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Hofmeyr GJ, Mathai M, Shah AN, Novikova N

Hofmeyr GJ, Mathai M, Shah AN, Novikova N.
Techniques for caesarean section.
Cochrane Database of Systematic Reviews 2008, Issue 1. Art. No.: CD004662.
DOI: 10.1002/14651858.CD004662.pub2.

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[Intervention Review]

Techniques for caesarean section

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Editorial group: Cochrane Pregnancy and Childbirth Group.
Publication status and date: Edited (no change to conclusions), published in Issue 9, 2012.

Citation: Hofmeyr GJ, Mathai M, Shah AN, Novikova N. Techniques for caesarean section. *Cochrane Database of Systematic Reviews* 2008, Issue 1. Art. No.: CD004662. DOI: 10.1002/14651858.CD004662.pub2.

ABSTRACT

Background

Rates of caesarean section (CS) have been rising globally. It is important to use the most effective and safe technique.

Objectives

To compare the effects of complete methods of caesarean section; and to summarise the findings of reviews of individual aspects of caesarean section technique.

Search methods

We searched the Cochrane Pregnancy and Childbirth Group's Trials Register (August 2007), the Cochrane Central Register of Controlled Trials (*The Cochrane Library* 2007, Issue 3) and reference lists of identified papers. *We updated this search on 15 February 2012 and added the results to the awaiting classification section.*

Selection criteria

Randomised controlled trials of intention to perform caesarean section using different techniques.

Data collection and analysis

Two review authors independently assessed studies and extracted data.

Main results

'Joel-Cohen based' compared with Pfannenstiel CS was associated with:

less blood loss, (five trials, 481 women; weighted mean difference (WMD) -64.45 ml; 95% confidence interval (CI) -91.34 to -37.56 ml);
shorter operating time (five trials, 581 women; WMD -18.65; 95% CI -24.84 to -12.45 minutes);
postoperatively, reduced time to oral intake (five trials, 481 women; WMD -3.92; 95% CI -7.13 to -0.71 hours);
less fever (eight trials, 1412 women; relative risk (RR) 0.47; 95% CI 0.28 to 0.81);
shorter duration of postoperative pain (two comparisons from one trial, 172 women; WMD -14.18 hours; 95% CI -18.31 to -10.04 hours);
fewer analgesic injections (two trials, 151 women; WMD -0.92; 95% CI -1.20 to -0.63); and
shorter time from skin incision to birth of the baby (five trials, 575 women; WMD -3.84 minutes; 95% CI -5.41 to -2.27 minutes).
Serious complications and blood transfusions were too few for analysis.

Authors' conclusions

'Joel-Cohen based' methods have advantages compared to Pfannenstiel and to traditional (lower midline) CS techniques, which could translate to savings for the health system. However, these trials do not provide information on mortality and serious or long-term morbidity such as morbidly adherent placenta and scar rupture.

[Note: The 19 citations in the awaiting classification section of the review may alter the conclusions of the review once assessed.]

PLAIN LANGUAGE SUMMARY

Techniques for caesarean section

Caesarean sections are performed as both elective and urgent procedures and the rates are rising. The major complications are intraoperative damage to organs, anaesthetic complications, bleeding, infection and thromboembolism. The techniques used vary considerably. Available evidence from randomised controlled trials suggests that the Joel-Cohen based techniques (Joel-Cohen, Misgav-Ladach) have short-term advantages over Pfannenstiel (11 trials) and traditional lower midline (two trials) methods. Blood loss, operating time, time from skin incision to birth of the baby, use of pain killers, time to oral intake and bowel function or mobilisation and fever are all reduced.

Use of Joel-Cohen based methods could result in improved short-term outcomes and savings for health systems but robust data on long-term outcomes (pain, fertility, morbidly adherent placenta and rupture of the uterus) after the different techniques (including two suture layers compared with single-layer uterine closure) are needed.

BACKGROUND

Caesarean section is one of the most commonly performed major abdominal operations in women in both affluent and low-income countries. Rates vary considerably between countries and health services (Dumont 2001; Murray 1997; Pai 1999). Global estimates indicate a caesarean section rate of 15% worldwide, ranging from 3.5% in Africa to 29.2% in Latin America and the Caribbean (Betran 2007). Studies from the United States of America (Menacker 2001), the United Kingdom (Thomas 2001) and China (Cai 1998) report rates between 20% and 25%. A study in Latin America found a range of 1.6% in a Haitian hospital to 40% in Chile, and above 50% in most private hospitals (Belizan 1999). Rates from West and East African countries ranged from 0.3% in Niger to 10.5% in Kenya (Beukens 2001). Before 1970, caesarean section rates in most middle- to high-income countries ranged between 3% and 5%.

There are many possible ways of performing a caesarean section. A study of obstetricians in the UK found a wide variation in techniques (Tully 2002). For elective surgery more than 80% used the Pfannenstiel abdominal entry and double-layer uterine closure. For emergency surgery, more used the Joel-Cohen abdominal entry. A North American survey of Obstetric and Gynaecologic residents found that 77% use a Pfannenstiel incision for urgent or emergency caesarean sections, 55% use single-layer closure of the uterine incision, 37% use double-layer closure, while 11% use single-layer closure only in women undergoing concomitant sterilization (Dandolu 2006). The history of caesarean section techniques has been reviewed by Lurie 2003. The techniques used may depend on many factors including the clinical situation and the preferences of the operator. Caesarean section is often performed as an emergency procedure after hours when senior staff may not be immediately available. It is important that all those who perform this operation use the most effective and safe techniques, as determined by a systematic review of randomised trials.

Caesarean sections may be elective or emergency procedures (usually during labour). Common reasons for carrying out caesarean section include:
1. failure to progress in labour;
2. suspected fetal distress (*see* review 'Operative versus conservative management for 'fetal distress' in labour' (Hofmeyr 1998));
3. previous uterine surgery;
4. very low birthweight (*see* review 'Elective caesarean section versus expectant management for delivery of the small baby' (Grant 2001));
5. fetal malpresentation (e.g. breech, transverse lie) (*see* review 'Planned caesarean section for term breech delivery' (Hofmeyr 2003));
6. placenta praevia (*see* review 'Interventions for suspected placenta praevia' (Neilson 2003a));
7. placental abruption (*see* review 'Interventions for treating placental abruption' (Neilson 2003b));
8. multiple pregnancy (*see* review 'Caesarean delivery for the second twin' (Crowther 1996));
9. suspected fetopelvic disproportion (*see* review 'Pelvimetry for fetal cephalic presentations at term' (Pattinson 1997));
10. cord prolapse;
11. severe pre-eclampsia, HELLP syndrome or eclampsia;
12. maternal infections (e.g. HIV, active Herpes simplex) (*see* review 'Interventions for reducing the risk of mother-to-child transmission of HIV infection' (Brocklehurst 2002));
13. mother's choice (*see* 'Caesarean section for non-medical reasons at term' (Lavender 2006) (Bèhague 2002; Efekhar 2000; Feldman 1985).
Less common indications include fetal coagulation defects (Silver 2000) and some fetal anomalies (How 2000; Luthy 1991).

The emphasis of this review is on surgical techniques for caesarean section but, for completeness, aspects of anaesthesia and pre- and postoperative care will be covered briefly.

Preoperative preparation includes clinical assessment; blood tests such as haemoglobin, Rhesus group and antibody screen, testing for syphilis and HIV, and blood compatibility testing in high-risk cases (Cousins 1996; Ransom 1999); anaesthetic assessment; oral intake restriction when caesarean section is anticipated (*see* review 'Restricting oral fluids and food during labour' (Singata 2002)); interventions to reduce the volume or acidity of stomach contents (Peskett 1973); intravenous fluids (avoiding excessive dextrose) (Kenepp 1982); antibiotic prophylaxis (*see* reviews 'Antibiotic prophylaxis for caesarean section' (Smaill 2002), and 'Antibiotic prophylaxis regimens and drugs for caesarean section' (Hopkins 1999)); and antiretroviral prophylaxis for HIV-positive women not yet receiving antiretroviral therapy (*see* review 'Antiretrovirals for reducing the risk of mother-to-child transmission of HIV infection' (Volmink 2007)). A urinary catheter is inserted, and hair in the region of the proposed skin incision may be clipped. The question of prophylaxis against venous thromboembolism is dealt with in a separate review ('Prophylaxis for venous thromboembolic disease in pregnancy and the early postnatal period' (Gates 2002)). In the operating theatre, the fetal lie, presentation and position are checked, and the presence of fetal heart beats confirmed. The indication for caesarean section is reviewed, as the obstetric situation may have changed since the original decision was made.

Preparedness includes the ability to arrange emergency caesarean sections within a limited time (e.g. 30 minutes) (ACOG 2001; James 2001), though the feasibility of this standard has been questioned (MacKenzie 2001; Tufnell 2001).

Regional analgesia (spinal and epidural) has largely replaced general anaesthesia in many services. When other methods are not available or safe, local analgesic infiltration may be used (Hofmeyr 1995; Ranney 1975). Aspects of anaesthetic choice and technique are dealt with in other reviews (*see* protocol for review 'Spinal versus epidural anaesthesia for caesarean section' (Ng 2004); 'Techniques for preventing hypotension during spinal anaesthesia for caesarean section' (Cyna 2006)).

Postoperative care includes regular checking of vital signs and urine output, and for signs of uterine relaxation and haemorrhage. Restricting oral intake has not been found to be of benefit ('Early compared with delayed oral fluids and food after caesarean section' (Mangesi 2002)). Analgesia is provided ('Single dose oral ibuprofen and diclofenac for postoperative pain' (Collins 1999); 'Single dose oxycodone and oxycodone plus paracetamol (acetominophen) for acute postoperative pain' (Edwards 2000); 'Single dose paracetamol (acetaminophen), with and without codeine, for postoperative pain' (Moore 1998)). Early mobility, skin-to-skin contact with the baby (Moore 2007) and breastfeeding are encouraged.

The major complications of caesarean section are intraoperative damage to organs such as the bladder or ureters (Nielsen 1984), anaesthetic complications, haemorrhage (Petitti 1985), infection (Duff 1986; Owen 1994) and thromboembolism (Gherman 1999; Simpson 2001). Maternal mortality is greater after caesarean than vaginal delivery (Frigoletto 1980; Lilford 1990; Schuitemaker 1997), though it is difficult to be sure to what extent this is due to the operation or to the reason for the operation. Transient tachypnoea of the newborn is more common after caesarean section, and birth trauma is not eliminated (Nielsen 1984). Long-term risks include an increased risk of placenta praevia (Ananth 1997), placental abruption (Lydon-Rochelle 2001a), placenta accreta (Clarke 1985) and uterine rupture (Lydon-Rochelle 2001b).

Over the years, many variations in the technique of caesarean section have developed. Some aspects of the technique are dealt with in separate reviews.

