the local learning and research institute as part of an ongoing service evaluation.

Inclusion / exclusion criteria

All patients included had a singleton, non-anomalous fetus in cephalic presentation and had been moved to obstetric theatre in the second stage of labour with the intention of performing a trial of operative vaginal delivery or a primary emergency full dilatation Caesarean section. Patient's with multiple pregnancy, fetal anomaly or where the case notes were unavailable for analysis were excluded (20 cases).

Data Collection

Consecutive patient case notes were reviewed prospectively as part of an ongoing service evaluation over a defined time period and therefore a power calculation was not performed prior to analysis. Data was organised into five groups according to the initial attempt at delivery once the patient had been moved to obstetric theatre: (1) Keilland's Forceps Delivery (KFD), (2) Direct Forceps Delivery (DFD), (3) Manual Rotation plus direct Forceps Delivery (MR + FD), (4) Ventouse Delivery (VD) and (5) Primary emergency full-dilatation Caesarean Section (pEmCS). Regardless of the final mode of delivery, all subsequent outcome data was analysed within these groups as per an 'intention to deliver' analysis.

Demographic data variables collected can be observed in Table 1 and in-labour and delivery variables in Supplementary Table 1. In cases where instrumental delivery was attempted (Groups 1-4) data was collected as to whether a successful vaginal delivery was achieved.

The immediate perinatal adverse outcome data collected were agreed via author consensus. These can be viewed in Table 2 and were grouped into maternal and neonatal outcomes. Maternal injury at instrumental was pre-defined as a cervical or significant vaginal laceration other than 3rd or 4th degree tear. Maternal injury at Caesarean section was pre-defined as a significant uterine or pelvic extension of excision, or an abdominal visceral injury. An overall composite risk score was produced from the maternal plus neonatal outcome data.

Outcomes

Primary outcome was successful vaginal delivery for all instrumental delivery groups (1-4). A secondary outcome of overall composite risk score was used for all delivery groups (1-5).

Statistical analysis

For each variable (demographic, in-labour and delivery) differences across delivery groups (1-5) were compared using either ANOVA or Kruskal-Wallace ANOVA for normal or non-normally distributed data respectively. 95% confidence intervals and odds ratios were calculated using univariate logistic regression analysis to examine 1) the association between instrumental delivery mode (groups 1-4) and spontaneous vaginal delivery, and 2) the relationship between all delivery modes (groups 1-5) and overall composite risk outcome.

To adjust for baseline risk, a stepwise, multivariate regression analysis was performed. Indices were included based on clinical plausibility and/ or a significant association with the following dependent variables in univariate analysis: successful vaginal delivery, maternal composite risk outcome, neonatal composite risk outcome and overall composite risk outcome. These were inputted alongside delivery mode to produce two final multivariate binomial regression models: one with a dependent variable of successful vaginal delivery (delivery groups 1-4) and another with a dependent variable of overall composite risk outcome (delivery groups 1-5). Receiver operating characteristic curve analysis was performed on these final models with an area under the curve (AUC) of 0.80 considered to represent reasonable prediction. All data was collected into Microsoft Excel and analysis performed using IBM SPSS statistical software Version 26.

Results

Figure 1 displays the breakdown of delivery types occurring at the hospital over the study period (2014-2018). Of 24,756 deliveries 66.5% were spontaneous vaginal deliveries, 22.48% were Caesarean deliveries and 10.6% were instrumental deliveries. From the 2631 instrumental deliveries performed over the study period, 991 (37.6%) were performed in obstetric theatre as a trial of instrumental delivery. Excluding unavailable or twin pregnancy data (20 datasets), remaining cases were organised into 5 groups according to the initial

delivery attempt from which 285 (29.3%) were KFD, 300 (30.8%) were DFD, 163 (16.7%) were MR+FD, 116 (11.9%) were VD, and 107 (11%) were pEmCS.

Across groups 1 to 5, the data collected for demographic variables is displayed in Table 1. Differences between groups were observed for both body mass index (BMI) and weight, with the pEmCS group having a significantly higher mean average weight. As height did not vary significantly between groups, this led to a weight-dependent difference in BMI between groups. This factor was accounted for with the inclusion of BMI as a final variable in the multivariate models described below.

