Vacuum extraction versus forceps for assisted vaginal delivery (Review)

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ABSTRACT

Background
Proponents of vacuum delivery argue that it should be chosen first for assisted vaginal delivery, because it is less likely to injure the mother.

Objectives
The objective of this review was to assess the effects of vacuum extraction compared to forceps, on failure to achieve delivery and maternal and neonatal morbidity.

Search strategy
We searched the Cochrane Pregnancy and Childbirth Group trials register. Date of last search: February 1999.

Selection criteria
Acceptably controlled comparisons of vacuum extraction and forceps delivery.

Data collection and analysis
Two reviewers independently assessed trial quality and extracted data. Study authors were contacted for additional information.

Main results
Ten trials were included. The trials were of reasonable quality. Use of the vacuum extractor for assisted vaginal delivery when compared to forceps delivery was associated with significantly less maternal trauma (odds ratio 0.41, 95% confidence interval 0.33 to 0.50) and with less general and regional anaesthesia. There were more deliveries with vacuum extraction (odds ratio 1.69, 95% confidence interval 1.31 to 2.19). Fewer caesarean sections were carried out in the vacuum extractor group. However the vacuum extractor was associated with an increase in neonatal cephalhaematomata and retinal haemorrhages. Serious neonatal injury was uncommon with either instrument.

Authors' conclusions
Use of the vacuum extractor rather than forceps for assisted delivery appears to reduce maternal morbidity. The reduction in cephalhaematoma and retinal haemorrhages seen with forceps may be a compensatory benefit.

BACKGROUND

Assisted vaginal delivery is an integral part of obstetric care worldwide. It may be performed as infrequently as in 1.5 % of deliveries (Czechoslavakian Republic) or as often as in 15% (Australia and Canada) (Stephenson 1992). Discrepant rates may be related to differences in labour management. In general, maternal outcome may be improved by a reduction in instrumental delivery rates.

Various techniques may help to achieve lower rates of assisted delivery, eg companionship in labour, active management of the second stage of labour with syntocinon, upright posture with use of the birth cushion or undertaking fetal scalp blood sampling rather than expedited delivery when fetal heart rate decelerations occur. When epidural analgesia is used, allowing time for the analgesic effect to wear off, or having a more liberal approach to the length of the second stage also reduces the need for assisted delivery.

Current evidence suggests that when assisted vaginal delivery is required, the ventouse should be chosen first, principally because it is significantly less likely to injure the mother (Chalmers et al 1989). However, this area remains controversial and selective review of the literature to support different views is common (Drife 1996). An updated systematic review of the current evidence is required.

This Cochrane review represents an update of the pre-Cochrane review undertaken by Richard Johanson.

OBJECTIVES

The objective of this review is to determine the effects of vacuum extraction versus forceps delivery on maternal, neonatal and child health.

CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW

Types of studies

All identifiable controlled trials comparing vacuum extraction versus forceps delivery, which have demonstrated an attempt to randomise participants to different interventions. All trials included in the review will be rated according to method of randomisation, blinding and handling of exclusions. The inclusion criteria are quite broad due to the small number of controlled trials available in this area and their variable methodological quality.

Types of participants

Primiparous and multiparous women who have required assisted delivery with a vacuum extractor or obstetric forceps.

Types of intervention

Vacuum extraction (any instrument) versus forceps delivery (any instrument).

Types of outcome measures

The main outcomes of interest are fetal outcome, perineal injury including extension of episiotomy, vaginal lacerations and injury to the perineal body. In addition, the review will consider maternal perception of short and long term pain.

SEARCH METHODS FOR IDENTIFICATION OF STUDIES

See: methods used in reviews.

This review draws on the search strategy developed for the Pregnancy and Childbirth Group as a whole. Published and unpublished reports of controlled trials were identified using methods described in Chalmers et al 1989.

Relevant trials have been identified in the Group's Specialised Register of Controlled Trials. See Review Group's details for more information. Date of last search: February 1999.

METHODS OF THE REVIEW

The two reviewers (Richard Johanson and Vijay Menon) have independently assessed the trials and selected those for inclusion in the review. Were any trials to have been excluded, the reason for exclusion have been clearly stated. It was not possible to assess the trials blinded; the reviewers knew the authors' names, institution, source of the publication and results when applying the inclusion criteria. Disagreements have been resolved by discussion.

The methodological quality of each trial has been independently assessed by the same two reviewers. Details of randomisation method, blinding and reasons for exclusions from the analysis are documented. Additional information was sought from trialists, where possible, when it was unclear if a criterion was met.

Data was entered directly from the published reports into the Review Manager software (RevMan) and a second coder checked the accuracy of the entered data. Where data was not presented in a suitable format for data entry, or if data was missing, additional information was sought from the trialists by personal communication in the form of a letter. Were there to be any questionable judgements or assumptions, a sensitivity analysis would have been undertaken.

DESCRIPTION OF STUDIES

See table of 'Characteristics of Included Studies'. No trials were excluded. Data in the study by Loghis (1991) were included in the

large report (Salamalekis 1995). Similarly, the data in the study Williams (1991a) is included in Williams 1991.

