Methods of delivering the placenta at caesarean section (Review)

Anorlu RI, Maholwana B, Hofmeyr GJ

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[Intervention Review]

Methods of delivering the placenta at caesarean section

Rose I Anorlu[1], Babalwa Maholwana[2], G Justus Hofmeyr[3]

[1]Department of Obstetrics and Gynaecology, University of Lagos, Lagos, Nigeria. [2]Effective Care Research Unit, East London, South Africa. [3]Department of Obstetrics and Gynaecology, East London Hospital Complex, University of the Witwatersrand, University of Fort Hare, Eastern Cape Department of Health, East London, South Africa

Contact address: Rose I Anorlu, Department of Obstetrics and Gynaecology, University of Lagos, College of Medicine, Surulere, Lagos, PMB 12003, Nigeria. rianorlu2004@gmail.com. (Editorial group: Cochrane Pregnancy and Childbirth Group.)

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ABSTRACT

Background

Worldwide, caesarean section is the most common major operation performed on women. Some of the reported short-term morbidities include haemorrhage, postoperative fever and endometritis. The method of delivering the placenta is one procedure that may contribute to an increase or decrease in the morbidity of caesarean section. Two common methods used to deliver the placenta at caesarean section are cord traction and manual removal.

Objectives

To compare the effects of manual removal of the placenta with cord traction at caesarean section.

Search strategy

We searched the Cochrane Pregnancy and Childbirth Group's Trials Register (30 September 2007).

Selection criteria

All randomised controlled trials comparing manual removal and cord traction or spontaneous of delivery of the placenta.

Data collection and analysis

Two authors independently assessed studies and extracted data.

Main results

We included 15 studies (4694 women). There was significant heterogeneity for the duration of surgery, blood loss and haematological outcomes. The only possible contributing factor found was greater protection from blood loss in two trials in which cord traction was combined with uterine massage. A random-effects model meta-analysis was used for these outcomes.

Manual removal of the placenta was associated with more endometritis (relative risk (RR) 1.64, 95% confidence interval (CI) 1.42 to 1.90; 4134 women, 13 trials); more blood loss (ml) (weighted mean difference (WMD) 94.42 ml, 95% CI 17.19 to 171.64; 2001 women, eight trials); more blood loss > 1000 ml (RR 1.81, 95% CI 1.44 to 2.28; 872 women, two trials); lower haematocrit after delivery (%) (WMD -1.55, 95% CI -3.09 to -0.01; 384 women, two trials); greater haematocrit fall after delivery (%) (WMD 0.39,

95% CI 0.00 to 0.78; 1777 women, five trials); longer duration of hospital stay (days) (WMD 0.39 days, 95% CI 0.17 to 0.61; 546 women, three trials).

The duration of surgery was shorter in one trial but not overall.

There were no significant differences in feto-maternal haemorrhage, blood transfusion, puerperal fever (numbers studied for these outcomes were small).

Authors' conclusions

Delivery of the placenta with cord traction at caesarean section has more advantages compared to manual removal. These are less endometritis; less blood loss; less decrease in haematocrit levels postoperatively; and shorter duration of hospital stay. Future trials should provide information on interval between the delivery of the infant and of the placenta, change in lochia, blood splashing during placental removal and uterine pain after operation, as well as the effects of delayed cord clamping.

PLAIN LANGUAGE SUMMARY

Placenta delivery at caesarean section

There are various methods of delivery of placenta at caesarean section. These include placental drainage with spontaneous delivery, cord traction and manual removal. The last two methods: cord traction (usually combined with massage or expression of the uterus) and manual removal are frequently used. The review identified 15 studies involving 4694 women. Delivery of the placenta by cord traction at caesarean section has more advantages compared to manual removal. These are less endometritis; less blood loss; less decrease in haematocrit levels postoperatively; and shorter duration of hospital stay.

BACKGROUND

Worldwide, caesarean section is the most common major operation performed on women. Some of the reported short-term morbidities include haemorrhage (Chamberlain 1999; Combs 1991), need for blood transfusion (Klapholz 1990), postoperative fever and endometritis (infection of the lining of the uterus) (Newton 1990). Long-term morbidities include placenta praevia (in which the placenta covers all or part of the cervical os), placenta accreta (in which the placenta is abnormally attached to uterine wall) and ectopic pregnancy (Almeida 2002; Gilliam 2002; Hemminki 1996). There are many possible ways of performing a caesarean section operation and variations in the techniques used may increase some of the complications mentioned. A series of Cochrane Reviews on this topic is currently being compiled (Alderdice 2003; Anderson 2004; Bamigboye 2003; Dodd 2004; Hofmeyr 2004; Jacobs-Jokhan 2004; Mathai 2007). The method of removing the placenta is one such procedure that may contribute to an increase or decrease in the morbidity of caesarean section.