The data representing all in-labour and delivery variables can be observed in Supplementary Table 1. There were a greater proportion of multiparous women in both the KFD and DFD groups compared with pEmCS; the deliverer was more often a doctor of greater experience undertaking the Keilland's deliveries compared with other groups and pEmCS were significantly more likely than other groups to be performed for fetal distress and to be performed under general anaesthetic. The direct forceps delivery group had a greater proportion of occipito-anterior position and low cavity (fetal station 2+ and below) deliveries than other groups. Use of 2 instruments was greater in the ventouse delivery group compared with other instrumental delivery groups.

The primary outcome of vaginal delivery was investigated initially via univariate regression analysis, with the instrumental delivery groups (1-4) compared, using group 1 (KFD) as the reference (Figure 2A). Attempt at manual rotation and direct forceps was associated with the greatest percentage of completed vaginal delivery (92%), with direct forceps (89.7%) and Keilland's (83.2%) second and third respectively. Attempt at ventouse delivery displayed the lowest percentage completion rate for vaginal delivery at 75%, consistent with ventouse delivery completion rates seen in existing literature [15]. When compared with the reference group of Keilland's forceps, raw odds ratios suggested that use of direct forceps delivery (OR 1.75, 95%CI: 1.08 – 2.05) and manual rotation plus forceps delivery (OR 2.33, 95%CI: 1.22-4.45) might increase chances of vaginal delivery; with ventouse delivery less likely to achieve vaginal delivery (OR 0.60, 95%CI: 0.36-1.02). A stepwise, multivariate regression analysis was performed to further investigate this trend and adjust for baseline confounding and risk factors. The final model adjusted for maternal BMI, birth weight, parity, analgesia, experience of deliverer, fetal position and fetal station. Ventouse delivery was significantly less likely to succeed at vaginal delivery when compared to KFD in this adjusted model (OR 0.426, 95%CI 0.227-0.797). To assess the robustness of predictive value for this model a receiver operator characteristic curve was produced (Supplementary Figure 1A) which demonstrated an area under the curve of 0.768.

The data demonstrating immediate perinatal adverse outcomes are presented in Table 2. There were two neonatal deaths in the cohort, one in the Keilland's group and one in the ventouse group, there were no significant neonatal injuries noted in any groups. Of note, instrumental deliveries other than Keilland's forceps were associated with higher rates of 3rd and 4th degree tears, with the highest proportion in the ventouse group at 10.3%. Primary emergency full dilatation Caesarean was associated with the highest proportion of maternal injuries during Caesarean (8.4%) and a greater frequency of babies with Apgar score of <7 at 5 minutes (9.3%), the latter possibly associated with a much higher proportion of these deliveries being performed under general anaesthetic (22.4%) than was observed in the other delivery groups (Supplementary Table 1).

The secondary outcome of overall composite risk score was investigated via univariate regression analysis, with the all delivery groups (1-5) compared, using group 5 (pEmCS) as the reference group, the results of which are displayed in Figure 2B. An outcome associated with immediate risk occurred in 22.8% of all deliveries in the cohort, indicating the high-risk nature of such full dilatation delivery trials. Keilland's forceps deliveries were associated with the lowest proportion of composite risk outcome occurrence (17.5%), and ventouse deliveries the highest (29.3%). When compared with the reference group of pEmCS, there were no significant associations between mode of delivery and composite risk outcome. This analysis was further modified using multivariate logistic regression to adjust for baseline risk factors. The final variables included in this model were: maternal BMI, birth weight, analgesia, experience of trial decision maker, indication for trial, experience of deliverer, fetal position and fetal station. The adjusted model demonstrated significant

differences (P=0.016) for composite risk outcome occurrence between the pEmCS and KFD delivery groups (OR 0.37, 95% CI: 0.16-0.81), however the receiver operating characteristic curve produced from this model demonstrated low predictive value with an area under the curve of 0.64 (Supplementary Figure 1B).

Discussion

Main findings

The key findings from the study are that ventouse delivery performed poorly in comparison to other instrumental delivery modes in achieving vaginal delivery in obstetric theatre trials once baseline factors, including fetal position and station, are taken into account. Additionally, Keilland's delivery had a lower chance of composite risk outcome when compared with primary emergency Caesarean delivery in a multivariate model adjusted for factors that can influence the outcome of delivery. The predictive value of the model performed poorly and therefore the authors do not conclude that Keilland's forceps presents reduced risk to women and their babies when compared to primary full dilatation Caesarean; however, the data does suggest that attempting Keilland's forceps delivery in this situation is reasonable, and is not associated with greater immediate perinatal risk than full dilatation Caesarean.