METHODOLOGICAL QUALITY

The trials included in this review are of variable quality. Potential bias occurred in the method of randomisation, particularly in the studies by Ehlers 1974 where forceps and vacuum extractor were used on alternate days of the week. The other studies used cards or sealed envelopes (Bofill 1996; Stoke/Wigan; Keele 1993; Portsmouth 1983; Williams 1991). No participants were withdrawn from allotted groups before analysis. In none of the studies was the observer 'blinded' to the method of delivery when assessing outcome. Salamalekis (Salamalekis 1995) used alternate allocation.

RESULTS

The vacuum extractor is significantly less likely to achieve a successful vaginal delivery than forceps. However, overall it is associated with a lower Caesarean section rate. The vacuum extractor (as demonstrated by the 'intention to delivery' analysis) is significantly less likely to cause serious maternal injury than is the forceps. It is associated with a lower usage of regional and general anaesthesia but with apparently less pain at delivery and significantly less pain at 24 hours. Although the vacuum extractor is associated with more cephalhaematomata, other facial/cranial injuries are more common with forceps. There is more maternal concern about the baby in the vacuum extractor group. Although there are no differences between methods in terms of 1-minute Apgar scores, there is a trend towards more low Apgar scores at 5 minutes in the vacuum extractor group. This result is largely influenced by the study of Lasbrey (Lasbrey 1964) where the vacuum extractor was used for longer periods of time. There are no significant differences in numbers of babies requiring phototherapy. The vacuum extractor is associated with an increased incidence of retinal haemorrhages, although this result is influenced by the study of Ehlers (Ehlers 1974), methodologically the least sound of the trials reviewed. Follow-up in the Portsmouth study showed no significant differences in attitudes of the mother to the two instruments or in terms of neonatal or infant re-admissions. In the study by Johanson (Keele 1993) a 'new vacuum extractor policy' was compared to forceps delivery: as metal cups have a success rate greater than soft cups they were used in the more difficult cases (especially the 'OP' cup for deflexed OP positions). However where difficulties were not anticipated, the soft cups were used because they are associated with less scalp trauma (Johanson 1999). The most recent study (Bofill 1996) with highest vacuum extractor success rate, used a new semi-rigid plastic cup. A systematic review of different vacuum extractor cups is currently being prepared.

DISCUSSION

The vacuum extractor is more likely to fail than the forceps. This may be due to the fact that it is not possible to pull as hard with this instrument, but also due to errors in technique e.g. incorrect cup application or pulling in the wrong direction. The overall Caesarean section rate is significantly lower with the vacuum extractor. The vacuum extractor may be more effective than forceps in some situations (such as deflexed 'OP' position, for example), alternatively the lower risk of caesarean section following vacuum extraction may be because after a failed vacuum extraction, delivery is usually by forceps whilst failed forceps is followed by caesarean section. The overall reduction in regional and general anaesthesia in itself is a benefit, especially as the studies which reported maternal perception of pain showed less discomfort in the vacuum extractor group. The overall reduction in severe maternal injuries is the most important immediate benefit associated with use of the vacuum extractor.

Although there do not appear to be any significant differences in serious neonatal morbidity, the overall numbers included in all these studies are relatively small in terms of being able to judge the relative risks of rare adverse outcomes. However, the vacuum extractor is associated with a well recognised increased risk of cephalhaematoma and of retinal haemorrhage. Neither of these problems have been linked to long term complications. Follow-up of the child was reported in only one study with no long term differences noted. A further study has been completed with 5-year follow-up of the Keele study (Keele 1993). This will be included in the review after peer review. Further data on Apgar scores and adverse neonatal outcomes are being sought from a number of the authors of included trials.

It is also hoped to include published (and unpublished) continuous data in the next update of this review.

AUTHORS' CONCLUSIONS

Implications for practice

Use of the vacuum extractor reduces severe maternal injuries. The reduction in cephalhaematomas and retinal haemorrhages may be regarded as compensating fetal 'benefits' to support the choice of forceps. Maternal and neonatal injury may be increased when a difficult failure of vacuum extraction is followed by an attempt to deliver with forceps.

Implications for research

The benefits to the mother of vacuum extraction have been established. It remains to be shown which instrument results in fewer major adverse neonatal effects; the increase in retinal haemorrhages and trend to low 5-minute Apgar scores in the vacuum group raise some concern and should be investigated further. Serious neonatal outcomes ranging from death to intracranial haemorrhage are

rare. To demonstrate a difference between the two instruments, very large numbers would be required. Future research examining which mothers are at particular risk of trauma, and which babies are at risk of cranial injuries would be valuable. Research at improving operator skill is essential. Examination of national birth registers to ascertain injury rates may be helpful.

FEEDBACK

Vacca, December 1997

Summary

Abstract:
The first objective, of assessing failure to achieve delivery, is not mentioned in the abstract results, although it is discussed in the review. The word 'fortunately' should be dropped from results.