The process of separation of the placenta starts immediately the baby is born when contraction and retraction of uterine muscles result in reduction in the size of the uterus. Consequently, the surface area of the uterus to which the placenta is attached (the placental bed) becomes smaller than the relatively incompressible placenta. As a result, the placenta is sheared off and the blood vessels supplying the now denuded placental bed are compressed by the continued contraction and retraction of the uterine muscles to reduce bleeding. Oxytocin is given either as an intravenous bolus dose, in an infusion or intramuscularly after the delivery of the baby to minimise blood loss. The value of routine oxytocics in the third stage of vaginal birth has been well established (Cotter 2001). Though little direct evidence exists, it seems reasonable to assume that these benefits would apply to caesarean delivery as well.

Different methods for the delivery of the placenta at caesarean section have been described: (1) placental drainage with spontaneous delivery (2) cord traction and (3) manual removal. In placental drainage, the end of the umbilical cord is left unclamped and placental blood is drained and the placenta delivers spontaneously through the uterine incision (Sharma 1995). This method is not widely used. The two methods most frequently used are cord traction, usually combined with external massage or expression of the uterus, and manual removal. Cord traction involves gentle traction on the umbilical cord with external uterine massage after an oxytocic has been given. Manual removal is the use of the gloved hand with a gentle sawing action to separate the placenta from its implantation site. Some obstetricians commonly practise manual removal as they consider it a quicker way to deliver the placenta than awaiting spontaneous separation. The process of manual removal of the placenta may cause more bleeding (Chamberlain 1999) and the introduction of a potentially contaminated hand into the uterus may increase the risk of infection (McCurdy 1992). Some studies (Atkinson 1996; Magann 1993) have found the procedure of manual removal of the placenta to increase postoperative morbidity, while others (Cernadas 1988) have not.

Caesarean section is a common operation and needs to be made as safe as possible. Techniques to reduce some of the morbidities associated with this operation are very important. The principal question is whether the practice of manual removal of the placenta at caesarean section should continue or not.

OBJECTIVES

To compare, using the best available evidence, the effects of manual removal of placenta compared with cord traction or other methods of removal of the placenta at caesarean section.

METHODS

Criteria for considering studies for this review

Types of studies

All published, unpublished and ongoing randomised controlled trials comparing manual removal of the placenta with cord traction or other methods at caesarean section. We excluded quasi-randomised trials (eg those randomised by date of birth or hospital number) from the analysis.

Types of participants

Women undergoing a caesarean section, whether emergency or elective.

Types of interventions

Manual removal of the placenta
Cord traction/expression to remove the placenta

Types of outcome measures

Primary outcomes

For the woman

Blood loss of more than 1000 ml at caesarean section and up to 24 hours after surgery.

Secondary outcomes

For the woman

1. Duration of operation (minutes);
2. duration of placental removal (minutes);
3. blood splashing during placental removal;
4. feto-maternal haemorrhage;
5. uterine pain after operation;
6. blood transfusion;
7. secondary postpartum haemorrhage (excess vaginal bleeding occurring from 24 hours to six weeks after delivery);

8. maternal haematocrit or haemoglobin level after delivery;
9. maternal haematocrit or haemoglobin level change after delivery;
10. postoperative anaemia as defined by trial authors;
11. postoperative anaemia or blood transfusion;
12. change in lochia, as described by trial authors;
13. endometritis, defined as fever of 38ºC or more, and uterine tenderness, or as defined by trial authors;
14. puerperal fever, defined as temperature of 38ºC or more 24 hours after delivery, or as defined by trial authors.

Health service use

1. Length of postoperative hospital stay for the mother (days).

Search methods for identification of studies

Electronic searches

We searched the Cochrane Pregnancy and Childbirth Group's Trials Register by contacting the Trials Search Co-ordinator (30 September 2007).

The Cochrane Pregnancy and Childbirth Group's Trials Register is maintained by the Trials Search Co-ordinator and contains trials identified from:

1. quarterly searches of the Cochrane Central Register of Controlled Trials (CENTRAL);
2. weekly searches of MEDLINE;
3. handsearches of 30 journals and the proceedings of major conferences;
4. weekly current awareness alerts for a further 44 journals plus monthly BioMed Central email alerts.

Details of the search strategies for CENTRAL and MEDLINE, the list of handsearched journals and conference proceedings, and the list of journals reviewed via the current awareness service can be found in the 'Specialized Register' section within the editorial information about the CochranePregnancyandChildbirthGroup. Trials identified through the searching activities described above are each assigned to a review topic (or topics). The Trials Search Co-ordinator searches the register for each review using the topic list rather than keywords.

Searching other resources

In addition, we handsearched the reference lists of relevant papers. We did not apply any language restrictions.

Data collection and analysis

We evaluated trials under consideration for appropriateness for inclusion and methodological quality without consideration of their results. This was done by two review authors according to the prestated eligibility criteria.