Strengths and weaknesses

All data in this study had been collected prospectively from consecutive cases by one observer as part of an in-unit ongoing safety analysis. This approach allowed a large number of in-labour and delivery variables to be collected, including position and station of the fetal head and experience level of the final deliverer, factors that can bear a considerable influence on the outcome of a delivery and which need to be accounted for in any analysis of delivery types. Deliveries were also analysed in an 'intention to deliver' fashion, reflecting the fact that an operator makes a judgement on which delivery mode to embark on without knowing if this will lead to success or failure, therefore the risks the patient is exposed to are not only those of the original delivery attempt, but also any subsequent or final mode of delivery. A further strength of the study was the use of specific groupings to allow for all methods of instrumental delivery to be compared with a control group of primary emergency full dilatation Caesarean.

This study was limited by data collection from only one delivery unit where there is a high degree of experience amongst consultant staff in the use of Keilland's forceps, it was notable that a greater proportion of Keilland's forceps were performed by consultant staff (Supplementary Figure 1). Although this suggests that such deliveries are safe in experienced hands, the findings of this study will be less generalisable to units where this experience with Keilland's forceps is not present, or where there is a predominance of alternative instrumental delivery types such as ventouse. The study was designed to look at the frequency of immediate outcomes that may present serious risk to mothers and babies, and due to the relative scarcity of such outcomes a composite score was designated. This carries limitations in two ways: firstly, such outcomes do not capture the longer-term picture, and any further research should endeavour to collect data on long term outcomes for both mothers and babies. Secondly, although producing a composite score of outcomes is pragmatically necessary when such outcomes are scarce, such an approach can be problematic as it assumes that all parts of the composite are of equal value to patients and clinicians which is not likely to be the case when comparing a neonatal death with, for example, an isolated low Apgar score, or a need for transfusion in an otherwise well woman. This underlines the urgent need for the development of core outcome sets in Obstetrics [16], with consideration of standardised outcome 'weighting' towards outcomes that are more significant to patient's real-life considerations when using a composite score [17].

Interpretation

A systematic review comparing forceps with ventouse delivery demonstrated that forceps were less likely to fail than ventouse (OR 0.65, 95%CI 0.45-0.94), but forceps carried an increased risk of maternal perineal trauma and there was a risk of neonatal injury with the use of both instruments (facial injury for forceps, and cephalohaematoma for ventouse) [18]. This review did not differentiate between rotational or direct forceps,

and data was insufficient to control for key confounding factors such as differences in fetal position or station. Additionally, no trials currently exist comparing primary emergency full dilatation Caesarean section with instrumental delivery [19].

The method of delivery and choice of instrument is a complex decision which represents a key dilemma for any obstetrician[20]. There is a multiplicity of factors to consider including the exact position and station of the fetal head, the adequacy of the female pelvis, the technique and experience of the operator and the wishes of the mother [21]; and the operator must ensure the highest likelihood of successful delivery that will minimise risk for both mother and fetus [6].

We aimed to investigate factors predisposing to successful or safe delivery for delivery suite trials using regression analysis. Due to a broad selection of confounding variables, we were unable to produce a highly predictive model. Despite this, there were trends that can be highlighted from the data: in the presence of experienced operators both Keilland's forceps and manual rotation plus direct forceps deliveries were associated with a high rate of completion with no increase in maternal or neonatal exposure to adverse perinatal outcome. Direct forceps without rotation also had a high rate of completed delivery, however this group had a very high proportion (74%) of babies in occipito-anterior position and examination of the use of direct forceps in babies with an occipito-posterior position demonstrated much lower rates of completion and high rates of adverse outcome, particularly maternal 3rd degree tear. Ventouse deliveries were associated with the lowest completion rates (75%) and the highest rates of composite risk outcome (29%), including high rates of 3rd degree tear and high rates of neonatal admission to NNU. These rates are higher than those published in systematic review[19] , perhaps due to the 'intention to deliver' analysis used in this study. It is notable from our data that 44% of ventouse cases required the use of second instrument (usually direct forceps) and therefore, in some cases, a woman undergoing attempted ventouse delivery will have been exposed to a risk of the original ventouse delivery, a risk of sequential instrument use and a further risk of full dilatation Caesarean section.

Success or failure of any delivery attempt cannot be known a priori, and therefore it is important for more studies to help guide clinicians in clarifying the likelihood of successful delivery from the different methods available, whilst minimising maternal and neonatal risks[22]. This is particularly important for delivery trials performed in obstetric theatre as this is a situation that has already been categorised by an operative decision maker as a potentially more challenging delivery.