1. The woman's position may be supine or with a lateral tilt ('Lateral tilt for caesarean section' (Wilkinson 2006a)).
2. The skin incision may be vertical (midline or paramedian) or transverse lower abdominal (Pfannenstiel, Joel-Cohen, Pelosi, Maylard, Mouchel or Cherney). For very obese women, a transverse incision above the umbilicus has been suggested, but not shown to decrease morbidity (Houston 2000). Electrocautery has been compared with cold knife incision for the abdominal wall opening (Meyer 1998). The lower leaf of the rectus sheath may be freed or not (Oguz 1998). A Cochrane review on abdominal surgical incisions for caesarean section is available (Mathai 2007).
3. The bladder peritoneum may be reflected downward or not (Hohlagschwandtn 2001).
4. The uterine incision may be transverse lower segment (Munro-Kerr), midline lower segment or midline upper segment ('classical').
5. The uterus may be opened with a scalpel, scissors, by blunt dissection, or using absorbable staples ('Absorbable staples for uterine incision at caesarean section' (Wilkinson 2006b)).
6. The placenta may be removed manually or with cord traction, and allowing the cord to bleed has been used to assist placental delivery ('Manual removal of placenta at caesarean section' (Wilkinson 2006c)).
7. The uterus may be delivered from the abdominal cavity or left in position during repair ('Extra-abdominal versus intra-abdominal repair of the uterine incision at caesarean section' (Jacobs-Jokhan 2004)).
8. The uterus may be closed with interrupted or continuous sutures in one, two or three layers ('Methods of closing the uterine incision at caesarean section'/'Single versus two layer suturing for closing the uterine incision at caesarean section' (Enkin 2006). Observational studies have suggested that a single-layer closure is associated with more ultrasound scar defects (Hayakawa 2006) and is more likely to dehisce in subsequent pregnancies (Bujold 2002; Gyamfi 2006; Hamilton 2001). In another study, increased uterine 'windows' were found following single-layer closure, but no scar ruptures occurred (Durnwald 2003).
9. Blood may be recovered during the procedure for re-transfusion (Rainaldi 1998).
10. The visceral or the parietal peritoneum, or both, may be sutured or left unsutured ('Peritoneal non-closure at caesarean section' (Bamigboye 2003)).
11. Various materials may be used for closure of the fascia. In women at increased risk for wound dehiscence, a running Smead-Jones suture has been suggested (Wallace 1980).
12. Careful handling of tissues and good surgical technique are suggested to reduce the risk of infection (Iffy 1979; Lyon 1987).
13. The subcutaneous tissues may be sutured or not (Naumann 1995).
14. Various techniques and materials may be used for skin closure ('Techniques and materials for skin closure in caesarean section' (Alderdice 2003)).

Apart from variations in individual aspects of the operation as outlined above, several complete techniques of caesarean section have been described. Comparisons of such complete techniques will be evaluated in this review. Described techniques include the following.

1. The Pfannenstiel caesarean section

A Pfannenstiel abdominal incision is used. The skin and rectus sheath are opened transversely using sharp dissection. The rectus sheath is dissected free from the underlying rectus abdominus muscles. The peritoneum is opened longitudinally using sharp dissection. The uterus is opened with a transverse lower segment hysterotomy. The uterine incision is closed with two layers of continuous sutures. Both peritoneal layers are closed with continuous sutures. The fascia is closed with continuous or interrupted sutures. The skin is closed with interrupted or a continuous intracutaneous suture.

2. The Pelosi-type caesarean section

A Pfannenstiel abdominal incision is used. Electrocautery is used to divide the subcutaneous tissues and the fascia transversely. The rectus muscles are separated by blunt dissection to provide space for both index fingers, which free the fascial vertically and transversely. The peritoneum is opened by blunt finger dissection and all the layers of the abdominal wall are stretched manually to the extent of the skin incision. The bladder is not reflected inferiorly. A small transverse lower segment incision is made through the myometrium, and extended laterally, curving upwards, with blunt finger dissection or scissors. The baby is delivered with external fundal pressure, oxytocin is administered and the placenta removed after spontaneous separation. The uterus is massaged. The myometrial incision is closed with a single-layer 0 chromic catgut continuous locking suture. Neither peritoneal layer is sutured. The fascia is closed with a continuous synthetic absorbable suture. If the subcutaneous layer is thick, interrupted 3-0 absorbable sutures are used to obliterate the dead space. The skin is closed with staples (Capeless 2002; Wood 1999).

3. The Joel-Cohen technique

This differs from the above technique in several respects. The 'Joel-Cohen' abdominal incision is used. This is a straight transverse incision through skin only, 3 cm below the level of the anterior superior iliac spines (higher than the Pfannenstiel incision). The subcutaneous tissues are opened only in the middle 3 cm. The fascia is incised transversely in the midline then extended laterally with blunt finger dissection (Joel-Cohen 1977; Wallin 1999). Finger dissection is used to separate the rectus muscles vertically and laterally and open the peritoneum. All the layers of the abdominal wall are stretched manually to the extent of the skin incision. The bladder is reflected inferiorly. The myometrium is incised transversely in the midline but not to breach the amniotic sac, then opened and extended laterally with finger dissection. Interrupted sutures are used for the closure of the myometrium. Retrospective

studies have suggested that these methods reduce operating time, blood loss and postoperative hospital stay (Song 2006). Various modifications of the Joel-Cohen technique have been described (Franchi 1998; Ferrari 2001; Stark 1995; Wallin 1999).

4. The Misgav-Ladach technique

This is a modification of the Joel-Cohen technique, developed by Stark and colleagues (Stark 1995). The Joel-Cohen abdominal incision is used (*see* above), except that the fascia is opened with a blind thrusting movement of the slightly open scissor-tips. The uterus is opened as for the Joel-Cohen method (above). The placenta is removed manually. The uterus is exteriorized. The myometrial incision is closed with a single-layer locking continuous suture. The peritoneal layers are not sutured. The fascia is sutured with a continuous suture. The skin is closed with two or three mattress sutures. Between these sutures, the skin edges are approximated with Allis forceps, which are left in place for about five minutes while the drapes are being removed (Holmgren 1999). The reported advantages include shorter operating time (Darj 1999; Franchi 1998; Mathai 2002; Wallin 1999), less use of suture material (Bjorklund 2000), less intraoperative blood loss (Bjorklund 2000; Darj 1999; Wallin 1999) less postoperative pain (Darj 1999; Mathai 2002) less wound infection (Franchi 1998), and fewer adhesions at repeat surgery (Stark 1995). A retrospective comparison found that the classical Joel-Cohen incision was associated with statistically less postoperative blood collection in the abdominal wall, pouch of Douglas and lower uterine segment than the modified incision, but the differences were small (Malvasi 2007).

5. The extraperitoneal caesarean section

Historically the extraperitoneal approach was used in septic cases in an attempt to limit the spread of sepsis prior to the advent of effective antibiotics (Haesslein 1980). It is seldom used today.

OBJECTIVES

1. To compare, using the best available evidence, the effects of complete methods of caesarean section not covered in the reviews of individual aspects of caesarean section technique.
2. To summarise the findings of reviews of individual aspects of caesarean section technique.
3. This will provide a holistic review of techniques of caesarean section with ready cross-reference to the detailed individual aspect reviews.

METHODS

Criteria for considering studies for this review

Types of studies

We considered all published, unpublished and ongoing randomised controlled trials comparing intention to perform caesarean section by different techniques, excluding individual aspects covered in other Cochrane reviews. We excluded quasi-randomised trials (e.g., those randomised by date of birth or hospital number) from the analysis unless there was a specific stated reason for inclusion. Studies reported only in abstract form with inadequate methodological information were included in the 'Studies awaiting assessment' category, to be included in the analyses when published as full reports, or adequate information was obtained from the authors. Studies were included if there was adequate allocation concealment and violations of allocated management and exclusions after allocation were not sufficient to materially affect outcomes.

Types of participants

Pregnant women due for delivery by elective or emergency caesarean section.

Types of interventions

Caesarean section performed according to a prespecified technique, not covered by other reviews of individual aspects of caesarean section technique.

Types of outcome measures

Primary outcomes

(1) Serious intraoperative and postoperative complications, including organ damage, blood transfusion, significant sepsis, thromboembolism, organ failure, high care unit admission or death;
(2) blood loss (as defined by trial authors);
(3) blood transfusion.

Secondary outcomes

Short-term outcome measures for the woman

(4) Operating time;
(5) maternal death;
(6) admission to intensive care unit;
(7) postoperative haemoglobin or haematocrit level, or change in these;
(8) postoperative anaemia, as defined by trial authors;
(9) wound infection, as defined by trial authors;
(10) wound haematoma;
(11) wound breakdown;
(12) endometritis, as defined by trial authors;
(13) time to mobilisation;
(14) time to oral intake;
(15) time to return of bowel function;
(16) time to breastfeeding initiation;
(17) fever treated with antibiotics or as defined by trialists;
(18) repeat operative procedures carried out on the wound;
(19) postoperative pain as measured by trial authors;
(20) use of analgesia, as defined by trial authors;
(21) unsuccessful breastfeeding (at discharge or as defined by the trial authors);
(22) mother not satisfied with care.

Short-term outcome measures for the infant

(23) Time from anaesthesia to delivery;
(24) time from skin incision to delivery;
(25) birth trauma;
(26) cord blood pH less than 7.2;
(27) cord blood base deficit greater than 15;
(28) Apgar score less than seven at five minutes;
(29) neonatal intensive care admission;
(30) encephalopathy;
(31) neonatal or perinatal death.

Longer-term outcomes for the mother

(32) Long-term wound complications e.g. numbness, keloid formation, incisional hernia;
(33) long-term abdominal pain;
(34) future fertility problems;
(35) complications in future pregnancy (e.g. uterine rupture, placenta praevia, placenta accreta);
(36) complications at future surgery (e.g. adhesion formation).

Health service use

(37) Length of postoperative hospital stay for mother or baby;
(38) readmission to hospital of mother or baby, or both;
(39) costs.

Outcomes were included if clinically meaningful; reasonable measures taken to minimise observer bias; missing data insufficient to materially influence conclusions; data available for analysis according to original allocation, irrespective of protocol violations; data available in a format suitable for analysis.

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 (August 2007). *We updated this search on 15 February 2012 and added the results to* Studies awaiting classification .

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. weekly searches of EMBASE;
4. handsearches of 30 journals and the proceedings of major conferences;
5. weekly current awareness alerts for a further 44 journals plus monthly BioMed Central email alerts.

Details of the search strategies for CENTRAL, MEDLINE and EMBASE, 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 Cochrane Pregnancy and Childbirth Group.

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.

In addition, we searched the Cochrane Central Register of Controlled Trials (*The Cochrane Library* 2007, Issue 3) using the search terms '(caesarean OR cesarean) AND technique' and conducted a manual search of the reference lists of all identified papers.

We did not apply any language restrictions.

Data collection and analysis

1. Review of techniques of caesarean section

Trials under consideration were evaluated 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.

Trials that met the eligibility criteria were assessed for quality using the following criteria:
1. generation of random allocation sequence: A = adequate, B = inadequate, C = unclear;
2. allocation concealment: A = adequate, B = inadequate, C = unclear;
3. blinding of participants: A = yes, B = inadequate, C = no, D = no information;
4. blinding of caregivers: A = yes, B = inadequate, C = no, D = no information;
5. blinding of outcome assessment: A = yes, B = inadequate, C = no, D = no information;
6. compliance with allocated intervention: A = less than 3% non-compliance, B = 3% to 9.9% non-compliance, C = 10% or more non-compliance, D = unclear;
7. 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;
8. analysis of participants in randomised groups: A = yes, B = inadequate, C = no, D = not clear.

If a publication did not report analysis of participants in their randomised groups, we attempted to restore them to the correct group (analysis by 'intention to treat'). If there was insufficient information in the report to allow this, we contacted the authors and requested further data.

Two authors extracted data from the original publications onto data extraction forms. We resolved differences of opinion by discussion or referral to the primary editor. Data from different trials were combined if we considered them sufficiently similar for this to be reasonable. We performed meta-analyses using relative risks as the measure of effect size for binary outcomes, and weighted mean differences for continuous outcome measures. If trials used different ways of measuring the same continuous outcome (for example, pain), we used standardised mean differences.

We used a 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 greater than 50%), we used a random-effects meta-analysis 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); high levels of postrandomisation losses or exclusions (D); or unblinded outcome assessment, or blinding of outcome assessment uncertain.

The following subgroup analyses were planned:

1. first versus repeat versus mixed or undefined caesarean section;

2. prelabour versus intrapartum versus mixed or undefined caesarean section;
3. preterm versus term versus mixed or undefined caesarean section.

Differences in the effect of the intervention between subgroups were to be investigated as described by Deeks 2001 (subject to sufficient numbers of trials).

