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Can formal education and training improve the outcome of instrumental delivery?

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Abstract

Objective(s): The primary objective was to examine the effect of formal education and training on instrumental delivery with respect to its success rate and associated neonatal and maternal morbidity. The secondary objective was to determine factors that could influence the success rate of instrumental delivery. *Study design*: Prospective case-control study with historical controls set in a teaching hospital in Sheffield. The prospective group included all women who had instrumental deliveries between 1 November 1999 and 29 February 2000. The control group included all women who delivered between 1 February 1997 and 1 February 1998. An educational package involving formal postgraduate training and self-directed learning were introduced in the time period between the prospective and the control groups. Medical notes were reviewed in the historical controls. For both the control and prospective groups, the following patient characteristics were recorded: maternal age, parity, whether or not onset of labour was induced, use of oxytocin in the second stage of labour, delay in the second stage, operator grade, vaginal findings at delivery and the use of epidural analgesia. *Results*: The overall failure rate was not different in the prospective group (16%) compared with the control group (18.5%). However, the introduction of an educational package was associated with significant decrease in maternal morbidity associated with cervical, severe labial and high vaginal tears (Odds Ratio (OR) 0.29, CI 0.09–0.97) and neonatal morbidity associated with admission to SCBU (OR 0.72, CI 0.02–0.60), severe neonatal scalp injury (OR 0.14, CI 0.02–0.98) and facial injuries (OR 0.02, CI 0.01–0.04). The factors identified to affect the success of instrumental deliveries were: OP and OT positions of the baby at delivery (OR 0.28, CI 0.17–0.44) and inexperienced operators (OR 0.11, CI 0.02–0.58). *Conclusion*: In this study, formal education and training of medical staff did not influence the success rate of instrumental delivery but was associated with improved safety for both mother and baby.

Keywords: Instrumental delivery; Vacuum; Ventouse; Forceps; Neonatal morbidity; Maternal morbidity; Education

1. Introduction

Many obstetricians now consider the vacuum extractor or ventouse as "the instrument of first choice" for assisted vaginal delivery [1,2]. In randomised controlled trials (RCT), the vacuum extractor has been shown to be associated with less use of regional/general anaesthesia and less maternal trauma compared with forceps [3]. However, vacuum extraction has a higher failure rate and is associated with more neonatal cephalohaematomas and retinal haemorrhages compared with forceps [3]. A follow-up study showed no differences in maternal and neonatal morbidity at 5 years [4].

RCTs have been widely accepted as the best evidence on which to practice. However, it might be difficult to reproduce the outcome reported by RCTs in clinical practice, where conditions might not be so controlled. With respect to instrumental delivery, complications have been mainly associated with incorrect technique used, as well as the inappropriate selection of instruments or the application of two instruments sequentially [5,6]. It has been suggested that adequate training might minimise the incidence of these complications [6]. Ideally training should be under the direct supervision of an experienced operator. Educational sessions using models, and computer-generated video materials can potentially supplement clinical experience. However, the benefit of such approach has not been tested.

The primary objective of this study was to examine the effect of formal education and training on the success rate of instrumental delivery and neonatal and maternal morbidity. The secondary objective was to determine factors that could influence the success of instrumental delivery and may be incorporated into a training programme.

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2. Materials and methods

This was a prospective cohort study with historical controls. The study was conducted in Jessop hospital for women, Sheffield, a teaching unit with 3500 deliveries each year. It was hypothesised that formal education and training of the junior staff could improve the outcome of instrumental delivery for both mother and fetus and increase the success rate of instrumental delivery. An educational programme and new guidelines on vaginal instrumental delivery were introduced. The educational programme included; postgraduate training sessions by senior medical staff using video material [7] and the doll and pelvis model. The trainees were also given a computer disk (compact disk) and its accompanying booklet for self-directed learning [8]. This educational programme was considered to cover all the practical and theoretical information required to conduct a safe forceps delivery and vacuum extraction. Techniques to reduce maternal and neonatal complications and failed instrumental delivery were of paramount importance and were discussed regularly during the teaching sessions and open forums. Training on the choice of instrument, correct placement of forceps, and both Silc and metal vaccum cups, especially for occipito-posterior position (OP) and occipito-transverse position (OT) were demonstrated using the doll and pelvis model. The postgraduate training sessions were administered on three separate occasions to ensure all junior medical staff had more than one opportunity to attend and discuss the self-learnt material provided to them earlier on in the programme. Year 1 senior house officers (SHOs) were only permitted to perform instrumental deliveries under direct supervision by a senior member of staff. Rotational forceps deliveries were only performed by a consultant or under direct supervision of a consultant. Revised written guidelines were introduced into the labour ward handbook to provide more detailed guidance on assisted delivery. The instruments available for use were Neville Barnes non-rotational forceps, Kiellands rotational forceps, Bird anterior and posterior metal cups and the Silc (soft) cup.