We assessed trials that met the eligibility criteria for quality using the following criteria:

1. generation of random allocation sequence: adequate, inadequate, unclear;
2. allocation concealment: A = adequate, B = unclear, C = inadequate;
3. blinding of participants: yes, no, inadequate, no information;
4. blinding of caregivers: yes, no, inadequate, no information;
5. blinding of outcome assessment: yes, no, inadequate or no information;
6. completeness of follow-up data (including any differential loss of participants from each group): A = less than 3% of participants excluded, B = 3% to 9.9% of participants excluded, C = 10% to 19.9% excluded, D = 20% or more excluded, E = unclear;
7. analysis of participants in randomised groups.

If a publication did not report analysis of participants in their randomised groups, we would attempt to restore them to the correct group.

Two review authors extracted data from the original publications onto data extraction forms. Data from different trials were combined if they were sufficiently similar for this to be reasonable in the judgment of the review authors. We performed meta-analyses using relative risks as the measure of effect size for binary outcomes, and weighted mean differences for continuous outcome measures, both with 95% confidence intervals. If trials used different ways of measuring the same continuous outcome (for example, pain), we used standardised mean differences.

We used fixed-effect meta-analysis for combining study data if the trials were judged to be sufficiently similar. We investigated heterogeneity by calculating I^2 statistics (Higgins 2002), and if this indicated a high level of heterogeneity among the trials included in an analysis ($I^2 > 50\%$)), random-effects meta-analysis was preferred for an overall summary. Where high levels of heterogeneity were found they were explored by the prespecified subgroup analyses and by sensitivity analyses excluding the trials most susceptible to bias based on the quality assessment: those with inadequate allocation concealment (B or C). Subgroup analysis was attempted for: elective caesarean section; emergency caesarean section; caesarean section mixed or undefined.

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies.

We retrieved 19 studies. We included 15 trials (N = 4694), eight of them (Atkinson 1996; Cernadas 1998; Chandra 2002; Lasley 1997; Magann 1993; Magann 1995; McCurdy 1992;

Sepilian 2003) from the USA, two (Baksu 2005; Gol 2004) from Turkey and one each (Dehbashi 2004; Hidar 2004; Morales 2004; Notelovitz 1972; Ramadani 2004) from Iran, Tunisia, Switzerland/Belgium, South Africa and Saudi Arabia, respectively. One of the included studies was a conference abstract (Sepilian 2003).
Three of the trials compared the effect of glove change on the development of endometritis in the two groups (Atkinson 1996; Cernadas 1998; Chandra 2002). Three trials compared the effect of in-situ repair of the uterine incision and exteriorisation of the uterus for repair of the incision on operative blood loss and endometritis (Baksu 2005; Magann 1993; Magann 1995). For further details see the 'Characteristics of included studies' table.
Three studies (Hidar 2004; Lasley 1997; McCurdy 1992) specified that uterine massage was used during cord traction.
We excluded two studies (Franchi 2002; Sharma 1995) from the review. The reasons for exclusion are described in the 'Characteristics of excluded studies' table.
Two reports of the study Magann 1993 appear to be of the same study population as the data in the two reports are very similar except for sample size. The numbers studied were 100 in the *Surgery, Gynecology and Obstetrics* paper and 120 in the *Infectious Diseases in Obstetrics and Gynaecology* paper. We have used data from the latter paper for all outcomes except those relating to blood loss. For blood loss outcomes, we have used data from the former paper, as blood loss was the main focus of the paper.
Two studies (Magann 1993; Magann 1995) used a factorial design with four groups: manual placental removal with in-situ and exteriorised uterine repair, and cord traction with in-situ and exteriorised uterine repair. For categorical data, we have added together the data from the in-situ and exteriorised groups. For continuous data, we have calculated pooled means and pooled standard deviations.
In one trial (Morales 2004), manual removal of the placenta was performed if spontaneous delivery had not occurred in 10 minutes or there was excessive bleeding.

Risk of bias in included studies

The sample size of the studies was variable. The largest study (Baksu 2005) enrolled 840 women, while two studies (McCurdy 1992; Notelovitz 1972) enrolled 62 women each.
Twelve trials (4223 women) had adequate concealment and in three trials (543 women) (Dehbashi 2004; Notelovitz 1972; Sepilian 2003), concealment was unclear.
The blood loss at operation was estimated by different methods in the various trials. Blood loss was taken as both amniotic fluid and blood in one trial (Gol 2004). In two other trials (Magann 1993; Morales 2004) the estimated liquor volume was subtracted from measured blood in the suction apparatus and the drapes/packs to determine the amount of blood loss. In the trial by Ramadani 2004, amniotic fluid was drained to minimise absorption by packs and the difference between wet and dry packs was taken as the blood loss. In one trial (Cernadas 1998), the surgeon estimated the blood loss. Because the amniotic fluid volume would be expected to be balanced between groups and would therefore not affect the difference between measured blood losses, we combined results including and excluding amniotic fluid.
Lower segment transverse incisions only were used in four trials (Baksu 2005; Dehbashi 2004; Gol 2004; Ramadani 2004). In others (Atkinson 1996; Hidar 2004; Magann 1993; Magann 1995; McCurdy 1992) classical, lower segment transverse and vertical incisions were used. All the included trials except one included women undergoing either emergency or elective caesarean section. Dehbashi 2004 included only women undergoing elective caesarean section. Three trials (Dehbashi 2004; Hidar 2004; Morales 2004) included only women whose gestational ages were 34 weeks and above.