2. Summary of other reviews of caesarean section techniques

Relevant reviews were summarised under the following headings.

1. Title
2. Review authors
3. Main results of the interventions, with numbers of trials and participants
4. Author' implications for practice
5. Authors' implications for research

A routine caesarean section technique based on best evidence was described, specifying options where no clear evidence for preference was found, and cross-referencing the relevant Cochrane reviews.

RESULTS

Description of studies

We identified 23 studies which compared different techniques of caesarean section based on the search strategies. *(Nineteen reports from an updated search in February 2012 have been added to* Studies awaiting classification *.)* We excluded four trials from the analyses as allocation to intervention groups was not based on randomisation in these trials (Ansaloni 2001; Gaucherand 2001; Redlich 2001; Wallace 2000). The details of these studies can be found in the table of 'Characteristics of excluded studies'.

Five studies (Behrens 1997; Decavalas 1997; Direnzo 2001; Hagen 1999; Meyer 1998b) were presented at various meetings and conferences and contain only limited results of the studies. We have not obtained the more detailed information on the results of the above-mentioned trials from the authors.

There was some variation in the details of techniques defined by the authors as 'Joel-Cohen', Misgav-Ladach', and 'modified Misgav-Ladach'. All these methods have been based on the surgical principles developed by Joel-Cohen: blunt separation of tissues along natural tissue planes, using a minimum of sharp dissection. For the purposes of this review we have classified the methods as subgroups of the 'Joel-Cohen based' techniques, as follows:

- 'Joel-Cohen': Joel-Cohen abdominal and uterine entry; uterus closed with interrupted sutures; peritoneum not closed; skin closed with subcutaneous suture (Wallin 1999b).
- 'Misgav-Ladach': Joel-Cohen abdominal entry and uterine entry; uterus closed with single-layer locked continuous suture; peritoneum not closed; skin closed with widely spaced interrupted sutures (Bjorklund 2000; Dani 1998; Darj 1999; Ferrari 2001; Heimann 2000; Li 2001; Mathai 2002; Moreira 2002).
- 'Modified Misgav-Ladach': as above but either skin closed with subcutaneous suture (Koettnitz 1999) or various skin closure methods (Xavier 2005) or uterus closed with single-layer non-locking continuous suture (Franchi 1998b; Franchi 2002); or visceral peritoneum not opened and uterus closed with two non-locked suture layers (Li 2001); or the skin opened at the level of the Pfannenstiel incision for cosmetic reasons (Heimann 2000).

Eleven studies have investigated the difference between Joel-Cohen-based and Pfannenstiel caesarean section techniques (Dani 1998; Darj 1999; Ferrari 2001; Franchi 1998b; Franchi 2002; Heimann 2000; Koettnitz 1999; Li 2001; Mathai 2002; Wallin 1999b; Xavier 2005).

Two studies (Bjorklund 2000; Moreira 2002) compared the Misgav-Ladach technique with traditional (lower midline abdominal incision) caesarean sections.

One study compared extraperitoneal and intraperitoneal caesarean section techniques (Mokgokong 1974).

Details of the above-mentioned studies are available in the 'Characteristics of included studies' table.

Risk of bias in included studies

The methodological quality of the included studies was variable. The allocation concealment was unclear in three studies (Dani 1998; Moreira 2002; Xavier 2005). Given the type of intervention, the surgical team was not blinded to the allocated intervention. The allocation was usually revealed just before the skin incision was made. Assessment of intraoperative variables (e.g. operating time, estimated blood loss) may have been subject to bias. However, the assessment of postoperative outcomes (e.g. febrile morbidity, pain, analgesic requirements) was blinded in the majority of studies. Refer to the table 'Characteristics of included studies' for more details on the methodological quality of the individual studies.

One study with inadequate allocation concealment and unexplained differences in group numbers (Mokgokong 1974) was included for historical interest.

Effects of interventions

'Joel-Cohen based' versus Pfannenstiel caesarean section (CS)

Eleven studies compared 'Joel-Cohen based' and Pfannenstiel CS. These were subgrouped as follows: Joel-Cohen (Mathai 2002; Wallin 1999b); Misgav-Ladach (Dani 1998; Darj 1999; Ferrari 2001; Li 2001); and Modified Misgav-Ladach (Franchi 1998b; Franchi 2002; Heimann 2000; Koettnitz 1999; Li 2001; Xavier 2005).

Serious complications were reported in only four trials (913 women) in the modified Misgav-Ladach versus Pfannenstiel comparisons, and were too few for meaningful statistical analysis (three and two events respectively).

Only three blood transfusions were reported, all in the modified Misgav-Ladach groups (three trials, 681 women).

'Joel-Cohen based' surgery was associated with:

- less blood loss in all trials (five trials, 481 women; weighted mean difference (WMD) 64.45 ml; 95% confidence interval (CI) -91.34 to -37.56 ml).
- shorter operating time in all trials. There was significant heterogeneity in the magnitude of the reduction (I^2 = 93%). The overall WMD was a reduction of 18.65 minutes (five trials,

481 women; 95% CI -24.84 to -12.45 minutes; random-effects model).

- no overall difference in the occurrence of wound infections (six trials, 1071 women, considerable heterogeneity).
- no difference in postoperative haematocrit level and haemoglobin fall greater than 4 g%, reported in one trial each (Heimann 2000; Mathai 2002), (101 women and 240 women respectively).
- a trend to increased wound haematoma in the modified Misgav-Ladach subgroup in one trial in which this outcome was reported (Heimann 2000; 240 women; relative risk (RR) 1.80; 95% CI 0.98 to 3.31).
- no significant difference in wound breakdown (three trials, 468 women).
- inadequate data on endometritis, reported in only one woman, in the Pfannenstiel group (three trials, 767 women).
- postoperatively, an overall reduction with significant heterogeneity (I^2 = 90%) in time to oral intake (five trials, 481 women; WMD -3.92; 95% CI -7.13 to -0.71 hours; random-effects model).
- no significant difference in time to return of bowel function.
- no significant difference in time to mobilisation (two trials, 208 women; WMD -2.86; 95% CI -11.29 to 5.56) or in time to breastfeeding initiation (one trial, 101 women).
- less fever, treated with antibiotics or as defined by trial authors (eight trials, 1412 women; RR 0.47; 95% CI 0.28 to 0.81).
- insufficient data on repeat operative procedure on the wound, which were reported in only one woman, in the Pfannenstiel group (two trials, 228 women).
- lower duration of postoperative pain (two comparisons from one trial, 172 women; WMD -14.18 hours; 95% CI -18.31 to -10.04 hours) and less use of analgesia, defined as number of analgesic injections (Darj 1999) or number of injections in the first 24 hours (Mathai 2002) (two trials, 151 women; WMD -0.92; 95% CI -1.20 to -0.63).
- shorter time from skin incision to birth of the baby in all trials. There was significant heterogeneity in the magnitude of the reduction (I^2 = 89.5%). The overall WMD was a reduction of 3.84 minutes (five trials, 575 women; 95% CI -5.41 to -2.27 minutes; random-effects model).
- insufficient data on low Apgar scores (two low scores in the Pfannenstiel group, one trial, 158 women).
- No difference in neonatal intensive care admission (one trial, 310 women).

Subgroup analyses

Four trials were reported to be limited to women undergoing abdominal surgery for the first time (Darj 1999; Ferrari 2001; Mathai 2002; Wallin 1999b). The results were similar to those for all the trials.

There were insufficient data to conduct further subgroup analyses.

Misgav-Ladach versus traditional (lower midline abdominal incision)

Only one of two trials contributed data for each outcome (Bjorklund 2000; Moreira 2002).

The Misgav-Ladach method was associated with reduced blood loss (339 women; WMD -93.00; 95% CI -132.72 to -53.28 ml); operating time (339 women; WMD -7.30; 95% CI -8.32 to -6.28 minutes); time to mobilisation (339 women; WMD -16.06; 95% CI -18.22 to -13.90 hours); and length of postoperative stay for the mother (339 women; WMD -0.82; 95% CI -1.08 to -0.56 days).

There were no significant differences in postoperative anaemia (339 women); wound infection (339 women); wound breakdown (339 women); endometritis (400 women); or fever (339 women).

Misgav-Ladach versus modified Misgav-Ladach methods

In one trial (Li 2001; 116 women), the Misgav-Ladach method was associated with a longer time from skin incision to birth of the baby (WMD 2.10; 95% CI 1.10 to 3.10 minutes), and no significant differences in blood loss, time to oral intake, time to return of bowel function, postoperative pain score, operating time, or length of postoperative stay of the mother.

Extraperitoneal versus intraperitoneal CS

One study with poor methodology by current standards compared extraperitoneal and intraperitoneal CS techniques (Mokgokong 1974). One woman out of 173 had serious complications during or after extraperitoneal CS in comparison to 12 women out of 239 in the group who had intraperitoneal CS (RR 0.12; 95% CI 0.02 to 0.88). The rate of maternal mortality did not differ between these two groups. The rate of fever treated with antibiotics was lower in the extraperitoneal CS group (RR 0.42; 95% CI 0.27 to 0.65). There was no significant difference in the numbers who had repeat procedures on the wound. The results should be interpreted with caution.

Subgroup analyses

There were insufficient trials which were limited to homogenous subgroups other than primary, prelabour and term CS for meaningful subgroup analyses.

Table 1 shows a summary of Cochrane reviews on various aspects of CS techniques.

We have also summarised a routine CS technique based on the evidence from these reviews in Table 2.

DISCUSSION

Four groups of comparison were undertaken in this review. No studies investigating the Pelosi-type caesarean section (CS) were identified.

The methodological quality of 14 included trials appeared generally satisfactory. However, some of the outcomes assessment was subject to bias, e.g. operating time, blood loss.

The data reported in the studies comparing CS techniques were limited to short-term outcomes. They have favoured 'Joel-Cohen-based' techniques (Joel-Cohen, Misgav-Ladach, and modified Misgav-Ladach) over the Pfannenstiel techniques in relation to such outcomes as time from skin incision to delivery of baby, operating time, blood loss, postoperative pain score, number of analgesic injections, time to oral intake, time to return of bowel function, time to mobilisation, febrile morbidity and postoperative mother stay; and over the traditional (lower midline abdominal incision) CS techniques in relation to such outcomes as operating

time, time to mobilisation and postoperative hospital stay. The only advantage of modified Misgav-Ladach techniques over Misgav-Ladach technique was shorter time from skin incision to delivery of baby.

Extraperitoneal CS in women with abdominal sepsis is of historical interest. There were no data from robust trials to provide reliable evidence.

None of the included trials have provided data on mother satisfaction, health service use and long-term outcomes, particularly with respect to subsequent fertility, morbidly adherent placenta, and uterine rupture. Darj 1999 reported that there were no significant differences between the Misgav-Ladach and the Pfannenstiel operation, assessed by the women, regarding evaluation of the scar, but no data were given.

AUTHORS' CONCLUSIONS

Implications for practice

Available evidence suggests that the 'Joel-Cohen based' techniques (Joel-Cohen, Misgav-Ladach and modified Misgav-Ladach) have advantages over Pfannenstiel and traditional (lower midline) caesarean section techniques in relation to short-term outcomes. There is no evidence in relation to long-term outcomes. In view of the evidence from several observational studies that single-layer uterine closure may be associated with increased risk of uterine rupture in subsequent pregnancies (*see* Background), a case can be made for use of double-layer uterine closure pending results from randomised trials, particularly in resource-poor settings where women may not have access to caesarean section facilities in subsequent pregnancies.

The results of this review together with other Cochrane reviews of specific aspects of technique for caesarean sections and other abdominal surgery support the following options for routine caesarean section.