Discussion:
The lower risk of caesarean section following vacuum extraction may be because after a failed vacuum extraction delivery is usually by forceps, while failed forceps is more likely to be followed by caesarean section. Maternal and neonatal injury may be increased when a difficult failure of vacuum extraction is followed by an attempt to deliver with forceps.
The statement 'overall caesarean section rate is significantly lower with the vacuum extractor suggesting that it may be more effective than forceps in some situations' should not be made on current evidence. The statement that failure to deliver with the vacuum extractor is 'because it is not possible to pull as hard' is opinion only. Anther possible explanation is error in technique, for example incorrect cup application or pulling in the wrong direction.

Conclusions:
The lower failure rate of forceps and the adverse effects of the vacuum extractor could be seen as compensating benefits for forceps.

Author's reply

These comments have been incorporated into the review.

[Summary of response from Richard Johanson, December 1998]

Contributors

Summary of comments from Aldo Vacca, December 1997.

Griffin, July 1999

Summary

Implications for practice:

As a user of vacuum I am conscious and proud of leaving an intact perineum. However, I have begun to wonder if this really is to the long term benefit of the woman. Visible perineal trauma may lead to better treatment of the muscular separation which occurs during vacuum deliveries, which will be unrepaired if the perineum is intact.

Author's reply

A response from the reviewer will be published as soon as it is available.

Contributors

Summary of comments from Chris Griffin, July 1999.

Airede, June 2004

Summary

Does anyone use the vacuum extractor, rather than forceps, for women with eclampsia?

Author's reply

A response from the reviewer will be published as soon as it is available.

Contributors

Summary of comment received from Lydia Airede, June 2004

POTENTIAL CONFLICT OF INTEREST

Richard Johanson is author of two of the trials reviewed.

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TABLES

Characteristics of included studies

Study	**Bofill 1996**
Methods	Series of numbered opaque envelopes that contained randomisation slips Patient randomised into one of three groups - forceps, continuous vacuum or intermittent vacuum Analysis was by intention to treat No exclusions after randomisation 'Blinding' not possible
Participants	Number of participants = 637 Pregnancies at >34 weeks or an estimated fetal weight = >1800 gm (if gestational age unknown)
Interventions	Forceps (variety, mainly) = 315 (choice of forceps left to operator) M-cup (semi-rigid plastic device) = 322
Outcomes	Failed delivery with selected instrument Maternal injury Scalp trauma Cephalhaematoma Phototherapy Use of pudendal anaesthesia Use of epidural anaesthesia
Notes	Jackson, Mississippi
Allocation concealment	D – Not used

Study	**Dell 1985**
Methods	Choice of instrument was determined at delivery by pulling the next card of a series of computer-generated random numbers Analysis was by intention to treat No exclusions after randomisation 'Blinding' not possible
Participants	Number of participants = 118 nulliparous patients delivered under conduction anaesthesia Age = 18> Gestational age = 36>
Interventions	Vacuum = 73 (Mityvac = 37 and Silastic = 36) Tucker-McLane forceps = 45
Outcomes	Failed delivery with selected instrument Maternal injury Apgar score <7 at 1 minute Apgar score <7 at 5 minutes Cephalhaematoma Use of phototherapy

Characteristics of included studies (*Continued*)

	Perinatal death
Notes	Louisiana State University, New Orleans
Allocation concealment	D – Not used

Study	**Ehlers 1974**
Methods	Consecutive series: forceps on uneven dates, ventouse on even dates Analysis by intention to treat No exclusions after randomisation 'Blinding' not possible
Participants	Number of participants = 206 Consecutive series of women requiring instrumental vaginal delivery
Interventions	Forceps = 99 Vacuum extractor = 107
Outcomes	Failed delivery with selected instrument Retinal haemorrhage
Notes	Denmark
Allocation concealment	D – Not used

Study	**Fall 1986**
Methods	Women were allocated "at random" to the forceps or vacuum extraction group Analysis by intention to treat No exclusions after randomisation 'Blinding' not possible
Participants	Number of participants = 36 Medically uneventful pregnancy Spontaneous onset of labour at term (>37 completed weeks) Vertex presentation Normal fetal heart rate pattern during labour Exclusion criteria - women with late or variable decelerations in fetal heart rate, constant bradycardia or tachycardia or meconium-stained amniotic fluid
Interventions	Forceps delivery = 16 Vacuum extraction delivery = 20
Outcomes	Perinatal death Caesarean section Cephalhaematoma Retinal haemorrhage
Notes	Sweden
Allocation concealment	D – Not used

Study	**Keele 1993**
Methods	Consecutive series of sealed, opaque envelopes prepared independently by the trial organisers. 1:1 randomisation within balanced blocks of varying size (4-10) Analysis by intention to treat No exclusions after randomisation 'Blinding' possible only for assessment of retinal haemorrhage Follow-up Women from North Staffordshire sent a follow-up questionnaire in August 1991
Participants	Number of participants = 607

Characteristics of included studies (*Continued*)