Most of the studies did not mention blinding at the time of measurement of blood loss in theatre and reading of charts on the wards. Only one trial (Cernadas 1998) recorded that the investigator reviewing the charts was blinded to study group.

Effects of interventions

There was significant heterogeneity for several outcomes. The random-effects model was used for meta-analysis of outcomes with significant heterogeneity.
Endometritis
Thirteen studies (Atkinson 1996; Baksu 2005; Cernadas 1998; Chandra 2002; Dehbashi 2004; Gol 2004; Hidar 2004; Lasley 1997; Magann 1993; Magann 1995; McCurdy 1992; Ramadani 2004; Sepilian 2003) reported on endometritis. The rate of endometritis was significantly higher in women who had manual removal of the placenta compared with those who had cord traction (relative risk (RR) 1.64, 95% confidence interval (CI) 1.42 to 1.90; 4134 women).

Operative blood loss We included eight studies (Cernadas 1998; Chandra 2002; Gol 2004; Magann 1993; Magann 1995; McCurdy 1992; Morales 2004; Ramadani 2004). Women who had manual removal of the placenta lost significantly more blood than those who had cord traction (weighted mean difference (WMD) 94.42 ml, 95% CI 17.19 to 171.64, random-effects model; 2001 women). There was significant heterogeneity (I^2 = 91%). This was not accounted for by trial quality (all trials with data had adequate allocation concealment). It was partly accounted for by trial size: sensitivity analysis excluding the two smallest trials reduced but did not eliminate the heterogeneity (I^2 = 69%).
Two other trials (Dehbashi 2004; Morales 2004) estimated blood loss greater than 1000 ml and this also was significantly more common in the manual removal group (RR 1.81, 95% CI 1.44 to 2.28; 872 women).
Haematocrit levels after delivery
Two trials (Magann 1993; Magann 1995) reported on the absolute haematocrit levels after delivery. The postdelivery haematocrit

levels were significantly lower in the manual removal group compared with the cord traction group (WMD -1.55, 95% CI -3.09 to -0.01, random-effects model; 384 women). There was significant heterogeneity, which was not accounted for by trial quality (both trials had adequate allocation concealment).

Maternal haematocrit fall after delivery

Four trials were included (Atkinson 1996; Baksu 2005; Hidar 2004; Magann 1993).There was a significantly greater fall in postoperative haematocrit when the placenta was delivered by manual removal compared to when it was delivered by cord traction (WMD 3.04, 95% CI 0.81 to 5.27, random-effects model; 1883 women). There was significant heterogeneity (I^2 = 98%).

Haemoglobin level after delivery

Two studies (Gol 2004; Ramadani 2004) reported on maternal haemoglobin levels after delivery. The difference was not statistically significant (WMD -0.36 g%, 95% CI -1.24 to 0.52, random-effects model; 600 women). THere was significant heterogeneity (I^2 = 94%).

Haemoglobin fall after delivery

Five studies (Baksu 2005; Chandra 2002; Gol 2004; Hidar 2004; McCurdy 1992) reported on fall in haemoglobin levels after delivery. There was a greater fall in haemoglobin levels in the women who had manual removal of the placenta which was of borderline statistical significance (WMD 0.39, 95% CI 0.00 to 0.78, random-effects model; 1777 women). There was significant heterogeneity (I^2 = 92%). The difference was significant for the two trials which specified that cord traction was combined with uterine massage (Hidar 2004; McCurdy 1992) (WMD 0.83 g%, 95% CI 0.23 to 1.42, random-effects model, I^2 = 85%), but not for the other trials (WMD 0.13, 95% CI -0.16 to 0.42, random-effects model, I^2 = 76%). This suggests that uterine massage may have added to the protective effect of cord traction.

Feto-maternal haemorrhage

Two studies were included (Morales 2004; Notelovitz 1972). They found no significant difference in the incidence of feto-maternal haemorrhage when the placenta was delivered by cord traction or by manual removal (RR 1.58, 95% CI 0.78 to 3.18; 534 women).

Postoperative blood transfusion

Four studies (Atkinson 1996; Gol 2004; Morales 2004; Ramadani 2004) reported on postoperative blood transfusion. There was no significant difference in the rate of transfusion when the placenta was delivered by manual removal or by cord traction (RR 0.70, 95% CI 0.40 to 1.20; P = 0.20, 1715 women).

Duration of operation (in minutes)

Eight trials (Cernadas 1998; Chandra 2002; Gol 2004; Magann 1993; Magann 1995; McCurdy 1992; Morales 2004; Ramadani 2004) reported on the duration of operation. They found no significant difference in the duration of operation (WMD -0.97, 95% CI -3.47 to 1.54, random-effects model; 2021 women). There was significant heterogeneity (I^2 = 91%). In one study (Gol 2004) the time measured was from initiation of surgery to delivery of the placenta, which was included as a proxy measurement of duration of the operation. Sensitivity analysis excluding this trail had no effect on the overall outcome.