- No preoperative hair removal; or clipping or depilatory creams on the day of surgery or the preceding day (no shaving)
- No specific antiseptic for preoperative bathing
- Antibiotic prophylaxis with ampicillin or a first-generation cephalosporin
- Spinal, epidural or general anaesthesia
- Chlorhexidine for skin preparation
- Double gloving
- Transverse lower abdominal wall opening and uterine opening using Joel-Cohen based methods
- Placental removal with cord traction
- Intra- or extra-abdominal repair of the uterus
- Uterine closure with interrupted or single-layer continuous locking suture has short-term benefits. However, the evidence from observational studies of an increased risk of scar rupture favours the use of double-layer closure pending evidence on this outcome from randomised trials
- Non-closure of both peritoneal layers
- No specific method for closure of the facia was assessed in these reviews
- Closure of the subcutaneous tissues
- No routine drainage of the subcutaneous tissues
- Skin closure with subcuticular or interrupted sutures, staples or tissue adhesive
- No withholding of oral fluids after surgery

The Joel-Cohen based methods are illustrated in a video programme on the World Health Organization Reproductive Health Library (rhlibrary.com).

Where no clear benefits of one method over another have been shown, the choice may influenced by the clinical setting. For example, in a resource-constrained environment where large numbers of caesarean sections are performed by junior surgical teams, a cost-effective choice may be spinal analgesia and Joel-Cohen based surgical methods, which require only two lengths of suture material for the operation, and double-layer closure of the uterus.

Implications for research

Further research of long-term outcomes (particularly long-term pain, fertility, morbidly adherent placenta and rupture of the uterus) after different caesarean section techniques is needed. The study of women and caregivers' satisfaction with surgery as well as healthcare facilities use will be useful, as well as studies comparing the original Joel-Cohen method with the Misgav-Ladach technique. There is a lack of research on techniques for repeat caesarean sections.

[Note: The 19 citations in the awaiting classification section of the review may alter the conclusions of the review once assessed.]

ACKNOWLEDGEMENTS

Denise Atherton, Lynn Hampson and Sonja Henderson for technical support.

As part of the pre-publication editorial process, this review has been commented on by three peers (an editor and two referees who are external to the editorial team), a member 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]*

Bjorklund 2000

Methods	Computer-randomised sequence in sealed opaque envelopes. Assessment could not be blinded.

Bjorklund 2000 *(Continued)*

Participants	Women undergoing elective or emergency CS with general anesthesia at > 37 gestational weeks. Exclusion criteria: repeat CS, previous abdominal surgery, pyrexia > 39C, severe anemia, bleeding disorders, uterine rupture, previous postpartum haemorrhage.
Interventions	Misgav-Ladach technique (n = 169) vs traditional CS (n = 170): lower midline abdominal incision, double-layer closure of the uterus, closure of both peritoneal layers.
Outcomes	Operating time, blood loss, blood loss exceeding 500 ml, suture material used, Apgar scores at 5 and 10 minutes, intraoperative antibiotics, postoperative complication, length of hospital stay.
Notes	Muhimbili medical centre, Dar es Salaam, Tanzania. 20.12.1996-08.03.1997. 16 surgeons. There was uncertainty about 4 possible losses to follow up. 1 women in each group received the non-allocated technique. Quality assessment: 1. generation of random allocation sequence: A. 2. allocation concealment: A. 3. blinding of participants: C. 4. blinding of caregivers: C. 5. blinding of outcome assessment: B. 6. compliance with allocated intervention: A. 7. completeness of follow-up data: A. 8. analysis of participants in randomised groups: A.

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Low risk	A - Adequate

Dani 1998

Methods	Randomisation not described. Assessment of outcome blind.
Participants	Infants delivered at > 36 gestational weeks admitted to nursery or intensive care. Excluded - major congenital abnormalities, 9 - incomplete data.
Interventions	76 (53%) delivered by Stark modified CS and 68 (47%) by traditional CS.
Outcomes	Respiratory depression, perinatal asphyxia, frequency and duration of hospital admission.
Notes	Hospital of Rovigo, Italy. January to December 1996. Quality assessment: 1. generation of random allocation sequence: C. 2. allocation concealment: B. 3. blinding of participants: C. 4. blinding of caregivers: C. 5. blinding of outcome assessment: A. 6. compliance with allocated intervention: A. 7. completeness of follow-up data: B. 8. analysis of participants in randomised groups: A.

Risk of bias

Dani 1998 *(Continued)*

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Unclear risk	B - Unclear

Darj 1999

Methods	Randomly allocated, used sealed opaque envelopes opened by women's husband before the surgery. Assessment not blind.
Participants	Women undergoing first CS. Exclusion - previous abdominal surgery.
Interventions	Misgav-Ladach (n = 25) vs Pfannenstiel (n = 25).
Outcomes	Duration of operation, blood loss, analgesic injections, duration and doses, time to drinking water and to standing up, first bowel action, days in hospital.
Notes	University Hospital Uppsala, Sweden. 1996-1997. 1 surgeon. No prophylactic antibiotics used. Quality assessment: 1. generation of random allocation sequence: C. 2. allocation concealment: A. 3. blinding of participants: C. 4. blinding of caregivers: C. 5. blinding of outcome assessment: C. 6. compliance with allocated intervention: A. 7. completeness of follow-up data: A. 8. analysis of participants in randomised groups: A.

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Low risk	A - Adequate

Ferrari 2001

Methods	Randomisation by sealed opaque envelopes stored by each of 10 surgeons.
Participants	Women requiring first CS, > 30 gestational weeks, eligible for CS by Pfannenstiel technique.
Interventions	Joel-Cohen (n = 83) vs Pfannenstiel (n = 75).
Outcomes	Day of Urinary catheter removal, stopping intravenous fluids, liquid intake, food intake, flatus, and mobilization; fever, pain on day 1 and 2.
Notes	San Raffaele Hospital and San Paolo Hospital of Milan School of Medicine, Italy. January 1997-June 1998. 10 senior surgeons. Quality assessment: 1. generation of random allocation sequence: C. 2. allocation concealment: A.

Ferrari 2001 *(Continued)*

3. blinding of participants: C.
4. blinding of caregivers: C.
5. blinding of outcome assessment: C.
6. compliance with allocated intervention: A.
7. completeness of follow-up data: A.
8. analysis of participants in randomised groups: A.

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Low risk	A - Adequate

Franchi 1998b

Methods	Randomisation computer-generated list of numbers. These assignments were placed in sequentially numbered sealed envelopes opened immediately before the start of operation.
Participants	Excluded - women with multiple pregnancy, 2 or more previous CS, previous longitudinal laparotomy, previous myomectomy, gestational age more than 30 weeks, antibiotics within 2 weeks prior to CS, requiring additional surgery.
Interventions	Joel-Cohen (n = 149) vs Pfannenstiel (n = 153).
Outcomes	Operative time, opening time, bladder injury, intraoperative transfusion, postoperative hospital stay, change in haemoglobin concentration, postoperative ileus, wound infection, postoperative morbidity.
Notes	Insubria University, Varese, Italy. April 1995-August 1997. Quality assessment: 1. generation of random allocation sequence: A. 2. allocation concealment: A. 3. blinding of participants: A. 4. blinding of caregivers: B. 5. blinding of outcome assessment: B. 6. compliance with allocated intervention: A. 7. completeness of follow-up data: A. 8. analysis of participants in randomised groups: A.

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Low risk	A - Adequate

Franchi 2002

Methods	Randomisation computer-generated, midwife opened sealed envelopes immediately before skin incision.
Participants	Excluded - multiple pregnancy, 2 or more previous CS, maternal disease, previous CS before 32 gestational weeks, myomectomy, previous longitudinal abdominal incision.

Franchi 2002 *(Continued)*

Interventions	Joel-Cohen (n = 154) vs Pfannenstiel (n = 158).
Outcomes	Operating time, extraction time, additional uterine stitches, additional haemostatic uterine stitches, intraoperative transfusion, bladder injury, change in haemoglobin concentration, time to passage of flatus, wound infection, postoperative morbidity, hospital stay.
Notes	Insubria University, Varese, Italy. January 1998-May 2000. Junior surgeons. 2 women excluded in Joel-Cohen group - they required caesarean hysterectomy. Quality assessment: 1. generation of random allocation sequence: A. 2. allocation concealment: A. 3. blinding of participants: A. 4. blinding of caregivers: B. 5. blinding of outcome assessment: B. 6. compliance with allocated intervention: A. 7. completeness of follow-up data: B. 8. analysis of participants in randomised groups: A.

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Low risk	A - Adequate

Heimann 2000

Methods	Randomisation not described.
Participants	Women with high-risk pregnancies. Groups didn't differ in age, gestational age, previous CS. Misgav-Ladach groups had more nulliparous women.
Interventions	Modified Misgav-Ladach (skin incision as low as Pfannenstiel, n = 117) vs Pfannenstiel (n = 123).
Outcomes	Duration of operation, Apgar score, cord blood pH, intraoperative complications, postoperative complications, fall in haemoglobin, haematoma formation, pyrexia, wound complications, hospital stay.
Notes	Wiesban, Germany. 24.11.1998-25.05.1999. 3 women from Misgav-Ladach group were transferred into Pfannenstiel group - 1 due to obesity, 1 due to scaring from previous CS, 1 due to tumour which required removal. Analysis by intention to treat. Quality assessment: 1. generation of random allocation sequence: B. 2. allocation concealment: B. 3. blinding of participants: C. 4. blinding of caregivers: C. 5. blinding of outcome assessment: C. 6. compliance with allocated intervention: B. 7. completeness of follow-up data: A. 8. analysis of participants in randomised groups: A.

Risk of bias

Bias	Authors' judgement	Support for judgement

Heimann 2000 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	B - Unclear

Koettnitz 1999

Methods	Randomisation alternative.
Participants	Women requiring CS.
Interventions	Modified Cohen with low skin incision (n = 44) vs Pfannenstiel (n = 42).
Outcomes	Wound infection, mobilisation, antibiotic use, operating time, cost of materials.
Notes	Frauenklinik, Duisburg, Germany January 1996-July 1996. Quality assessment: 1. generation of random allocation sequence: C. 2. allocation concealment: C. 3. blinding of participants: C. 4. blinding of caregivers: C. 5. blinding of outcome assessment: C. 6. compliance with allocated intervention: A. 7. completeness of follow-up data: A. 8. analysis of participants in randomised groups: A.

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment (selection bias)	High risk	C - Inadequate

Li 2001

Methods	Randomisation not described.
Participants	Women requiring CS.
Interventions	Modified Misgav-Ladach (transversely incising fascia 2-3 cm, then dividing bluntly without opening and dissociating the visceral peritoneum, 2 layers suturing of low transverse uterine incision, closing the skin by continuous suturing, n = 59) vs Misgav-Ladach (n = 57) vs Pfannenstiel (n = 56).
Outcomes	Operating time, delivery time, blood loss, postoperative pain, diet, bowel movement, and hospital stay.
Notes	Xiehe Hospital, Tonojii. May-December 1999. Quality assessment: 1. generation of random allocation sequence: C. 2. allocation concealment: C. 3. blinding of participants: D. 4. blinding of caregivers: D. 5. blinding of outcome assessment: D. 6. compliance with allocated intervention: A. 7. completeness of follow-up data: A.

Li 2001 *(Continued)*

	8. analysis of participants in randomised groups: A.