	Singleton pregnancy Cephalic presentation Gestational age = >35 completed weeks Follow-up: Number of participants = 313 September 1989 to May 1990 Comparison of forceps (n = 162) or ventouse (n = 151) delivery Questionnaire and assessment 24-48 hours after delivery Questionnaire in the 2nd year after delivery
Interventions	Vacuum extractor = 296 (Silc-cup - 177, OA metal - 95, OP metal - 23, VE not used - 1) Forceps = 311 (Neville Barnes - 258, Kjellands - 44, Manual rotation - 5, Lift Out - 0, Forceps not used - 4)
Outcomes	Failed delivery - Caesarean section Perineal pain Apgar score <7 at 5 minutes Cephalhaematoma Scalp/face injuries (not cephalhaematoma) Use of phototherapy Retinal haemorrhage Failed delivery with selected instrument Use of regional, pudendal or general anaesthesia Significant maternal injury Moderate/severe pain at delivery Maternal worries about baby Follow-up (Johanson 1993b): Moderate/severe pain at delivery, severe perineal pain at 24 hours, maternal worries about baby and perinatal death
Notes	Four district general hospitals in West Midlands, England North Staffordshire only for follow-up Johanson (1993b)
Allocation concealment	D – Not used

Study	**Lasbrey 1964**
Methods	Slip of paper was drawn using the "approved random-sample manner" to indicate which equipment should be used Analysis by intention to treat No exclusions after randomisation 'Blinding' not possible
Participants	Number of participants = 252
Interventions	Forceps delivery = 131 Malmstrom vacuum extractor = 121
Outcomes	Failed delivery with selected instrument Caesarean section Use of general anaesthesia Apgar score <7 at 5 minutes Perinatal death Significant maternal injury
Notes	Durban, South Africa
Allocation concealment	D – Not used

Study	**Portsmouth 1983**
Methods	Random treatment allocation made by opening the top envelope in a box of serially numbered envelopes.

Characteristics of included studies (*Continued*)

	Analysis by intention to treat No exclusions after randomisation 'Blinding' not possible
	Follow-up: 9 month follow-up of all patients (Carmody 1986)
	Follow-up: 66 of the patients selected for interview. Selection was not made by formal random sampling (Garcia 1985)
Participants	Number of participants = 304 Single pregnancies Vertex presentation Gestational age = at least 37 completed weeks Instrumental assistance required for 2nd stage
	Follow-up (Carmody 1986): Number of participants = 304, 2 perinatal deaths and 2 cot deaths. 300 babies eligible for follow-up at 9 months. Instrumental assistance required during second stage of labour. Follow-up group = 232
	Follow-up (Garcia 1985): Number of participants = 304. Singleton pregnancy, cephalic presentation, gestation age+ >37 completed weeks
Interventions	Haig Ferguson's and Kjellands forceps = 152 50mm anterior and posterior Bird vacuum extractor cups = 152
Outcomes	Failed delivery with selected instrument Caesarean section Use of pudendal anaesthesia Use of general anaesthesia Use of epidural anaesthesia Significant maternal injury Apgar score <7 at 1 minute Apgar score <7 at 5 minutes Cephalhaematoma Scalp/face injuries (not cephalhaematoma) Use of phototherapy Perinatal death
	Follow-up (Carmody 1986): Hearing abnormal (confirmed/suspected), strabismus/vision abnormality, follow-up/readmission by hospital.
	Follow-up (Garcia 1985): Moderate/severe pain at delivery and maternal worries about baby
Notes	Portsmouth, England
Allocation concealment	D – Not used

Study	**Salamalekis 1995**
Methods	Alternate allocation ('quasi-random') Analysis by intention to treat No exclusions after randomisation 'Blinding' not possible
Participants	Number of participants = 400 Singleton pregnancies Cephalic presentation Gestational age = 37> weeks
Interventions	Forceps = 200 Rubber vacuum extractor = 200

Characteristics of included studies (*Continued*)

Outcomes	Failures with instrument Significant maternal injury Apgar score <7 at 1 minute
Notes	Athens, Greece
Allocation concealment	D – Not used

Study	**Stoke/Wigan**
Methods	Randomly assigned Consecutive series of sealed opaque envelopes No exclusions after randomisation 'Blinding' not possible Follow-up: Questions were asked with the interviewer 'blind' to the mode of delivery No pre-selection for interview
Participants	Number of participants = 264 Singleton pregnancy Cephalic presentation Gestational age = >35 completed weeks Follow-up: Number of participants = 209
Interventions	'Silc cup' ventouse = 132 Forceps = 132 Follow-up: Silc cup = 107 and Forceps = 102
Outcomes	Failed delivery with selected instrument Caesarean section Use of regional, pudendal or general anaesthesia Significant maternal injury Apgar score <7 at 5 minutes Cephalhaematoma Scalp/face injuries (not cephalhaematoma) Retinal haemorrhage Perinatal death No differences in neonatal morbidity Follow-up: Moderate/severe pain at delivery, severe perineal pain at 24 hours and maternal worries about baby
Notes	North Staffordshire and Billinge Maternity Hospital (Wigan), England Maternal questionnaire: Pusey et al (1991)
Allocation concealment	D – Not used

Study	**Williams 1991**
Methods	Prospective randomised study Randomised by drawing sealed envelopes containing randomisation slips Analysis by intention to treat No exclusions after randomisation 'Blinding' not possible
Participants	Number of participants = 99 Maternal age =/>18 Gestational age =/>35 completed weeks Cephalic presentation