Puerperal fever

Only two studies (Cernadas 1998; Morales 2004) reported on puerperal fever. Analysis of these two studies did not show any significant difference in the rate of puerperal fever among women who had manual removal of and those who had cord traction (RR 1.14, 95% CI 0.63 to 2.08; 580 women).

Length of hospital stay in days

Three trials (Gol 2004; Magann 1995; McCurdy 1992) reported on duration of hospital stay. This was significantly longer when the placenta was delivered by manual removal than by cord traction (WMD 0.39, 95% CI 0.17 to 0.61; 546 women).

None of the trials reported on blood splashing during placenta removal, duration of placenta delivery, secondary postpartum haemorrhage (excess vaginal bleeding occurring from 24 hours to six weeks after delivery), postoperative anaemia, change in lochia, and uterine pain after the operation.

DISCUSSION

This review shows that manual removal of the placenta at caesarean section is associated with an increased risk of postcaesarean endometritis compared with placental delivery by cord traction. Tissue trauma, entry of bacterially contaminated blood into uterine sinuses before involution of the placental implantation site, surgical contamination and increased blood loss are possible explanations for the increased endometritis (McCurdy 1992). During manual removal the placenta is directly detached from the uterine wall, leaving dilated sinuses which may be inoculated directly by bacteria from the surgeon's glove. It has been shown that in labouring women who undergo caesarean section, the glove of the dominant hand (the one that is introduced into the uterus for manual removal) of the primary surgeon is contaminated with pathogenic bacterial in 71% of cases (Yancey 1996). Changing gloves during manual removal does not reduce infection as the new glove still passes through the contaminated wound before contact with sinuses (Atkinson 1996).

The overall rate of endometritis in the manual removal group was about 18.4% compared with 11.3% in the cord traction group. Chandra 2002 attributed his finding of a relatively low rate (2.5%) perhaps to the use of three doses of antibiotics instead of a single dose used in the other trials. Endometritis was not the primary objective of the study by Ramadani 2004.

Blood loss was significantly greater following manual removal of the placenta. There was significant heterogeneity between the results (I^2 = 91%). There was no clear pattern of studies that estimated blood loss having larger treatment effects than those that

measured it. In the third stage of labour, the reduction in the uterine size leads to reduction of the surface area of the placental bed. This causes shearing of the relatively incompressible placenta. Release of endogenous oxytocin causes continued retraction of the myometrium and the compression of the blood vessels supplying the placental site by the oblique muscles of the middle layer of the myometrium. This process leads to haemostasis. When the placenta is grasped and manually detached from the uterine wall it leaves no time for the described physiological process of haemostasis to take place. This leaves open dilated sinuses, which bleed until the uterine musculature eventually compresses them.

The concern that measurement or estimation of blood loss may have been subject to observer bias is addressed by the fact that there were significantly greater absolute and falls in haematocrit levels in the manual removal group. Change in haematocrit level is a more objective method of measuring blood loss than estimation of volume of blood loss at operation. The fall in haemoglobin levels was in the same direction, though of borderline statistical significance. Manual removal is therefore associated with significantly greater blood loss compared with delivery of the placenta by cord traction.

The rate of blood transfusion was similar in both groups. Few women were transfused in the included trials.

The duration of operation was not, overall, significantly different between groups. There was significant heterogeneity of results (I^2 = 91%). Seven trials showed no significant difference, while one trial (Ramadani 2004) found the operating time to be significantly shorter in the manual removal group. Only one trial (Morales 2004) reported the interval from birth of the baby to delivery of the placenta, which was significantly shorter in the manual removal of the placenta group (P = 0.0001). Perhaps future trials should look at the time interval between the delivery of the fetus and the delivery of the placenta, as the duration of operation depends on several factors with time taken to deliver the placenta being just one of them. However, it is possible that time saved by manual removal of the placenta may be counteracted by delays in closure of the uterus related to increased bleeding.

Women who had manual removal had a significantly longer postoperative hospital stay. The significant morbidity associated with manual removal may be responsible. This could have cost implications though cost analyses were not done.

Research has shown that delayed cord clamping after vaginal birth reduces anaemia in childhood, and for preterm births reduces the risk of intraventricular haemorrhage. The timing of cord clamping was not addressed in these trials. Delaying cord clamping might allow time for placental separation prior to applying cord traction.

AUTHORS' CONCLUSIONS

Implications for practice

Delivery of the placenta by cord traction at caesarean section has more advantages than manual removal. There is less endometritis; less blood loss; less decrease in haematocrit levels postoperatively and shorter duration of hospital stay. A possible longer interval between birth of the baby and delivery of the placenta is the only disadvantage, but this did not significantly increase the overall duration of surgery.