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	High risk	C - Inadequate

Mathai 2002

Methods	Randomisation in blocks, slips of paper with the allocated incision were placed in identical, consecutively-numbered sealed opaque envelopes Blood loss and time for surgery assessed by anaesthetist; postoperative analgesia on demand; allocation not known to anaesthetist or staff in postoperative ward.
Participants	Women with singleton pregnancy, longitudinal lie, at term requiring CS under spinal anesthesia. Excluded: multiple pregnancy, previous abdominal surgery, need for midline or paramedian incision, spinal anesthesia contraindicated.
Interventions	Joel-Cohen (n = 51) vs Pfannenstiel (n = 50).
Outcomes	Time to analgesia, delivery time, operative time, blood loss, time to oral fluids, total dose of analgesics, febrile morbidity, postoperative haematocrit, time to breastfeeding, time in special care nursery, hospital stay.
Notes	Christian Medical College and Hospital, Vellore, India. 1 of 31 registrars performed the surgery. 4 women excluded from analysis: in Joel-Cohen group - 1 had caesarean hysterectomy, 1 had vaginal delivery prior to CS, 1 had ineffective spinal block; in Pfannenstiel group - 1 woman had ineffective spinal block. Quality assessment: 1. generation of random allocation sequence: A. 2. allocation concealment: A. 3. blinding of participants: D. 4. blinding of caregivers: D. 5. blinding of outcome assessment: D. 6. compliance with allocated intervention: A. 7. completeness of follow-up data: B. 8. analysis of participants in randomised groups: A.

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Low risk	A - Adequate

Mokgokong 1974

Methods	Randomisation using odd and even numbers of admission number.
Participants	Women requiring CS who had intrauterine infection. 412 black and Indian women.
Interventions	Extraperitoneal (n = 239) vs intraperitoneal (n = 173) CS.

Mokgokong 1974 *(Continued)*

Outcomes	Time to delivery, peritonitis, pelvic abscess, abdominal wound sepsis, secondary postpartum haemorrhage, further surgery, septicaemic shock, hospital stay, mortality.
Notes	Kind Edward VIII Hospital, Durban, SA. Quality assessment: 1. generation of random allocation sequence: B. 2. allocation concealment: C. 3. blinding of participants: D. 4. blinding of caregivers: D. 5. blinding of outcome assessment: D. 6. compliance with allocated intervention: A. 7. completeness of follow-up data: B. 8. analysis of participants in randomised groups: A.

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	High risk	C - Inadequate

Moreira 2002

Methods	Randomisation was not described.
Participants	Women requiring CS.
Interventions	Misgav-Ladach (n = 200) vs traditional (n = 200).
Outcomes	Time to delivery, operative time, use of suture material, dose of analgesia, postoperative complications, hospital stay, cost.
Notes	Dakar Teaching Hospital, Senegal. April-July 2000. Quality assessment: 1. generation of random allocation sequence: C. 2. allocation concealment: B. 3. blinding of participants: D. 4. blinding of caregivers: D. 5. blinding of outcome assessment: D. 6. compliance with allocated intervention: A. 7. completeness of follow-up data: A. 8. analysis of participants in randomised groups: A.

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Unclear risk	B - Unclear

Wallin 1999b

Methods	Randomisation - computer-generated in large blocks, using sealed envelopes opened by physicians just before surgery. Results of randomisation were known only to a single obstetrician who performed surgery. Outcome assessment was blind
Participants	Women requiring elective CS with no history of abdominal surgery.
Interventions	Modified Joel-Cohen (3 cm higher than original Pfannenstiel, n = 36) vs Pfannenstiel (skin incision 3 cm higher than originally described, n = 36).
Outcomes	Operating time, blood loss, intravenous fluids, blood effusion, haemoglobin, C-reactive protein, hospital stay.
Notes	Sahlgrenska University Hospital, Gothenburg, Sweden. Quality assessment: 1. generation of random allocation sequence: A. 2. allocation concealment: A. 3. blinding of participants: B. 4. blinding of caregivers: B. 5. blinding of outcome assessment: B. 6. compliance with allocated intervention: A. 7. completeness of follow-up data: A. 8. analysis of participants in randomised groups: A.

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Low risk	A - Adequate

Xavier 2005

Methods	Randomisation - outcome assessment blinded.
Participants	Women for CS by 1 of 3 surgeons.
Interventions	Modified Misgav-Ladach (n = 88) vs Pfannenstiel-Kerr (n = 74).
Outcomes	Operating time, requested paracetamol, bowel recovery, febrile morbidity, postoperative antibiotics, endometritis, wound complications.
Notes	Porto University Hospital de Sao Joao, Portugal. 3 surgeons. Quality assessment: 1. generation of random allocation sequence: A. 2. allocation concealment: A. 3. blinding of participants: D. 4. blinding of caregivers: D. 5. blinding of outcome assessment: D. 6. compliance with allocated intervention: A. 7. completeness of follow-up data: B. 8. analysis of participants in randomised groups: A.

Risk of bias

Bias	Authors' judgement	Support for judgement

Xavier 2005 *(Continued)*

Allocation concealment (selection bias)	Low risk	A - Adequate

CS: caesarean section
vs: versus

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

Study	Reason for exclusion
Ansaloni 2001	Randomisation by alternative allocation. Not blinded.
Gaucherand 2001	Randomisation using odd and even numbers of the date of surgery.
Redlich 2001	Randomised by the first letter of surname, unequal groups 105 in Misgav-Ladach versus 67 in traditional group.
Wallace 2000	Randomisation depended on availability of 1 of 3 surgeons. Women were randomised and then transferred between groups depending on the surgeons' availability. Intraperitoneal versus extraperitoneal caesarean section.

DATA AND ANALYSES

Comparison 1. Joel-Cohen based versus Pfannenstiel (all trials)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Serious complications	4	913	Risk Ratio (M-H, Fixed, 95% CI)	1.31 [0.29, 5.91]
1.1 Joel-Cohen	0	0	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
1.2 Misgav-Ladach	1	158	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
1.3 Modified Misgav-Ladach	3	755	Risk Ratio (M-H, Fixed, 95% CI)	1.31 [0.29, 5.91]
2 Blood loss	4	481	Mean Difference (IV, Fixed, 95% CI)	-64.45 [-91.34, -37.56]
2.1 Joel-Cohen	1	101	Mean Difference (IV, Fixed, 95% CI)	-58.0 [-108.51, -7.49]
2.2 Misgav-Ladach	3	293	Mean Difference (IV, Fixed, 95% CI)	-58.57 [-97.43, -19.71]
2.3 Modified Misgav-Ladach	1	87	Mean Difference (IV, Fixed, 95% CI)	-84.0 [-139.18, -28.82]
3 Blood transfusion	3	681	Risk Ratio (M-H, Fixed, 95% CI)	4.08 [0.46, 36.40]
3.1 Joel-Cohen	1	72	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
3.2 Misgav-Ladach	0	0	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.3 Modified Misgav-Ladach	2	609	Risk Ratio (M-H, Fixed, 95% CI)	4.08 [0.46, 36.40]
4 Operating time (minutes)	4	481	Mean Difference (IV, Random, 95% CI)	-18.65 [-24.84, -12.45]
4.1 Joel-Cohen	1	101	Mean Difference (IV, Random, 95% CI)	-11.40 [-16.55, -6.25]
4.2 Misgav-Ladach	3	293	Mean Difference (IV, Random, 95% CI)	-17.93 [-25.39, -10.47]
4.3 Modified Misgav-Ladach	1	87	Mean Difference (IV, Random, 95% CI)	-28.2 [-33.74, -22.66]
7 Postoperative haematocrit level	1	101	Mean Difference (IV, Fixed, 95% CI)	0.90 [-0.80, 2.60]
7.1 Joel-Cohen	1	101	Mean Difference (IV, Fixed, 95% CI)	0.90 [-0.80, 2.60]
7.2 Misgav-Ladach	0	0	Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]
7.3 Modified Misgav-Ladach	0	0	Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]
8 Haemoglobin fall > 4 g%	1	240	Risk Ratio (M-H, Fixed, 95% CI)	0.42 [0.08, 2.13]
8.1 Joel-Cohen	0	0	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
8.2 Misgav-Ladach	0	0	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
8.3 Modified Misgav-Ladach	1	240	Risk Ratio (M-H, Fixed, 95% CI)	0.42 [0.08, 2.13]
9 Wound infection	6	1071	Risk Ratio (M-H, Random, 95% CI)	1.43 [0.52, 3.91]
9.1 Joel-Cohen	1	72	Risk Ratio (M-H, Random, 95% CI)	1.0 [0.07, 15.38]
9.2 Misgav-Ladach	1	158	Risk Ratio (M-H, Random, 95% CI)	3.61 [0.79, 16.49]
9.3 Modified Misgav-Ladach	4	841	Risk Ratio (M-H, Random, 95% CI)	1.21 [0.33, 4.51]
10 Wound haematoma	1	240	Risk Ratio (M-H, Fixed, 95% CI)	1.80 [0.98, 3.31]
10.1 Joel-Cohen	0	0	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
10.2 Misgav-Ladach	0	0	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
10.3 Modified Misgav-Ladach	1	240	Risk Ratio (M-H, Fixed, 95% CI)	1.80 [0.98, 3.31]
11 Wound breakdown	2	412	Risk Ratio (M-H, Fixed, 95% CI)	0.75 [0.33, 1.70]
11.1 Joel-Cohen	0	0	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

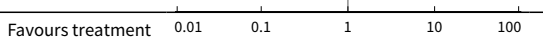
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
11.2 Misgav-Ladach	1	85	Risk Ratio (M-H, Fixed, 95% CI)	0.17 [0.01, 3.97]
11.3 Modified Misgav-Ladach	2	327	Risk Ratio (M-H, Fixed, 95% CI)	0.87 [0.36, 2.08]
12 Endometritis	3	767	Risk Ratio (M-H, Fixed, 95% CI)	0.34 [0.01, 8.17]
12.1 Joel-Cohen	0	0	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
12.2 Misgav-Ladach	1	158	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
12.3 Modified Misgav-Ladach	2	609	Risk Ratio (M-H, Fixed, 95% CI)	0.34 [0.01, 8.17]
13 Time to mobilisation (hours)	2	208	Mean Difference (IV, Random, 95% CI)	-2.86 [-11.29, 5.56]
13.1 Joel-Cohen	0	0	Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
13.2 Misgav-Ladach	2	208	Mean Difference (IV, Random, 95% CI)	-2.86 [-11.29, 5.56]
13.3 Modified Misgav-Ladach	0	0	Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
14 Time to oral intake (hours)	4	481	Mean Difference (IV, Random, 95% CI)	-3.92 [-7.13, -0.71]
14.1 Joel-Cohen	1	101	Mean Difference (IV, Random, 95% CI)	-2.10 [-3.87, -0.33]
14.2 Misgav-Ladach	3	293	Mean Difference (IV, Random, 95% CI)	-3.43 [-8.58, 1.71]
14.3 Modified Misgav-Ladach	1	87	Mean Difference (IV, Random, 95% CI)	-8.2 [-11.96, -4.44]
15 Time to return of bowel function (hours)	2	222	Mean Difference (IV, Random, 95% CI)	-6.72 [-15.26, 1.81]
15.1 Joel-Cohen	0	0	Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
15.2 Misgav-Ladach	2	135	Mean Difference (IV, Random, 95% CI)	3.98 [-27.47, 35.43]
15.3 Modified Misgav-Ladach	1	87	Mean Difference (IV, Random, 95% CI)	-12.3 [-16.25, -8.35]
16 Time to breastfeeding initiation (hours)	1	101	Mean Difference (IV, Fixed, 95% CI)	-5.5 [-13.62, 2.62]
16.1 Joel-Cohen	1	101	Mean Difference (IV, Fixed, 95% CI)	-5.5 [-13.62, 2.62]