Conclusion:

This study adds to existing literature by investigating all types of delivery mode available to an operator for full dilatation deliveries in obstetric theatre and providing a comparison, adjusted for confounding factors, of both the likelihood of success and the immediate risk of such 'trials' to both mothers and babies. The data presented further supports the notion that attempting instrumental delivery in delivery suite theatre, as an alternative to primary emergency Caesarean section, is both reasonable and safe. In this study, ventouse delivery was less likely to achieve vaginal delivery than other methods of instrumental, potentially exposing patients in some cases to the risks of more than one form of delivery. There remains an urgent need for further research to examine in detail the factors associated with likely completion of instrumental delivery to allow obstetricians and women to make careful informed decisions regarding a safe and successful delivery trial.

Disclosure of interests

None to declare

Contribution to authorship

LG designed the study, organised and analysed data and wrote the final article. BW and CE assisted study design and data analysis and reviewed and edited the article. AS assisted data organisation and edited the

article. HS prospectively collected all data and reviewed and edited the article. All authors approve the final version.

Details of ethics approval

Approval was granted to collect, analyse and publish the data as part of a service evalution project by the Research & Development / Academic Division at South Tees Institute of Learning, Research and Innovation in the James Cook University Hospital.

References

1. Spencer C, Murphy D, Bewley S. Caesarean delivery in the second stage of labour. BMJ (Clinical research ed). 2006;333(7569):613-4.

2. Souza JP, Gulmezoglu A, Lumbiganon P, Laopaiboon M, Carroli G, Fawole B, et al. Caesarean section without medical indications is associated with an increased risk of adverse short-term maternal outcomes: the 2004-2008 WHO Global Survey on Maternal and Perinatal Health. BMC Med. 2010 Nov 10;8:71.

3. Hutchinson AM, Nagle C, Kent B, Bick D, Lindberg R. Organisational interventions designed to reduce Caesarean section rates: a systematic review protocol. BMJ Open. 2018;8(7):e021120.

4. American College of O, Gynecologists, Society for Maternal-Fetal M, Caughey AB, Cahill AG, Guise JM, et al. Safe prevention of the primary cesarean delivery. Am J Obstet Gynecol. 2014 Mar;210(3):179-93.

5. RCOG. Operative Vaginal Delivery. Royal College of Obstetricians and Gynaecologists. 2011.

6. Edozien LC. Towards safe practice in instrumental vaginal delivery. Best Practice & Research Clinical Obstetrics & Gynaecology. 2007 2007/08/01/;21(4):639-55.

7. O'Mahony F, Hofmeyr GJ, Menon V. Choice of instruments for assisted vaginal delivery. Cochrane Database Syst Rev. 2010 Nov 10(11):CD005455.

8. Ecker JL, Frigoletto FD, Jr. Cesarean delivery and the risk-benefit calculus. N Engl J Med. 2007 Mar 1;356(9):885-8.

9. Loudon JA, Groom KM, Hinkson L, Harrington D, Paterson-Brown S. Changing trends in operative delivery performed at full dilatation over a 10-year period. J Obstet Gynaecol. 2010 May;30(4):370-5.

10. Vousden N, Cargill Z, Briley A, Tydeman G, Shennan AH. Caesarean section at full dilatation: incidence, impact and current management. 2014;16(3):199-205.

11. Wood SL, Tang S, Crawford S. Cesarean delivery in the second stage of labor and the risk of subsequent premature birth. Am J Obstet Gynecol. 2017 Jul;217(1):63 e1- e10.

12. Bahl R, Van de Venne M, Macleod M, Strachan B, Murphy DJ. Maternal and neonatal morbidity in relation to the instrument used for mid-cavity rotational operative vaginal delivery: a prospective cohort study. BJOG : an international journal of obstetrics and gynaecology. 2013 Nov;120(12):1526-32.

13. Stock SJ, Josephs K, Farquharson S, Love C, Cooper SE, Kissack C, et al. Maternal and neonatal outcomes of successful Kielland's rotational forceps delivery. Obstet Gynecol. 2013 May;121(5):1032-9.

14. Tempest N, Hart A, Walkinshaw S, Hapangama DK. A re-evaluation of the role of rotational forceps: retrospective comparison of maternal and perinatal outcomes following different methods of birth for mal-position in the second stage of labour. BJOG : an international journal of obstetrics and gynaecology. 2013 Sep;120(10):1277-84.