Interventions	Simpson and Tucker-McLane obstetric forceps = 51 CMI (Columbian Medical and Surgical Inc) Soft Touch cup polyethylene vacuum cup, used in conjunction with CMI hand vacuum pump = 48
Outcomes	Failed delivery with selected instrument Caesarean section Retinal haemorrhage
Notes	Tampa General Hospital, Florida
Allocation concealment	D – Not used

ANALYSES

Comparison 01. VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Failed delivery with selected instrument	9	2849	Peto Odds Ratio 95% CI	1.69 [1.31, 2.19]
02 Caesarean section	7	1662	Peto Odds Ratio 95% CI	0.56 [0.31, 1.02]
03 Use of regional or general anaesthesia	12	5051	Peto Odds Ratio 95% CI	0.59 [0.51, 0.68]
04 Significant maternal injury	7	2582	Peto Odds Ratio 95% CI	0.41 [0.33, 0.50]
05 Moderate/severe pain at delivery	3	541	Peto Odds Ratio 95% CI	0.77 [0.53, 1.14]
06 Maternal worries about baby	3	561	Peto Odds Ratio 95% CI	2.17 [1.19, 3.94]
07 Severe perineal pain at 24 hours	2	495	Peto Odds Ratio 95% CI	0.54 [0.31, 0.93]
08 Apgar score <7 at 1 minute	3	822	Peto Odds Ratio 95% CI	1.13 [0.76, 1.68]
09 Apgar score <7 at 5 minutes	5	1545	Peto Odds Ratio 95% CI	1.67 [0.99, 2.81]
10 Cephalhaematoma	6	1966	Peto Odds Ratio 95% CI	2.38 [1.68, 3.37]
11 Scalp/face injuries (not cephalhaematoma)	6	2330	Peto Odds Ratio 95% CI	0.89 [0.70, 1.13]
12 Use of phototherapy	4	1648	Peto Odds Ratio 95% CI	1.08 [0.66, 1.77]
13 Retinal haemorrhage	5	445	Peto Odds Ratio 95% CI	1.99 [1.35, 2.96]
14 Perinatal death	7	1800	Peto Odds Ratio 95% CI	0.80 [0.18, 3.52]
15 Follow-up/readmission by hospital	1	232	Peto Odds Ratio 95% CI	1.33 [0.58, 3.05]
16 Hearing abnormal (confirmed/ suspected)	1	232	Peto Odds Ratio 95% CI	1.66 [0.54, 5.06]
17 Strabismus/vision abnormality suspected	1	232	Peto Odds Ratio 95% CI	1.38 [0.47, 4.05]

INDEX TERMS

Medical Subject Headings (MeSH)

Extraction, Obstetrical; *Obstetrical Forceps; *Vacuum Extraction, Obstetrical

MeSH check words

Female; Humans; Pregnancy

COVER SHEET

Title Vacuum extraction versus forceps for assisted vaginal delivery

Authors	Johanson RB, Menon V
Contribution of author(s)	Information not supplied by author
Issue protocol first published	1997/1
Review first published	1997/3
Date of most recent amendment	26 January 2005
Date of most recent SUBSTANTIVE amendment	31 December 1998
What's New	January 2005 The review team are currently preparing a new protocol to combine and update the 'Vacuum extraction versus forceps for assisted vaginal delivery' and 'Soft versus rigid vacuum extractor cups for assisted vaginal delivery' reviews.
Date new studies sought but none found	Information not supplied by author
Date new studies found but not yet included/excluded	Information not supplied by author
Date new studies found and included/excluded	Information not supplied by author
Date authors' conclusions section amended	Information not supplied by author
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Editorial group code	HM-PREG

GRAPHS AND OTHER TABLES

Analysis 01.01. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 01 Failed delivery with selected instrument

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 01 Failed delivery with selected instrument

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
Bofill 1996	18/319	25/305		17.2	0.67 [0.36, 1.25]
Dell 1985	14/73	3/42		5.8	2.58 [0.89, 7.48]
Ehlers 1974	13/107	0/99		5.2	7.73 [2.52, 23.72]
Keele 1993	45/296	32/311		28.8	1.56 [0.97, 2.51]
Lasbrey 1964	12/121	3/131		6.1	3.88 [1.37, 11.02]
Portsmouth 1983	19/142	15/144		12.9	1.33 [0.65, 2.71]
× Salamalekis 1995	0/200	0/200		0.0	Not estimable
Stoke/Wigan	35/130	13/130		16.8	3.06 [1.64, 5.73]
Williams 1991	10/48	11/51		7.2	0.96 [0.37, 2.50]
Total (95% CI)	1436	1413		100.0	1.69 [1.31, 2.19]

Total events: 166 (Treatment), 102 (Control)

Test for heterogeneity chi-square=24.02 df=7 p=0.001 I^2 =70.9%

Test for overall effect z=4.01 p=0.00006

Analysis 01.02. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 02 Caesarean section