The prospective group consisted of all the women who had instrumental vaginal deliveries after the introduction of the education programme for a period of 4 months (1 November–29 February 2000 inclusive). A historical control group was selected by including all the women who had instrumental vaginal delivery in the period from 1 February 1997 to 31 January 1998. By doing so, we eliminated any possible bias in the selection of the control group.

All the women in both the prospective and control groups had singleton pregnancies at term (37–42 weeks gestation) with a cephalic presentation. Both the prospective and the control groups were stratified according to the instrument selected to assist the delivery, which was subject to operator preference. If two instruments were used in sequence, the woman was allocated to the first instrument chosen. This created two subgroups of study patients with their respective controls.

The following clinical characteristics of the prospective and control groups were recorded on a designed *pro forma*: maternal age, parity, whether or not onset of labour was induced, use of oxytocin in the second stage of labour, delay in the second stage, operator grade, vaginal findings at delivery and the use of epidural analgesia. A second stage duration longer than 2 h from the time of diagnosing full dilatation was considered prolonged and assessment was carried out to decide on the mode of delivery. Recorded vaginal findings prior to delivery included the presence or absence and the degree of the following:

(1) occipito-posterior (OP) or occipito-transverse (OT),
(2) caput,
(3) the station of the fetal head,
(4) moulding.

Moulding was defined as 0, 1, 2 or 3 according to Philpott [9]. Caput was classified as mild, moderate or severe according to the assessment of the operator. The following details of maternal morbidity were noted: cervical or high vaginal tears, laceration and anal sphincter tears. The following neonatal complications that could be related to instrumental delivery were documented: cephalohaematoma, bruising requiring phototherapy, admission to the special care baby unit (SCBU), nerve palsies and death.

The second objective of our study was to determine factors that may contribute to the success of an instrumental delivery [10]. For this purpose, both the prospective and control groups were combined together and a correlation analysis was carried out between the success rate of instrumental delivery and the variables may influence this mode of delivery. The variables studied were parity, whether or not labour was induced, use of oxytocin in the second stage of labour, delay in second stage of labour, use of the epidural analgesia, vaginal findings at the time of delivery, instrument used and seniority of operator.

2.1. Statistical analysis

Statistical Package for Social Sciences (SPSS), Version 10, Sheffield, United Kingdom was used for statistical analysis. Data was analysed using student *t*-test and binary logistic regression for nominal and categorical data, respectively. $P < 0.05$ was considered statistically significant. The data were presented as means and odds ratio (OR) with their corresponding 95% confidence interval of the odds ratio.

3. Results

3.1. Clinical characteristics

The average age of the control and prospective control groups were 28 years (S.D. 5.6) and 30 years (S.D. 5.4), respectively. The clinical characteristics of the control and prospective groups are compared in Table 1. There was no

Table 1
The characteristics of the prospective and control groups

	Total	n (%)		OR	95% CI	
		Control ($n = 389$)	Prospective ($n = 155$)		Lower	Upper
Primigravida	405	297 (75)	108 (69)	0.93	0.53	1.06
Induction of labour	196	131 (33)	65 (42)	1.27	0.44	1.08
Use of oxytocin in the second stage of labour	404	288 (72)	116 (75)	1.04	0.92	2.19
SHO (year 1)	27	22 (6)	5 (3)	0.55	0.17	1.76
SHO (year >1)	160	134 (34)	26 (16)	0.49	0.21	1.10
SpR (year 1)	139	85 (21)	52 (34)	1.63	0.72	3.63
SpR (years 2–3)	117	95 (24)	22 (14)	0.60	0.26	1.38
SpR (year >3)/non-training grades	110	65 (16)	45 (29)	1.81	0.77	4.21
Use[a] of epidural	378	251 (63)	127 (82)	1.33	1.53	4.14
Delay in second stage of labour	323	239 (60)	84 (54)	0.90	0.59	1.35

[a] $P < 0.05$.

difference in the number of primigravida, inductions of labour, use of oxytocin in the second stage of labour, delay in the second stage of labour and operator grade comparing the two groups. Significantly, more women in the prospective group received epidural anaesthesia ($P < 0.05$).