Implications for research

There is limited information on the interval between the delivery of the infant and of the placenta, change in lochia, blood splashing during placental removal and uterine pain after the operation. However, given the clear disadvantages of manual removal of the placenta, further research employing this method may not be justified. Future research might assess the risks and benefits of uterine massage or expression during delivery of the placenta, as well as strategies for placental delivery associated with delayed clamping of the umbilical cord.

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As part of the pre-publication editorial process, this review has been commented on by two peers (an editor and referee who is external to the editorial team), one or more members of the Pregnancy and Childbirth Group's international panel of consumers and the Group's Statistical Adviser.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Atkinson 1996

Methods	Women were randomised into 4 groups using computer-generated group assignment.
Participants	643 women undergoing elective or emergency caesarean section. Women with chorioamnionitis and those who required emergency caesarean hysterectomy were excluded from the study.
Interventions	Manual removal of placenta and expression of placenta by cord traction with or without intraoperative glove change.
Outcomes	Endometritis, change in haematocrit and postdelivery transfusion.
Notes	Exteriorisation of uterus for repair-single layer closure of uterus. Single dose of cephalosporin was given for prophylaxis. USA.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Baksu 2005

Methods	Women were randomised to 1 of the 4 study groups. Randomisation was achieved through use of a computer-generated random-number table with group assignments sealed in opaque envelopes which were not opened until immediately before the woman entered the operation room.
Participants	840 women undergoing either elective or emergency caesarean section. Women who received intrapartum antibiotics for any reason, had chorioamnionitis, had rupture of membranes for more than 12 hrs, with a bleeding diathesis, had abnormal placentation or prior postpartum haemorrhage and who required an emergency cesarean hysterectomy were excluded from the study.
Interventions	Manual removal of placenta and expression of placenta by cord traction; uterus left in situ or exteriorised for repair.
Outcomes	Decrease in haematocrit and haemoglobin 24 hrs after delivery, incidence of endometritis.
Notes	6 women who required caesarean hysterectomy and 34 who had to use antibiotics for various reasons were excluded from the analysis. Single-dose cephalosporin and 20 units of syntocinon were given after clamping cord. No glove change. Single layer closure of uterine incision. Turkey, June 1998 to November 2002.

Baksu 2005 (*Continued*)

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Yes	A - Adequate

Cernadas 1998

Methods	Women were randomised into 4 groups using computer-generated random-group assignment.
Participants	108 women undergoing either elective or emergency caesarean. Women section (primary or repeat). Women with multiple pregnancy, pre-existing maternal conditions such as urinary tract infections, upper respiratory tract infections, pneumonia or clinically documented infections other than chorioamnionitis were excluded.
Interventions	Manual removal of placenta and expression of placenta by cord traction; with or without intraoperative glove change.
Outcomes	Estimated blood loss, duration of operation, febrile morbidity, endometritis and length of hospital stay.
Notes	Data collection from records was performed blind to the group allocation. The method of uterine repair was not stated. Women with clinical chorioamnionitis were included in the study. Intraoperative antibiotics were used based on attending physician's preference and clinical circumstances. USA October 1995 to March 1996.

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Yes	A - Adequate

Chandra 2002

Methods	Randomisation was achieved by the use of table of random numbers and sealed opaque envelopes.
Participants	386 women undergoing nonemergency caesarean section. Women with chorioamnionitis, placenta accreta and those undergoing emergency caesarean section were excluded.
Interventions	Manual removal of placenta and expression of placenta by cord traction. Glove change prior to removal of placenta.
Outcomes	Estimated blood loss, change in haemoglobin and endometritis.

Chandra 2002 (*Continued*)

Notes	Discrepancy in groups not accounted for (198 vs 177). Exteriorisation of uterus for a 2-layer uterine repair. 20 units of oxytocin prior to removal of placenta. Intraoperative cephalosporin followed by 2 doses over next 24 for hrs. Inadequate data in 11 (5 manual removal, 6 cord traction, excluded) and failure to adhere to assigned method of placenta delivery in 10 (3,7). Data analysed in 375 women on 'intention-to-treat' basis. USA, November 1998 to March 2000.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Dehbashi 2004

Methods	Randomisation into 2 groups.
Participants	400 consecutive women undergoing elective caesarean deliveries only were considered.
Interventions	Manual removal of placenta and expression of placenta by cord traction.
Outcomes	Significant haemoglobin drop, ie more than 1 gm/dl. Endometritis.
Notes	Method of randomisation not stated. No prophylactic antibiotics given. The uterus was exteriorised for a 3-layer closure of the low transverse incision. Iran.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Gol 2004

Methods	Consenting women were randomised, using numerically-ordered cards in sealed envelopes, to either the study group, manual placenta removal or the control group, spontaneous separation.
Participants	200 women undergoing primary or repeat caesarean delivery (elective or emergency).
Interventions	Manual placenta removal and spontaneous separation.
Outcomes	Duration of surgery, intraoperative blood loss, decrease in haemoglobin and postoperative hospital stay.