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 02 Caesarean section

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
× Dell 1985	0/73	0/45		0.0	Not estimable
× Fall 1986	0/20	0/16		0.0	Not estimable
Keele 1993	6/296	12/311		40.7	0.53 [0.21, 1.35]
× Lasbrey 1964	0/121	0/131		0.0	Not estimable
Portsmouth 1983	7/142	14/144		45.5	0.50 [0.20, 1.20]
Stoke/Wigan	2/132	1/132		6.9	1.96 [0.20, 18.98]
Williams 1991	1/48	2/51		6.8	0.54 [0.05, 5.30]
Total (95% CI)	832	830		100.0	0.56 [0.31, 1.02]
Total events: 16 (Treatment), 29 (Control)					
Test for heterogeneity chi-square=1.25 df=3 p=0.74 I^2 =0.0%					
Test for overall effect z=1.88 p=0.06					

Analysis 01.03. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 03 Use of regional or general anaesthesia

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 03 Use of regional or general anaesthesia

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
01 Use of pudendal anaesthesia					
Bofill 1996	101/322	160/315		18.6	0.45 [0.33, 0.61]
Keele 1993	74/296	134/311		16.5	0.45 [0.32, 0.63]
Portsmouth 1983	4/152	24/152		3.1	0.21 [0.10, 0.45]
Stoke/Wigan	42/132	76/132		7.9	0.35 [0.22, 0.57]
Subtotal (95% CI)	902	910		46.0	0.41 [0.33, 0.50]
Total events: 221 (Treatment), 394 (Control)					
Test for heterogeneity chi-square=3.86 df=3 p=0.28 I^2 =22.2%					
Test for overall effect z=8.73 p<0.00001					
02 Use of general anaesthesia					
Keele 1993	2/296	12/311		1.6	0.24 [0.08, 0.70]

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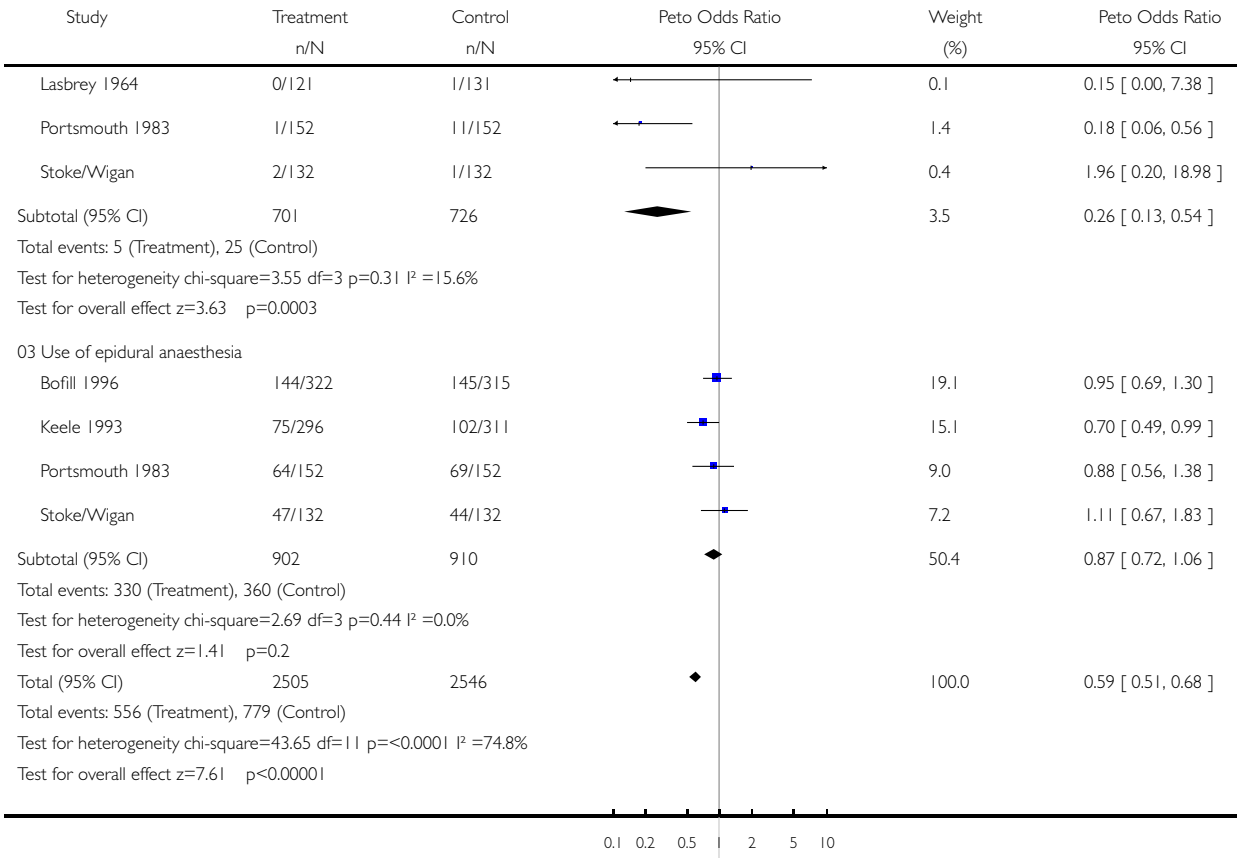

Analysis 01.04. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 04 Significant maternal injury

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 04 Significant maternal injury