3.2. Mode of delivery

During both the historical control period and the prospective study, the vaccum was selected as the instrument of first choice in two-thirds of assisted deliveries (Table 2). Between 1 February 1997 and 1 February 1998 (historical controls), the unit delivered 3563 women with an instrumental delivery rate of 11% and a caesarean section rate of 22%. During this time, there were 196 vacuum extractions (51% of all instrumental deliveries) and 185 forceps (49% of all instrumental deliveries). Between 1 November 1999 and 29 February 2000 (prospective study period), there were a total of 1082 deliveries with 216 (20%) caesarean sections and 154 (14%) instrumental deliveries. There were 78 vacuum extractions (51% of all instrumental deliveries) and 76 forceps (49% of all instrumental deliveries).

3.3. Impact of teaching on mode of delivery, maternal and neonatal morbidity

3.3.1. Failure rate of instrumental delivery (Table 2)

The overall failed instrumental delivery rate in the control group was 18.5% (72/389) and in the prospective group was 16% (25/155). This difference was not statistically significant. The incidence of failed forceps was 2% (3/125) in the control group and 0% in the prospective group. Failed vacuum delivery occurred in 69 (26%) of the control group and 25 (24%) of the prospective group. This difference was not significant. In both the prospective and the control group, most of the failed vacuum deliveries were successfully delivered by forceps.

3.3.2. Vaginal findings prior to delivery

Moderate to severe caput and moulding was recorded more often in the prospective group compared to the control group (Table 3). There was no difference in the number of OP/OT positions or high stations (>2).

3.3.3. Maternal morbidity

Maternal morbidity is shown in Table 4. There was no difference in the incidence of anal sphincter injury comparing the prospective group with the historical controls. In the prospective group, there were less cervical, severe labial and high vaginal tears compared to the control group.

3.3.4. Neonatal morbidity and mortality

Table 4 compares neonatal morbidity. There were significantly fewer admissions to SCBU in the prospective group compared to the control group ($P < 0.05$). There was also a reduction in the number of neonatal scalp injuries and facial injuries ($P < 0.05$). One baby in the control group died of sub-aponeurotic haemorrhage after a vacuum

Table 2
Comparison of intended mode of delivery with actual mode of delivery (n)

Intended mode of delivery	Control group		Prospective group	
	Forceps ($n = 125$)	Vacuum extraction ($n = 264$)	Forceps ($n = 52$)	Vacuum extraction ($n = 103$)
Number delivered by intended method	122	195	52	78
Delivery achieved by sequential use of two instruments	1	63	0	24
Caesarean section after failed instrumental delivery	2	6	0	1

Table 3
Vaginal findings in the study group versus the control group

	n (%)		OR	95% CI	
	Control (n = 389)	Prospective (n = 155)		Lower	Upper
Position (OP + OT)	103 (26)	49 (32)	1.23	0.77	1.86
Caput[a] (moderate to severe)	96 (24)	80 (52)	2.17	1.92	4.37
Station (<2)	177 (44)	59 (38)	0.86	0.48	1.10
Moulding[a] (>2)	27 (7)	48 (31)	4.42	3.03	8.86

OR: odds ratio, 95% CI: 95% confidence interval.
[a] $P < 0.01$.