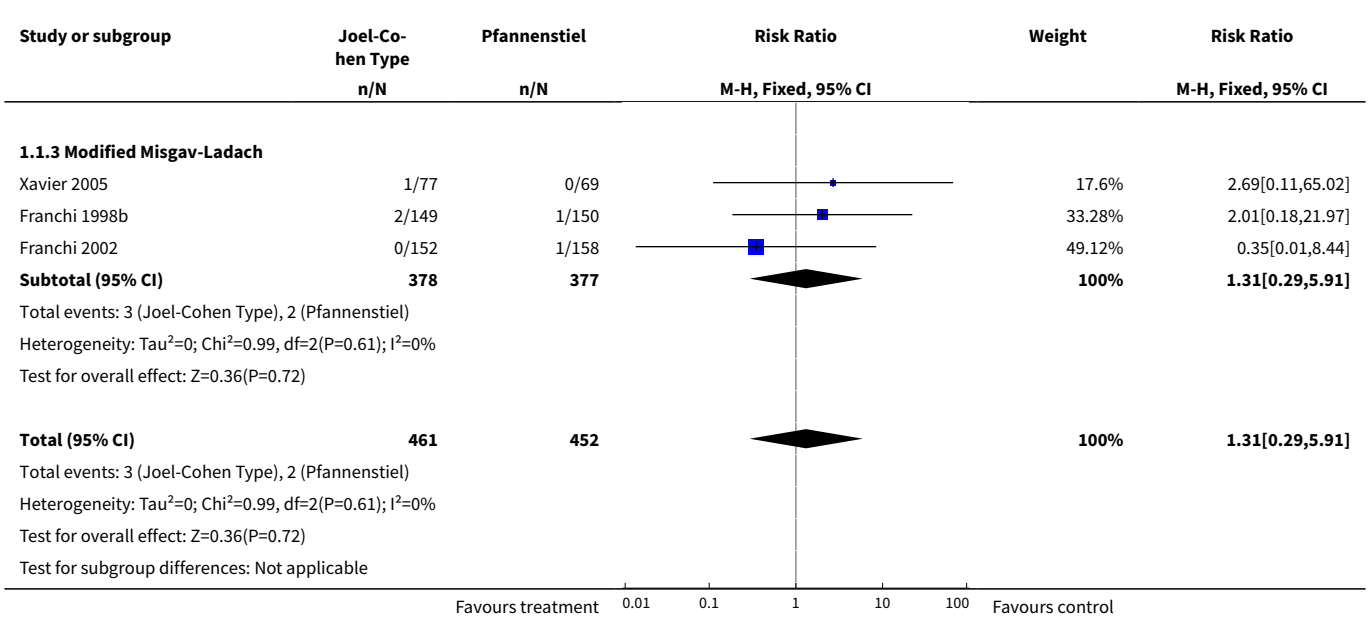
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
16.2 Misgav-Ladach	0	0	Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]
16.3 Modified Misgav-Ladach	0	0	Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]
17 Fever treated with antibiotics or as defined by trial authors	8	1412	Risk Ratio (M-H, Fixed, 95% CI)	0.47 [0.28, 0.81]
17.1 Joel-Cohen	2	173	Risk Ratio (M-H, Fixed, 95% CI)	0.28 [0.10, 0.81]
17.2 Misgav-Ladach	1	158	Risk Ratio (M-H, Fixed, 95% CI)	0.90 [0.23, 3.49]
17.3 Modified Misgav-Ladach	5	1081	Risk Ratio (M-H, Fixed, 95% CI)	0.52 [0.25, 1.06]
18 Repeat operative procedures on the wound	1	172	Risk Ratio (M-H, Fixed, 95% CI)	0.16 [0.02, 1.54]
18.1 Joel-Cohen	0	0	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
18.2 Misgav-Ladach	1	85	Risk Ratio (M-H, Fixed, 95% CI)	0.17 [0.01, 3.97]
18.3 Modified Misgav-Ladach	1	87	Risk Ratio (M-H, Fixed, 95% CI)	0.16 [0.01, 3.83]
19 Postoperative pain as measured by trial authors	1	172	Mean Difference (IV, Fixed, 95% CI)	-14.18 [-18.31, -10.04]
19.1 Joel-Cohen	0	0	Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]
19.2 Misgav-Ladach	1	85	Mean Difference (IV, Fixed, 95% CI)	-13.0 [-18.91, -7.09]
19.3 Modofied Misgav-Ladach	1	87	Mean Difference (IV, Fixed, 95% CI)	-15.3 [-21.08, -9.52]
20 Number of analgesic injections	2	151	Mean Difference (IV, Fixed, 95% CI)	-0.92 [-1.20, -0.63]
20.1 Joel-Cohen	1	101	Mean Difference (IV, Fixed, 95% CI)	-0.89 [-1.19, -0.59]
20.2 Misgav-Ladach	1	50	Mean Difference (IV, Fixed, 95% CI)	-1.20 [-2.19, -0.21]
20.3 Modofied Misgav-Ladach	0	0	Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]
24 Time from skin incision to delivery (minutes)	4	575	Mean Difference (IV, Random, 95% CI)	-3.84 [-5.41, -2.27]
24.1 Joel-Cohen	1	101	Mean Difference (IV, Random, 95% CI)	-1.90 [-2.53, -1.27]
24.2 Misgav-Ladach	3	387	Mean Difference (IV, Random, 95% CI)	-3.39 [-4.91, -1.86]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
24.3 Modified Misgav-Ladach	1	87	Mean Difference (IV, Random, 95% CI)	-7.70 [-9.74, -5.66]
28 Apgar score < 7 at 5 minutes	1	158	Risk Ratio (M-H, Fixed, 95% CI)	0.18 [0.01, 3.71]
28.1 Joel-Cohen	0	0	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
28.2 Misgav-Ladach	1	158	Risk Ratio (M-H, Fixed, 95% CI)	0.18 [0.01, 3.71]
28.3 Modified Misgav-Ladach	0	0	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
29 Neonatal intensive care admission	1	310	Risk Ratio (M-H, Fixed, 95% CI)	1.19 [0.44, 3.20]
29.1 Joel-Cohen	0	0	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
29.2 Misgav-Ladach	0	0	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
29.3 Modified Misgav-Ladach	1	310	Risk Ratio (M-H, Fixed, 95% CI)	1.19 [0.44, 3.20]
37 Length of postoperative stay for mother (days)	3	323	Mean Difference (IV, Fixed, 95% CI)	-0.99 [-1.44, -0.54]
37.1 Joel-Cohen	1	101	Mean Difference (IV, Fixed, 95% CI)	-1.5 [-2.16, -0.84]
37.2 Misgav-Ladach	2	135	Mean Difference (IV, Fixed, 95% CI)	-0.43 [-1.10, 0.24]
37.3 Modified Misgav-Ladach	1	87	Mean Difference (IV, Fixed, 95% CI)	-1.20 [-2.82, 0.42]

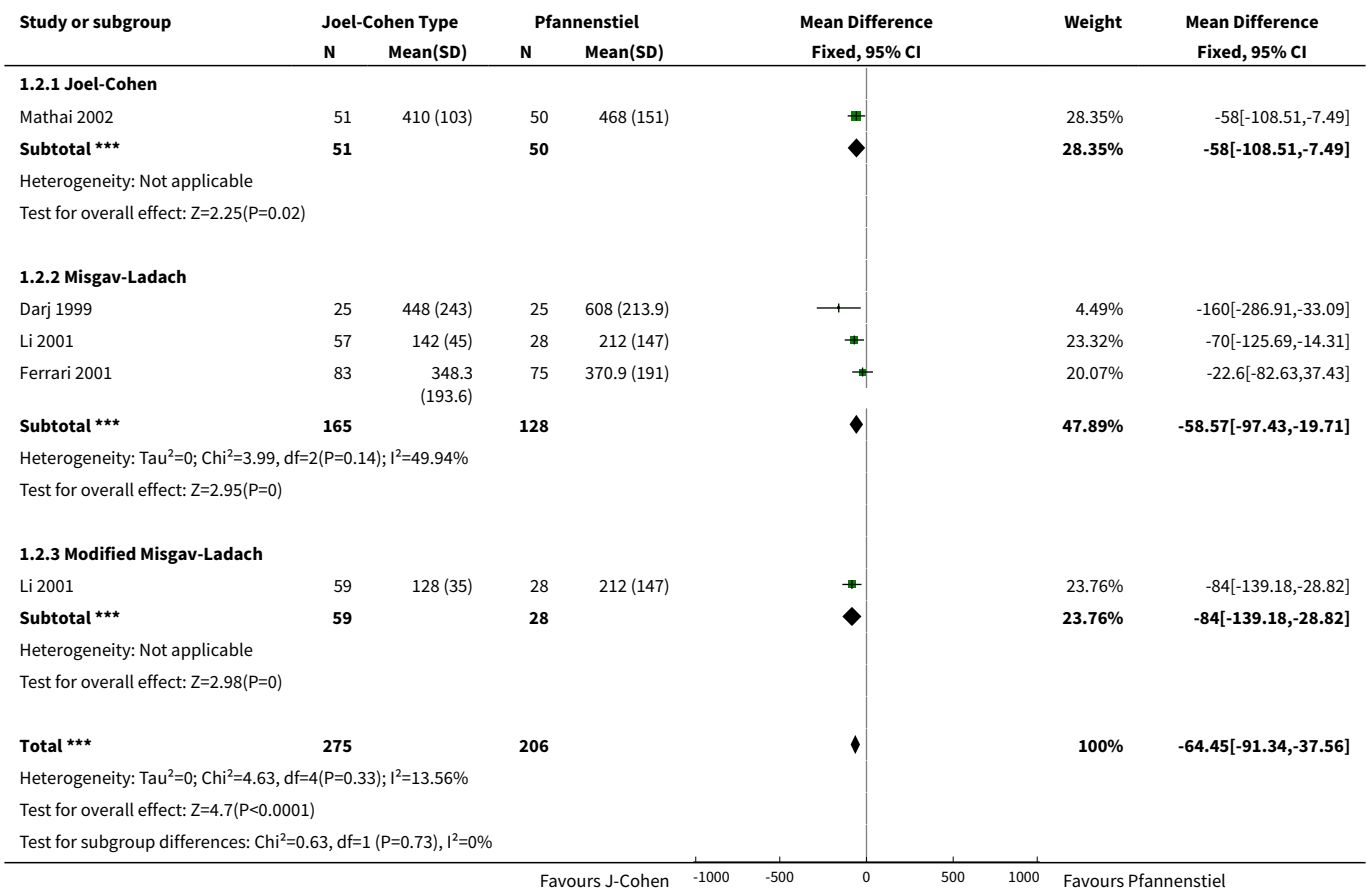
Analysis 1.1. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 1 Serious complications.

Study or subgroup	Joel-Cohen Type n/N	Pfannenstiel n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
1.1.1 Joel-Cohen					
Subtotal (95% CI)	**0**	**0**			**Not estimable**
Total events: 0 (Joel-Cohen Type), 0 (Pfannenstiel)					
Heterogeneity: Not applicable					
Test for overall effect: Not applicable					
1.1.2 Misgav-Ladach					
Ferrari 2001	0/83	0/75			Not estimable
Subtotal (95% CI)	**83**	**75**			**Not estimable**
Total events: 0 (Joel-Cohen Type), 0 (Pfannenstiel)					
Heterogeneity: Not applicable					
Test for overall effect: Not applicable					



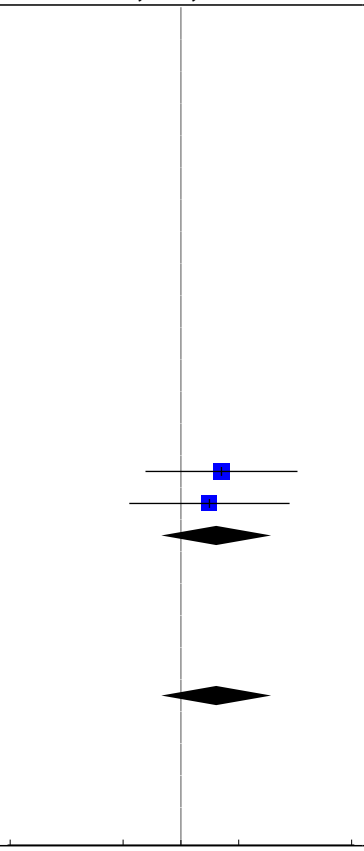


Analysis 1.2. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 2 Blood loss.