Gol 2004 (*Continued*)

Notes	Syntocinon 20 units and single dose of cephalosporin given. No glove change. Uterine incision closed in 1 layer. Turkey.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Hidar 2004

Methods	Assignment was made through the use of a computer-generated random-numbers table. The assigned treatment was written on a card and sealed in opaque envelopes consecutively numbered that were opened just immediately before the procedure.
Participants	302 women undergoing primary or repeat caesarean delivery (elective or emergency). Women diagnosed with gestational diabetes, severe pre-eclampsia, placenta previa, chorioamnionitis, multiple gestations, maternal coagulopathy, or < 20 years were excluded.
Interventions	Spontaneous separation of placenta and manual removal of placenta.
Outcomes	Endometritis, drop in haematocrit and haemoglobin, mean oxytocin dose used.
Notes	Peri-operative single dose cephalosporin and oxytocin infusion after delivery of infant. In-situ repair of uterus. 151 of the 153 in the manual group completed trial while 2 of 149 were in the spontaneous placenta delivery group but in 2 cases had manual delivery because of failure of spontaneous delivery. Turkey.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Lasley 1997

Methods	Women randomised into 2 groups. Randomisation was achieved through use of a computer-generated random-numbers table and group assignments sealed in opaque envelopes that were not opened until immediately the woman entered the operating suite.
Participants	334 women undergoing either elective or caesarean section. Women who received intrapartum antibiotics for chorioamnionitis or group B streptococcus were excluded from the study.

Lasley 1997 (*Continued*)

Interventions	Manual removal of placenta and expression of placenta by cord traction. Glove change for delivery of placenta.
Outcomes	Endometritis, wound infection.
Notes	Oxytocin infusion and single-dose cephalosporin given after delivery of fetus. Uterus exteriorised for repair. USA.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Magann 1993

Methods	Women randomised into 4 groups (manual removal of placenta in situ or exteriorisation of uterus for repair and spontaneous delivery in situ or exteriorisation of uterus for repair) using a table of random numbers.
Participants	120 women undergoing elective or emergency caesarean section (primary or repeat). Women with chorioamnionitis, on steroids or insulin and those with thrombocytopenia or coagulopathy were excluded. In the report in Surgery, Gynecology and Obstetrics, data on 100 women were reported.
Interventions	Manual removal or spontaneous delivery of placenta; uterus left in situ or exteriorised for repair.
Outcomes	Endometritis, intraoperative blood loss and drop in haematocrit.
Notes	No glove change for placenta delivery. No prophylactic antibiotics given at delivery. USA.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Magann 1995

Methods	Random assignment by computer-generated cards in sealed envelopes.
Participants	284 women undergoing caesarean section with prophylactic antibiotics. Exclusion criteria: prior caesarean section without labour, chorioamnionitis.

Magann 1995 (*Continued*)

Interventions	1. Spontaneous placental removal (gentle uterine massage and cord traction), in-situ uterine repair. 2. spontaneous placental removal, exteriorised uterine repair. 3. manual placental removal, in-situ uterine repair. 4. manual placental removal, exteriorised uterine repair.
Outcomes	Operative blood loss was calculated by measuring blood in the suction apparatus and on sterile drapes, lap pads and sponges. Endometritis was based on pyrexia of 38 degrees C on 2 occasions 6 hrs apart excluding the first 24 hrs, uterine tenderness or foul smelling lochia.
Notes	Mississippi Medical Center, USA, October 1993 to April 1994.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

McCurdy 1992

Methods	Women were randomised into study and control groups by cards in numerically ordered and sealed envelopes.
Participants	62 women undergoing either elective or emergency caesarean section. Women < 18 years old were excluded.
Interventions	Manual removal of placenta vs delivery of the placenta by cord traction.
Outcomes	Operative blood loss measured from packs and fluids; decrease in haemoglobin at 12 and 48 hrs post op; duration of hospital stay; endometritis; other complications.
Notes	Surgeons were board-certified obstetricians. Uterine incisions were transverse or vertical. Single dose of cephalosporin given intraoperatively. USA.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Morales 2004

Methods	Allocation was by computer-generated numbers, with randomly permuted blocks of 4, 6 and 8 participants. Women with gestational age less than 34 weeks, multiple pregnancy, placenta praevia, intrapartum fever, suspected chorioamnionitis, and clotting disorders were excluded.
Participants	472 women undergoing elective or an emergency caesarean section (primary or repeat). The exclusion criteria were gestational age less than 34 weeks, multiple pregnancy, placenta praevia, intrapartum fever and suspected chorioamnionitis, and clotting disorders.
Interventions	Spontaneous delivery and manual removal of the placenta.
Outcomes	Interval between delivery of infant and of the placenta, use of additional ocytocin, blood loss, operating time, feto-maternal transfusion and antibiotic administration.
Notes	In the control group manual removal was done if spontaneous delivery had not occurred after 10 minutes, or there was excessive bleeding. In both groups, oxytocin and a cephalosporin were given intravenously after the delivery of the infant. No exteriorisation of uterus during repair. 31 (13%) in the spontaneous group deviated from the protocol. Tunisia, Belgium, Switzerland.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Notelovitz 1972