15. Groom KM, Jones BA, Miller N, Paterson-Brown S. A prospective randomised controlled trial of the Kiwi Omnicup versus conventional ventouse cups for vacuum-assisted vaginal delivery. BJOG : an international journal of obstetrics and gynaecology. 2006 Feb;113(2):183-9.

16. Duffy J, Rolph R, Gale C, Hirsch M, Khan K, Ziebland S, et al. Core outcome sets in women's and newborn health: a systematic review. 2017;124(10):1481-9.

17. Duc AN, Wolbers M. Weighted analysis of composite endpoints with simultaneous inference for flexible weight constraints. Stat Med. 2017;36(3):442-54.

18. O'Mahony F, Hofmeyr GJ, Menon V. Choice of instruments for assisted vaginal delivery. Cochrane Database of Systematic Reviews. 2010(11).

19. Majoko F, Gardener G. Trial of instrumental delivery in theatre versus immediate Caesarean section for anticipated difficult assisted births. The Cochrane database of systematic reviews. 2012;10:CD005545-CD.

20. Gurney L SN, Ononeze BO. Rising rate of second stage C-section: who is to blame? A questionnaire based study of trainees in the North East of England. Arch Dis Child Fetal Neonatal Ed. 2010;95:84-5.

21. Sinha P, Dutta A, Langford K. Instrumental delivery: how to meet the need for improvements in training. 2010;12(4):265-71.

22. Palatnik A, Grobman WA, Hellendag MG, Janetos TM, Gossett DR, Miller ES. Predictors of Failed Operative Vaginal Delivery in a Contemporary Obstetric Cohort. Obstet Gynecol. 2016 Mar;127(3):501-6.

Figure and Table Legends

Figure 1 – Flow diagram demonstrating mode of delivery for woman within the cohort.

Table 1 – Demographic characteristics of cohort. Data presented as mean average, standard deviation and range. *Data presented as median and interquartile range (IQR).

Figure 2

A Completion of vaginal delivery for different instrumental delivery methods. Data are present as raw and adjusted odds ratio with Keilland's forceps delivery as referent group. * Adjusted for maternal BMI, birth weight, parity, analgesia, experience of deliverer, fetal position and fetal station.

B Immediate perinatal adverse outcome following all delivery modes. Data are present as raw and adjusted odds ratio with pEmCS delivery as referent group. ** Adjusted for maternal BMI, birth weight, analgesia, experience of trial decision maker, indication for trial, experience of deliverer, fetal position and fetal station.

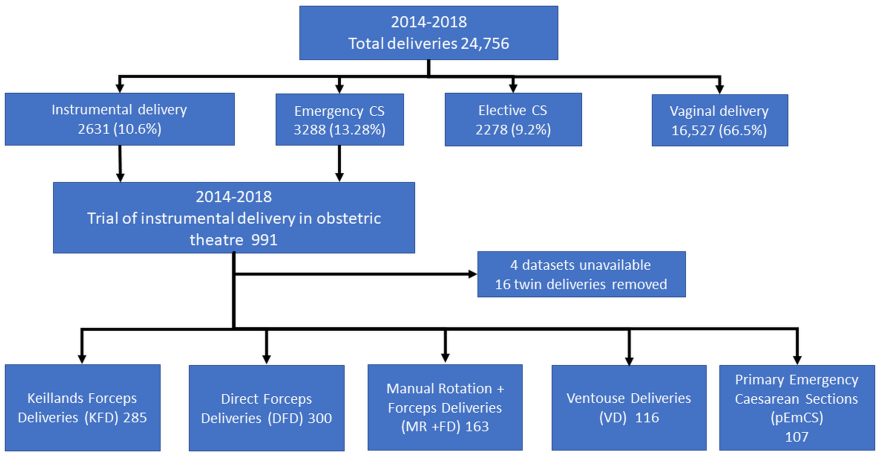
Table 2 Immediate perinatal adverse outcomes following all delivery modes

Supplementary Table 1 – Data representing all in-labour and delivery variables

Supplementary Figure 1 – Receiver-operator characteristic curves generated from multivariate regression analysis models

A Relationship between delivery mode and completed vaginal delivery - adjusted for maternal BMI, birth weight, parity, analgesia, experience of deliverer, fetal position and fetal station. AUC. 0.768 (Std Error 0.025)