Table 4
Morbidity in the control group versus the prospective group

	n (%)		OR	95% CI	
	Control (n = 389)	Prospective (n = 155)		Lower	Upper
(a) Maternal morbidity					
Anal sphincter involvement	4 (1)	5 (3)	3.00	0.94	16.91
Cervical[a], severe labial, high vaginal tear	55 (14)	6 (4)	0.29	0.08	0.96
(b) Neonatal morbidity					
Scalp[a] injury (cephalohaematoma/severe bruising)	111 (28)	6 (4)	0.14	0.02	0.98
Phototherapy	29 (7)	6 (4)	1.65	0.01	2.40
SCBU[a] admission	26 (7)	8 (5)	0.72	0.02	0.60
Facial[a] injury	7 (2)	1 (0.1)	0.02	0.01	0.04

OR: odds ratio, 95% CI: 95% confidence interval.
[a] $P < 0.05$.

extraction. No nerve injury was attributable to the mode of delivery in either group.

3.4. Variables that may influence the success of an instrumental delivery

3.4.1. Operator status

Year 1 SHOs had a significantly lower incidence of success compared with other grades of operator (Table 5). However, this had no overall impact on success rate as year 1 SHOs were the smallest group ($n = 28$).

3.4.2. Use of metal cups

There was an increase in the use of metal cups after the introduction of the educational program. A metal cup was used for 4 (1.5%) attempted vacuum extractions in the historical controls compared with 16 (15%) of the attempted vacuum extractions in the prospective group. The increased

Table 5
Factors affecting the success of instrumental deliveries (including both prospective and control groups)

	n (%)		OR	95% CI	
	Success (n = 447)	Failure (n = 97)		Lower	Upper
Primigravida	345 (77)	60 (62)	1.25	0.84	1.87
Induction of labour	174 (39)	25 (26)	1.49	0.88	2.53
Oxytocin in the second stage	349 (78)	79 (81)	0.95	0.59	1.57
SHO[a] (year 1)	19 (4)	9 (9)	0.11	0.02	0.58
SHO (year >1)	135 (30)	28 (29)	0.25	0.06	1.12
SpR (year 1)	98 (22)	21 (22)	0.41	0.08	1.92
SpR (years 2–3)	99 (22)	23 (24)	0.23	0.05	1.02
SpR (year >3)/non-training grade	96 (21)	16 (16)	0.23	0.05	1.09
Use of epidural	302 (68)	75 (77)	0.87	0.51	1.89
Delay in second stage of labour	250 (56)	70 (72)	0.78	0.48	1.27
Vaginal findings: position[a] (OP + OT)	102 (23)	50 (52)	0.27	0.17	0.44
Caput (moderate to severe)	141 (32)	35 (36)	0.73	0.45	1.19
Station (<2)	198 (44)	38 (39)	1.06	0.66	1.70
Moulding (>2)	62 (14)	13 (13)	1.03	0.53	2.03

OR: odds ratio, 95% CI: 95% confidence interval.
[a] $P = 0.01$.

use of metal cups was not associated with change in success rate of instrumental delivery.

3.4.3. Induction of labour, epidural analgesia, delay in the second stage of labour, use of oxytocin in the second stage

Comparing successful instrumental delivery with failure, there was no difference in induction of labour, administration of epidural analgesia, delay in the second stage of labour or use of oxytocin in the second stage (Table 5).

3.4.4. Vaginal findings

OP and OT positions were associated with a significant risk of failed instrumental delivery ($P = 0.01$) shown in Table 5.

4. Discussion

Much has been written on the technique of instrumental delivery, success rates and maternal and neonatal morbidity. We believe our study is one of the first attempts to evaluate the impact of education and training on the outcome of instrumental deliveries.

4.1. Factors associated with failed instrumental deliveries

Failure of instrumental delivery is usually due to either poor technique or the fetal head fails to descend. With respect to the vaccum extractor, failure due to detachment of the cup is usually due to poor technique and/or malposition rather than true disproportion. Failure of forceps delivery is either due to poor technique or disproportion. In our study, most of the failed instrumental deliveries were failed vaccum extractions.

4.1.1. Operator inexperience

The aim of the educational package was to to improve knowledge in the use of forceps and vaccum extractor. Formal training packages should go hand and hand with supervised formal experience. It is possible that a factor in the failure of a change in success rate was lack of experience in the operator despite an increase in theoretical knowledge. Operator experience in instrumental delivery was extrapolated from the seniority of the operator but this may have been a false assumption.