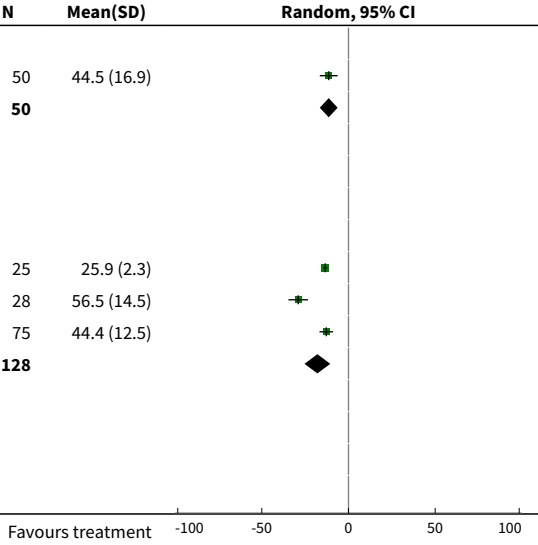
Analysis 1.3. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 3 Blood transfusion.

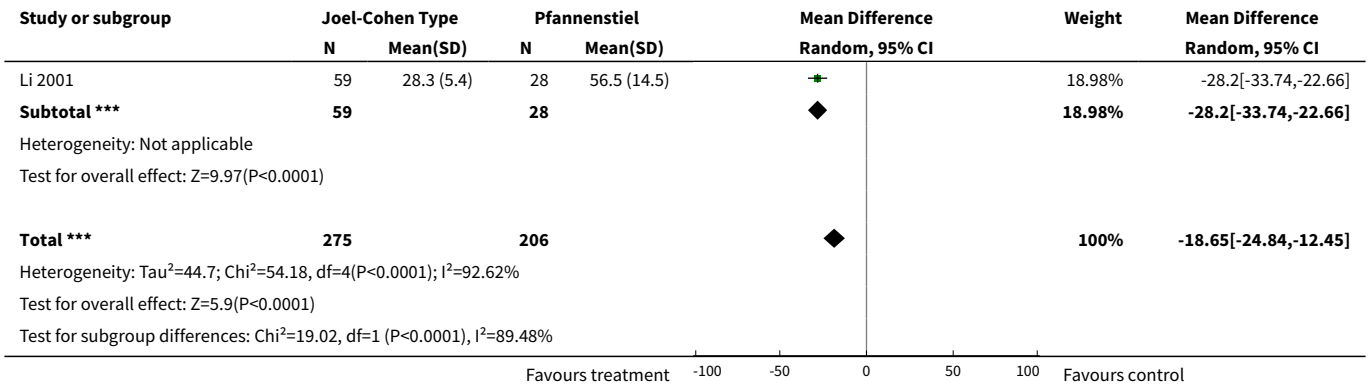
Study or subgroup	Joel-Cohen Type n/N	Pfannenstiel n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
1.3.1 Joel-Cohen					
Wallin 1999b	0/36	0/36			Not estimable
Subtotal (95% CI)	**36**	**36**			**Not estimable**
Total events: 0 (Joel-Cohen Type), 0 (Pfannenstiel)					
Heterogeneity: Not applicable					
Test for overall effect: Not applicable					
1.3.2 Misgav-Ladach					
Subtotal (95% CI)	**0**	**0**			**Not estimable**
Total events: 0 (Joel-Cohen Type), 0 (Pfannenstiel)					
Heterogeneity: Not applicable					
Test for overall effect: Not applicable					
1.3.3 Modified Misgav-Ladach					
Franchi 1998b	2/149	0/150		50.4%	5.03[0.24,103.96]
Franchi 2002	1/152	0/158		49.6%	3.12[0.13,75.94]
Subtotal (95% CI)	**301**	**308**		**100%**	**4.08[0.46,36.4]**
Total events: 3 (Joel-Cohen Type), 0 (Pfannenstiel)					
Heterogeneity: Tau^2=0; Chi^2=0.05, df=1(P=0.83); I^2=0%					
Test for overall effect: Z=1.26(P=0.21)					
Total (95% CI)	**337**	**344**		**100%**	**4.08[0.46,36.4]**
Total events: 3 (Joel-Cohen Type), 0 (Pfannenstiel)					
Heterogeneity: Tau^2=0; Chi^2=0.05, df=1(P=0.83); I^2=0%					
Test for overall effect: Z=1.26(P=0.21)					
Test for subgroup differences: Not applicable					



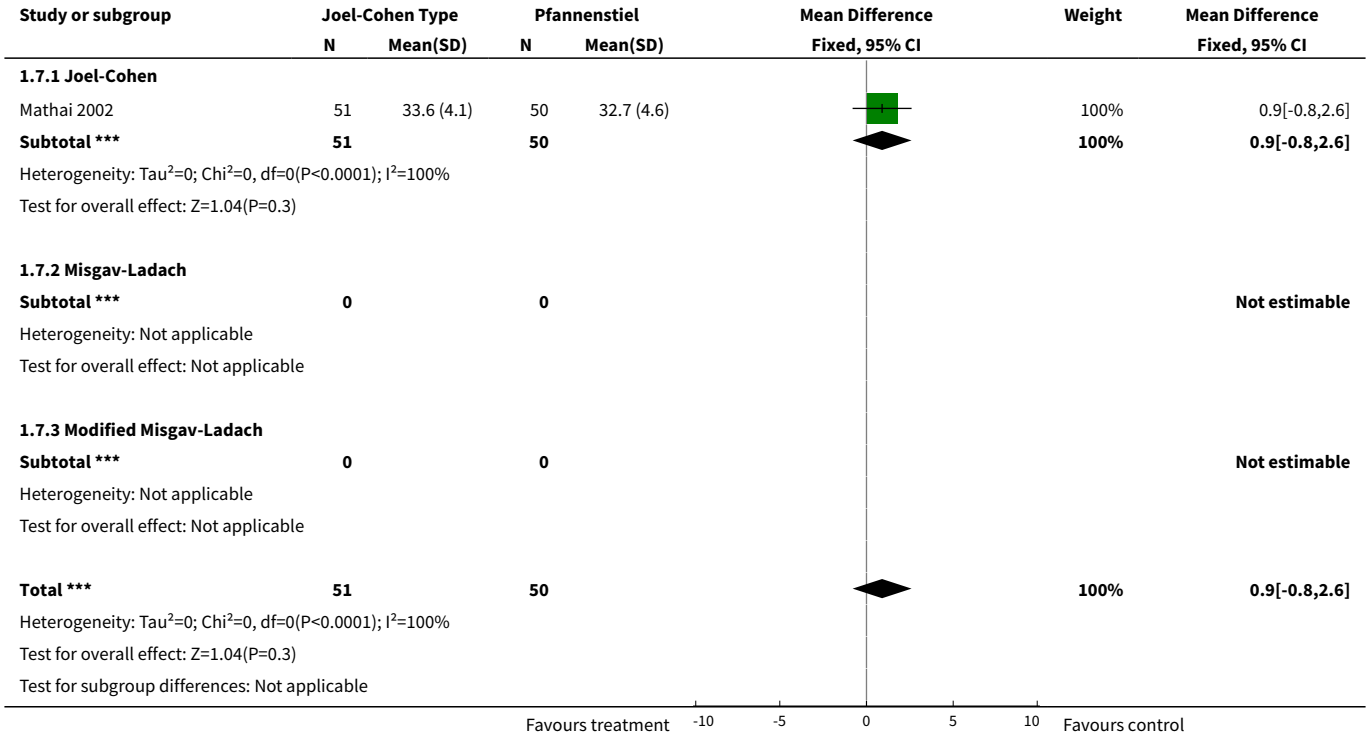
Analysis 1.4. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 4 Operating time (minutes).

Study or subgroup	Joel-Cohen Type N	Mean(SD)	Pfannenstiel N	Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
1.4.1 Joel-Cohen							
Mathai 2002	51	33.1 (7.8)	50	44.5 (16.9)		19.39%	-11.4[-16.55,-6.25]
Subtotal ***	**51**		**50**			**19.39%**	**-11.4[-16.55,-6.25]**
Heterogeneity: Not applicable							
Test for overall effect: Z=4.34(P<0.0001)							
1.4.2 Misgav-Ladach							
Darj 1999	25	12.5 (2.1)	25	25.9 (2.3)		22.19%	-13.4[-14.62,-12.18]
Li 2001	57	27.5 (6.5)	28	56.5 (14.5)		18.89%	-29[-34.63,-23.37]
Ferrari 2001	83	31.6 (12.6)	75	44.4 (12.5)		20.55%	-12.8[-16.71,-8.89]
Subtotal ***	**165**		**128**			**61.63%**	**-17.93[-25.39,-10.47]**
Heterogeneity: Tau^2=39.5; Chi^2=28.57, df=2(P<0.0001); I^2=93%							
Test for overall effect: Z=4.71(P<0.0001)							
1.4.3 Modified Misgav-Ladach							