B Relationship between delivery mode and overall composite risk score - adjusted for maternal BMI, birth weight, analgesia, experience of trial decision maker, indication for trial, experience of deliverer, fetal position and fetal station. AUC 0.642 (Std Error 0.024)



A

Delivery type	SVD(%)	Non-SVD (%)	OR	95% CI	P-value	aOR*	95% CI	P-value
KFD	237 (83.2%)	48 (16.8%)	Referent	Referent	Referent	Referent	Referent	Referent
FD	269 (89.7%)	31 (10.3%)	1.757	1.083 - 2.852	0.022	0.836	0.404-1.731	0.630
MR+FD	150 (92%)	13 (8%)	2.337	1.225 - 4.459	0.010	1.957	0.930-4.119	0.077
VD	87 (75%)	29 (25%)	0.608	0.360 - 1.024	0.062	0.426	0.227-0.797	0.008

B

Delivery type	Adverse outcome(%)	No adverse outcome(%)	OR	95% CI	P-value	aOR**	95% CI	P-value
KFD	50 (17.5%)	235 (82.5%)	0.736	0.426 - 1.272	0.272	0.373	0.167 - 0.831	0.016
FD	68 (22.7%)	232 (77.3%)	1.014	0.597 - 1.720	0.960	0.807	0.339 - 1.920	0.628
MR+FD	36 (22.1%)	127 (77.9%)	0.980	0.546 - 1.761	0.947	0.513	0.219 - 1.202	0.124
VD	34 (29.3%)	82 (70.7%)	1.434	0.783 - 2.626	0.243	1.059	0.457 - 2.453	0.894
pEmCS	24 (22.4%)	83 (77.6%)	Referent	Referent	Referent	Referent	Referent	Referent

	Delivery Mode																				
	KFD				NBFD				Rotation + NBFD				Ventouse				Primary CS				
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	P
Age	28.3	5.5	16.0	43.0	28.9	5.6	16.0	44.0	28.3	4.9	16.0	41.0	27.8	5.4	16.0	39.0	29.3	6.2	17.0	47.0	0.185
BMI *	25		22	29	25		22	29	25		22	29	24		22	27	27		23	31	0.035
Height (m)	1.64	.06	1.44	1.83	1.64	.07	1.47	1.83	1.64	.06	1.50	1.76	1.64	.06	1.45	1.75	1.65	.07	1.45	1.80	0.908
Weight (kg) *	68.0		59.9	78.5	66.0		58.0	76.0	67.7		59.0	78.5	65.0		57.0	77.2	70.4		63.0	83.5	0.013
Completed Gestation (weeks) *	40		39	41	40		40		40		39	40	40		39	41	40		39	41	0.336
Birth Weight	3539	470	2310	4830	3527	485	1740	5090	3508	488	2070	4710	3459	563	2125	4875	3547	527	2050	4755	0.708

Outcome		Delivery mode				
		KFD	FD	MR+FD	VD	Primary CS
		Count (%)	*Count (%)*	*Count (%)*	*Count (%)*	*Count (%)*
Maternal outcomes	Blood_loss >1500mls	13 (4.6%)	5 (1.7%)	1 (0.6%)	5 (4.3%)	6 (5.6%)
	Transfusion	6 (2.1%)	12 (4.0%)	1 (0.6%)	1 (0.9%)	2 (1.9%)
	Third / Fourth degree tear	15 (5.3%)	24 (8.0%)	19 (11.7%)	12 (10.3%)	0 (0.0%)
	Maternal injury Instrument	4 (1.4%)	9 (3.0%)	2 (1.2%)	2 (1.7%)	0 (0.0%)
	Maternal injury at CS	5 (1.8%)	3 (1.0%)	0 (0.0%)	4 (3.4%)	9 (8.4%)
Neonatal outcomes	Unexpected admission NNU	8 (2.8%)	14 (4.7%)	3 (1.8%)	11 (9.6%)	3 (2.8%)
	Arterial cord pH <7	4 (1.4%)	1 (0.3%)	3 (1.8%)	4 (3.4%)	3 (2.8%)
	5 minute Apgar <7	13 (4.6%)	13 (4.3%)	3 (1.8%)	3 (2.6%)	10 (9.3%)
	Shoulder Dystocia	10 (3.5%)	10 (3.3%)	7 (4.3%)	4 (3.4%)	0 (0.0%)
	Neonatal injury / death	1 (0.4%)	0 (0.0%)	0 (0.0%)	1 (0.9%)	0 (0.0%)