Methods	Women were allocated 'on a random sample basis'.
Participants	62 women undergoing elective or emergency caesarean section. Women who were Rh negative were excluded.
Interventions	Manual removal of placenta versus expression of placenta by cord traction.
Outcomes	Feto-maternal transfusion.
Notes	Syntocinon given with the crowning of the head through incision. No glove change. Method of uterine repair not stated. South Africa.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Ramadani 2004

Methods	Women were randomised into study and control groups using randomised cards, which were placed in numerically ordered and sealed envelopes.
Participants	400 women undergoing primary, repeat, elective or emergency caesarean section. Women with multiple gestations were excluded from the study.
Interventions	Manual removal of placenta and expression of placenta by cord traction.
Outcomes	Endometritis, estimated blood loss, postoperative haemoglobin, duration of surgery.
Notes	Operations were performed by a 3rd- or 4th-year resident supervised by a Board-certified consultant. Exteriorisation of uterus for repair. 2 grams of a 2nd-generation cephalosporin was given for antibiotic prophylaxis. Saudi Arabia.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Sepilian 2003

Methods	Women were randomised into 2 groups.
Participants	81 women undergoing elective caesarean section.
Interventions	Spontaneous delivery and manual removal of the placenta.
Outcomes	Endometritis, postoperative drop in haemoglobin and length of hospital stay. No standard deviations given.
Notes	USA.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

hrs: hours
vs: versus

Characteristics of excluded studies *[ordered by study ID]*

Franchi 2002	This study compared Joel-Cohen incision and Pfannenstiel incision. The delivery of the placenta was not randomised. Cord traction was the method used in delivering the placenta.
Sharma 1995	Excluded because method of allocation not described, and there was a large discrepancy between the groups (64 versus 84). The study evaluated the efficacy of unclamping the cord for spontaneous delivery of the placenta and cord traction. The placenta was removed by cord traction if spontaneous delivery by unclamping the cord failed and manual removal was done if cord traction failed.

DATA AND ANALYSES

Comparison 1. Manual placental removal versus cord traction

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Endometritis	13	4134	Risk Ratio (M-H, Fixed, 95% CI)	1.64 [1.42, 1.90]
2 Puerperal fever	2	580	Risk Ratio (M-H, Fixed, 95% CI)	1.14 [0.63, 2.08]
3 Feto-maternal haemorrhage	2	534	Risk Ratio (M-H, Fixed, 95% CI)	1.58 [0.78, 3.18]
4 Operative blood loss (ml)	8	2001	Mean Difference (IV, Random, 95% CI)	94.42 [17.19, 171.64]
5 Blood loss > 1000 ml	2	872	Risk Ratio (M-H, Fixed, 95% CI)	1.81 [1.44, 2.28]
6 Duration of operation (minutes)	8	2021	Mean Difference (IV, Random, 95% CI)	-0.97 [-3.47, 1.54]
7 Haematocrit levels after delivery	2	384	Mean Difference (IV, Random, 95% CI)	-1.55 [-3.09, -0.01]
8 Maternal haematocrit fall after delivery	4	1883	Mean Difference (IV, Random, 95% CI)	3.04 [0.81, 5.27]
9 Haemoglobin levels after delivery	2	600	Mean Difference (IV, Random, 95% CI)	-0.36 [-1.24, 0.52]
10 Maternal haemoglobin fall after delivery	5	1777	Mean Difference (IV, Random, 95% CI)	Not estimable
11 Blood transfusion	4	1715	Risk Ratio (M-H, Fixed, 95% CI)	0.70 [0.40, 1.20]
12 Length of postoperative hospital stay for the mother	3	546	Mean Difference (IV, Fixed, 95% CI)	0.39 [0.17, 0.61]

WHAT'S NEW

Last assessed as up-to-date: 13 March 2008.

18 March 2008	Amended	Converted to new review format.

HISTORY

Protocol first published: Issue 2, 2004

Review first published: Issue 3, 2008

CONTRIBUTIONS OF AUTHORS

RI Anorlu (RIA) and B Maholwana (BW) prepared the protocol. RIA and BH collected the data. RIA and GJ Hofmeyr (GJH) did the data extraction and analysis. RIA wrote the draft review and revised it in response to editorial feedback. GJH commented on all drafts.

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

- Effective Care Research Unit, University of the Witwatersrand/University of Fort Hare, South Africa.
- South African Medical Research Council, South Africa.

External sources

- Effective Health Care Alliance Programme, International Health Research Group, Liverpool School of Tropical Medicine, UK.
- South African Cochrane Centre, South Africa.
- Effective Care Research Unit, University of the Witwatersrand/University of Fort Hare, South Africa.

INDEX TERMS

Medical Subject Headings (MeSH)

Blood Loss, Surgical; *Cesarean Section; Endometritis [etiology]; *Labor Stage, Third; *Placenta; Randomized Controlled Trials as Topic; Specimen Handling [adverse effects; *methods]; Traction [*methods]

MeSH check words

Female; Humans; Pregnancy