4.1.2. Incorrect technique

Several factors are known to be associated with failed vaccum extraction. The inappropriate use of a soft cup—when the fetal position is not OA—is a recognised factor. Cups made of soft plastic or silicone have been shown to be associated with increased failure rate (mean of 16%) compared to rigid plastic or metal cups (mean failure rate 9%) even when used in appropriate clinical situations [3].

In our study, there was an increased use of metal cups for vaccum extraction comparing the control and the prospective groups. However, metal cups were used in only 20 of all the attempted vacuum extractions, despite 103 of the control group and 49 of the prospective group being in an OT or OP position. It is likely, that although the use of metal cups increased after the introduction of the educational package, the numbers were too small to influence the overall success rate. In this aspect of vaccum technique, the training programme was a failure.

One of the most important variables determining the outcome of vaccum extraction is correct placement of the cup on the fetal head. It is a criticism of our study that we did not record this information and thus, we could not examine whether this aspect of technique had been influenced by education and training.

4.1.3. Vaginal findings prior to delivery

It has been previously shown that selection of the vacuum extractor for delivery, when the fetal caput is moderate/severe is associated with a high failure rate [11]. In our prospective group, we found that the introduction of formal training and education was associated with an increase in the diagnosis of moderate and severe caput and moulding by the operator. This could indicate a real difference between the prospective and control groups. Alternatively, the introduction of a data collection proforma with a defined classification of moulding and caput may have resulted in an apparent increase in diagnosis. A third possibility is that education and training had generated more operator awareness about factors affecting the success of instrumental deliveries. Although, the failure rate was similar in both the prospective and control groups, the neonatal and maternal morbidity was significantly reduced. We conclude that in our study, formal education and training was associated with improved the safety of instrumental deliveries, despite the unchanged failed instrumental delivery rate. This suggests that in our hospital the sequential use of two instruments was not a cause per se of increased morbidity. However, sequential use of instruments is not recommended. Large epidemiological studies have consistently showed an adverse association between multiple instrumentation and neonatal and maternal injury [5].

4.1.4. Use of epidural

The increase in use of epidural analgesia among the prospective group may have contributed to the failed instrumental delivery rate—especially vaccum extraction. Epidural analgesia administered during labour has been shown to be associated with a longer second stage of labour [12] and an increased risk of instrumental delivery [13]. Johanson et al. [10] observed a reduction of failed vacuum extraction from 27 to 15% when the use of epidural block in these deliveries fell from 35 to 26%. In the presence of an epidural nerve block, the Ferguson reflex is abolished and this is perhaps the physiology behind a prolonged second stage and a higher rate of instrumental delivery in women with epidural during labour. We could not control for method of analgesia in our study. However, we did not identify a positive correlation between failure of instrumental delivery and the use of epidural analgesia.

4.2. Possible impact of formal training and eduction

Although, it is difficult to explain the inability of the formal education and training to reduce the failed vacuum extraction rate, its impact on the neonatal and maternal morbidity is certainly positive and encouraging. We speculate that general improvement in knowledge and understanding of the technique of vacuum delivery may have contributed to the changes in outcomes.

Almost, all the failed vacuum extractions were subsequently successfully delivered using forceps. This suggests that incorrect technique was responsible for many of the failures. It is likely that the use of the soft (Silc) cup for most of the vacuum extractions regardless of fetal position was an important factor in failure. The training programme was ineffective in improving this aspect of delivery technique.

Education is an ongoing process. Its effect might not be apparent during a short study period and may prove more fruitful in the long term. Currently most trainees in the UK rotate between hospitals every 12 months. This makes it difficult to assess the long term impact of educational programmes on practical skills.

5. Conclusion

It is important for every maternity unit to know their instrumental rate and complications. We feel that a failed vacuum extraction rate of 25% is unacceptable and greater efforts should be directed to reduce these rates. The various methods used to minimize complications should be explored, including the introduction and update of guidelines and continuous education of trainee medical staff. The effect of an educational program must be assessed and may not be predictable. Longer study periods may be required to evaluate the influence of education, with perhaps more formal assessment of the improvement of knowledge and skills after education. This study showed that formal training and education was associated with improved safety of instrumental delivery for both the mother and baby and we speculate that this may be secondary to the improvement in knowledge and understanding of the technique of vacuum delivery.

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