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
Bofill 1996	38/322	95/315		33.3	0.33 [0.23, 0.48]
Dell 1985	21/73	22/45		8.2	0.42 [0.20, 0.91]
Keele 1993	32/296	52/311		22.9	0.61 [0.38, 0.97]
Lasbrey 1964	2/121	10/131		3.6	0.27 [0.08, 0.86]
Portsmouth 1983	14/152	34/152		12.8	0.37 [0.20, 0.69]
Salamalekis 1995	12/200	22/200		9.8	0.53 [0.26, 1.06]
Stoke/Wigan	8/132	26/132		9.4	0.30 [0.15, 0.61]
Total (95% CI)	1296	1286		100.0	0.41 [0.33, 0.50]

Total events: 127 (Treatment), 261 (Control)

Test for heterogeneity chi-square=5.94 df=6 p=0.43 I^2 =0.0%

Test for overall effect z=8.04 p<0.00001

Analysis 01.05. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 05 Moderate/severe pain at delivery

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 05 Moderate/severe pain at delivery

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
Keele 1993	95/130	98/137		51.6	1.08 [0.63, 1.84]
Portsmouth 1983	7/33	12/32		13.1	0.46 [0.16, 1.33]
Stoke/Wigan	19/107	28/102		35.2	0.57 [0.30, 1.10]
Total (95% CI)	270	271		100.0	0.77 [0.53, 1.14]

Total events: 121 (Treatment), 138 (Control)

Test for heterogeneity chi-square=3.22 df=2 p=0.20 I^2 =37.8%

Test for overall effect z=1.31 p=0.2

Analysis 01.06. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 06 Maternal worries about baby

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 06 Maternal worries about baby

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
Keele 1993	10/139	4/148		31.1	2.62 [0.90, 7.67]
Portsmouth 1983	21/33	12/32		38.4	2.80 [1.07, 7.35]
Stoke/Wigan	8/107	6/102		30.5	1.29 [0.44, 3.80]
Total (95% CI)	279	282		100.0	2.17 [1.19, 3.94]

Total events: 39 (Treatment), 22 (Control)

Test for heterogeneity chi-square=1.28 df=2 p=0.53 I^2 =0.0%

Test for overall effect z=2.53 p=0.01

Analysis 01.07. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 07 Severe perineal pain at 24 hours

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 07 Severe perineal pain at 24 hours

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
Keele 1993	14/140	19/146		57.0	0.75 [0.36, 1.54]
Stoke/Wigan	7/107	18/102		43.0	0.35 [0.15, 0.81]
Total (95% CI)	247	248		100.0	0.54 [0.31, 0.93]

Total events: 21 (Treatment), 37 (Control)

Test for heterogeneity chi-square=1.80 df=1 p=0.18 I^2 =44.3%

Test for overall effect z=2.22 p=0.03

Analysis 01.08. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 08 Apgar score <7 at 1 minute

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 08 Apgar score <7 at 1 minute

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
Dell 1985	6/73	2/45		7.2	1.81 [0.42, 7.87]
Portsmouth 1983	45/152	46/152		65.3	0.97 [0.59, 1.58]
Salamalekis 1995	17/200	12/200		27.5	1.45 [0.68, 3.08]
Total (95% CI)	425	397		100.0	1.13 [0.76, 1.68]

Total events: 68 (Treatment), 60 (Control)

Test for heterogeneity chi-square=1.19 df=2 p=0.55 I^2 =0.0%

Test for overall effect z=0.62 p=0.5

Analysis 01.09. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 09 Apgar score <7 at 5 minutes

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 09 Apgar score <7 at 5 minutes

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
× Dell 1985	0/73	0/45		0.0	Not estimable
Keele 1993	6/296	4/311		17.5	1.58 [0.45, 5.51]
Lasbrey 1964	19/121	11/131		47.0	2.00 [0.93, 4.29]
Portsmouth 1983	10/152	7/152		28.6	1.45 [0.55, 3.86]
Stoke/Wigan	2/132	2/132		7.0	1.00 [0.14, 7.18]
Total (95% CI)	774	771		100.0	1.67 [0.99, 2.81]

Total events: 37 (Treatment), 24 (Control)

Test for heterogeneity chi-square=0.56 df=3 p=0.90 I^2 =0.0%

Test for overall effect z=1.92 p=0.05

Analysis 01.10. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 10 Cephalhaematoma

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 10 Cephalhaematoma

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
Bofill 1996	37/322	19/315		40.7	1.97 [1.14, 3.41]
Dell 1985	11/73	1/45		8.2	4.03 [1.19, 13.71]
Fall 1986	7/20	2/16		5.5	3.21 [0.72, 14.35]
Keele 1993	27/296	8/311		26.3	3.33 [1.68, 6.59]
Portsmouth 1983	14/152	8/152		16.3	1.80 [0.76, 4.27]
Stoke/Wigan	2/132	2/132		3.1	1.00 [0.14, 7.18]
Total (95% CI)	995	971		100.0	2.38 [1.68, 3.37]

Total events: 98 (Treatment), 40 (Control)

Test for heterogeneity chi-square=3.40 df=5 p=0.64 I^2 =0.0%

Test for overall effect z=4.85 p<0.00001

Analysis 01.11. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 11 Scalp/face injuries (not cephalhaematoma)

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 11 Scalp/face injuries (not cephalhaematoma)

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
Bofill 1996	5/322	8/315		4.7	0.61 [0.20, 1.83]
Dell 1985	22/73	23/45		9.8	0.41 [0.19, 0.89]
Keele 1993	26/296	37/311		20.8	0.72 [0.43, 1.21]
Portsmouth 1983	7/152	14/152		7.2	0.49 [0.20, 1.19]
Salamalekis 1995	85/200	84/200		36.0	1.02 [0.69, 1.52]
Stoke/Wigan	50/132	36/132		21.4	1.62 [0.97, 2.70]
Total (95% CI)	1175	1155		100.0	0.89 [0.70, 1.13]

Total events: 195 (Treatment), 202 (Control)

Test for heterogeneity chi-square=12.40 df=5 p=0.03 I^2 =59.7%

Test for overall effect z=0.99 p=0.3

Analysis 01.12. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 12 Use of phototherapy

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 12 Use of phototherapy

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
Bofill 1996	20/322	17/315		54.9	1.16 [0.60, 2.25]
Dell 1985	2/73	0/45		2.9	5.11 [0.29, 89.65]
Keele 1993	3/296	7/311		15.5	0.47 [0.13, 1.63]
Portsmouth 1983	10/142	8/144		26.6	1.29 [0.50, 3.33]
Total (95% CI)	833	815		100.0	1.08 [0.66, 1.77]
Total events: 35 (Treatment), 32 (Control)					
Test for heterogeneity chi-square=3.04 df=3 p=0.39 I^2 =1.2%					
Test for overall effect z=0.31 p=0.8					

Analysis 01.13. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 13 Retinal haemorrhage

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 13 Retinal haemorrhage

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
Ehlers 1974	69/107	38/99		52.1	2.83 [1.64, 4.89]
Fall 1986	4/20	3/16		5.8	1.08 [0.21, 5.56]
Keele 1993	27/50	23/59		27.4	1.82 [0.86, 3.86]
Stoke/Wigan	1/15	1/15		1.9	1.00 [0.06, 16.79]
Williams 1991	8/32	9/32		12.8	0.85 [0.28, 2.57]
Total (95% CI)	224	221		100.0	1.99 [1.35, 2.96]
Total events: 109 (Treatment), 74 (Control)					
Test for heterogeneity chi-square=4.69 df=4 p=0.32 I^2 =14.7%					
Test for overall effect z=3.44 p=0.0006					

Analysis 01.14. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 14 Perinatal death

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 14 Perinatal death

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
× Dell 1985	0/73	0/45		0.0	Not estimable
× Ehlers 1974	0/107	0/112		0.0	Not estimable
× Fall 1986	0/20	0/16		0.0	Not estimable
Keele 1993	1/296	1/311		28.7	1.05 [0.07, 16.85]
Lasbrey 1964	1/121	3/131		56.8	0.39 [0.05, 2.83]
Portsmouth 1983	1/152	0/152		14.4	7.39 [0.15, 372.38]
× Stoke/Wigan	0/132	0/132		0.0	Not estimable
Total (95% CI)	901	899		100.0	0.80 [0.18, 3.52]

Total events: 3 (Treatment), 4 (Control)

Test for heterogeneity chi-square=1.77 df=2 p=0.41 I^2 =0.0%

Test for overall effect z=0.30 p=0.8

Analysis 01.15. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 15 Follow-up/ readmission by hospital

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 15 Follow-up/readmission by hospital

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
Portsmouth 1983	14/115	11/117		100.0	1.33 [0.58, 3.05]
Total (95% CI)	115	117		100.0	1.33 [0.58, 3.05]

Total events: 14 (Treatment), 11 (Control)

Test for heterogeneity: not applicable

Test for overall effect z=0.68 p=0.5

Analysis 01.16. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 16 Hearing abnormal (confirmed/suspected)

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 16 Hearing abnormal (confirmed/suspected)

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
Portsmouth 1983	8/115	5/117		100.0	1.66 [0.54, 5.06]
Total (95% CI)	115	117		100.0	1.66 [0.54, 5.06]

Total events: 8 (Treatment), 5 (Control)

Test for heterogeneity: not applicable

Test for overall effect z=0.89 p=0.4

Analysis 01.17. Comparison 01 VACUUM EXTRACTION VS FORCEPS DELIVERY, Outcome 17 Strabismus/vision abnormality suspected

Review: Vacuum extraction versus forceps for assisted vaginal delivery

Comparison: 01 VACUUM EXTRACTION VS FORCEPS DELIVERY

Outcome: 17 Strabismus/vision abnormality suspected

Study	Treatment n/N	Control n/N	Peto Odds Ratio 95% CI	Weight (%)	Peto Odds Ratio 95% CI
Portsmouth 1983	8/115	6/117		100.0	1.38 [0.47, 4.05]
Total (95% CI)	115	117		100.0	1.38 [0.47, 4.05]

Total events: 8 (Treatment), 6 (Control)

Test for heterogeneity: not applicable

Test for overall effect z=0.58 p=0.6