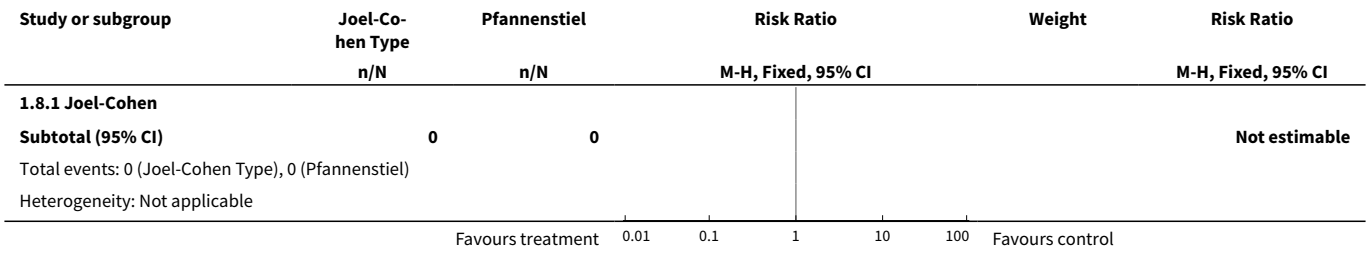


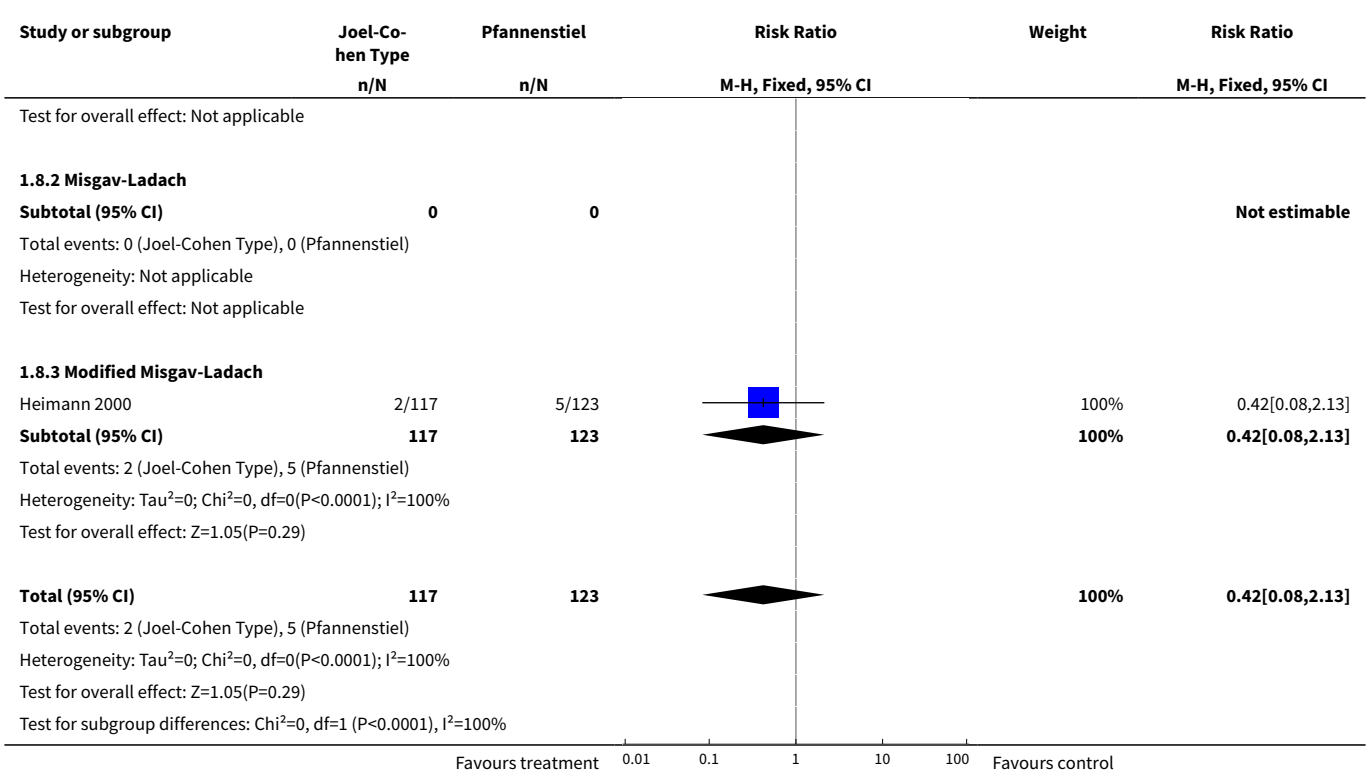


Analysis 1.7. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 7 Postoperative haematocrit level.

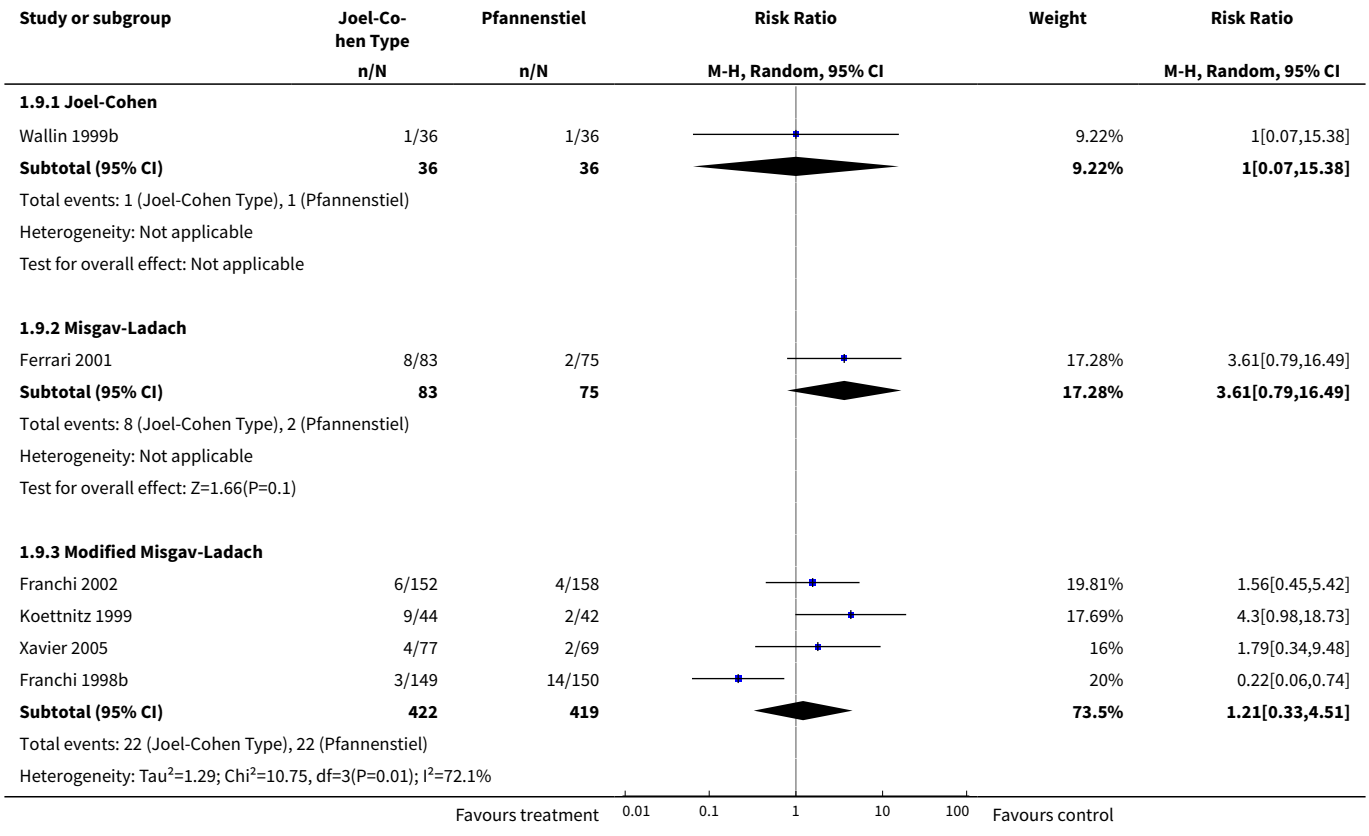


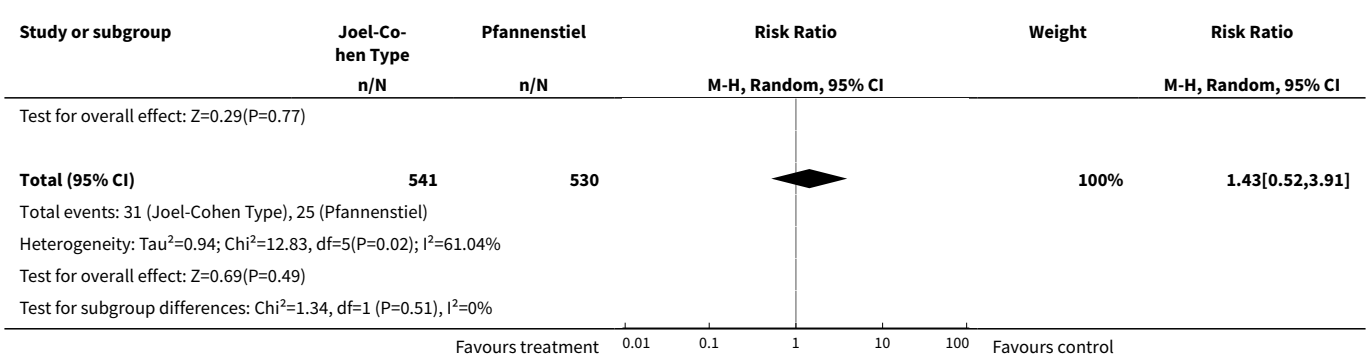
Analysis 1.8. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 8 Haemoglobin fall > 4 g%.



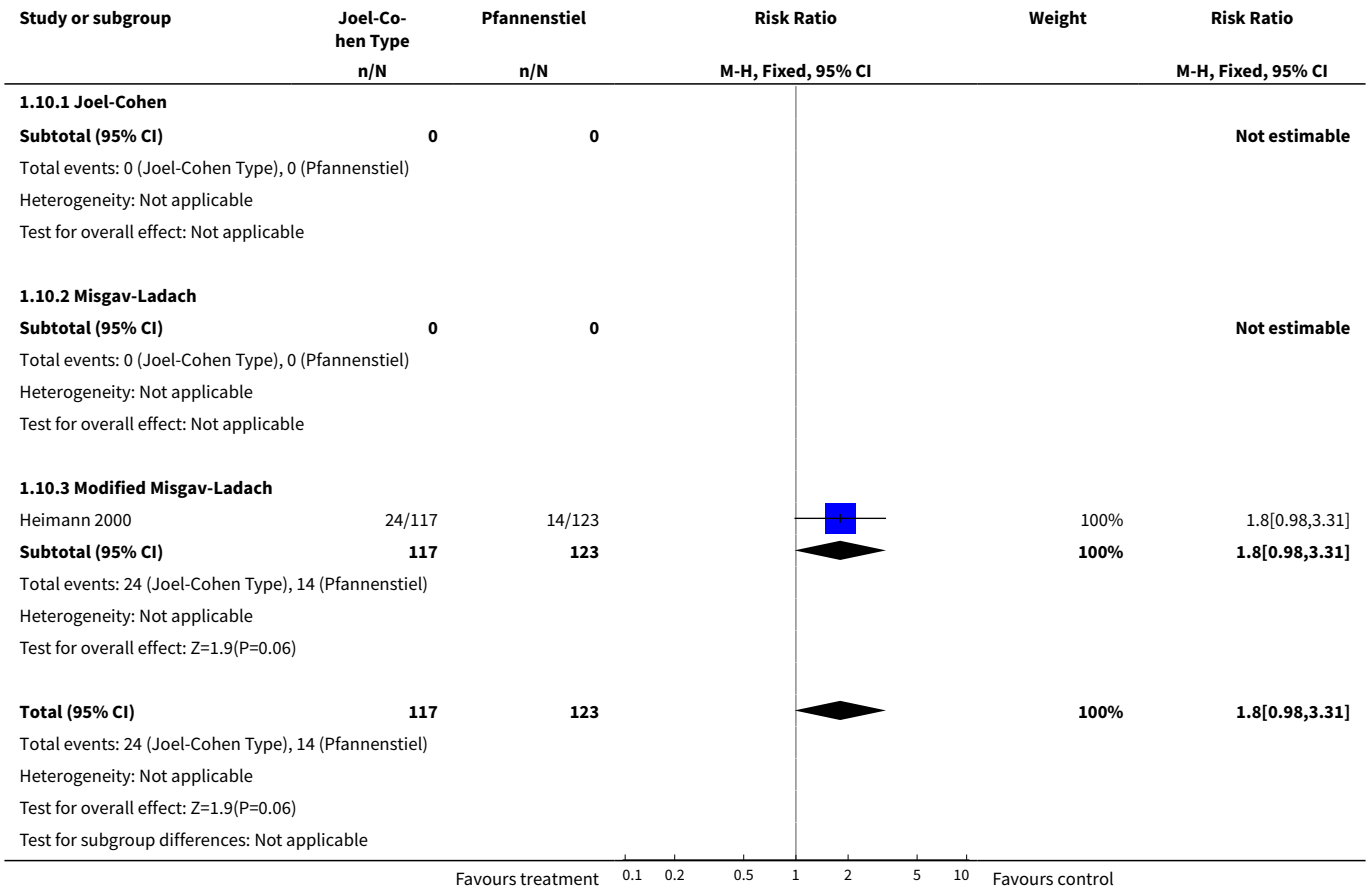


Analysis 1.9. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 9 Wound infection.

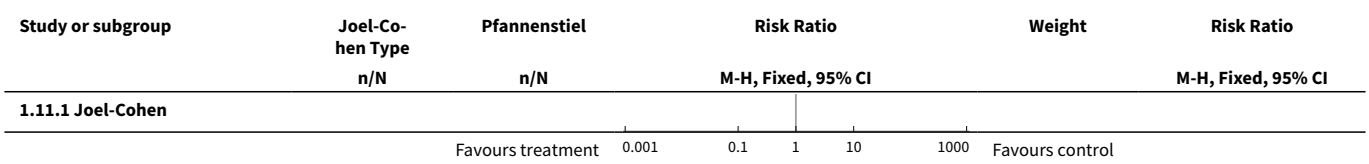


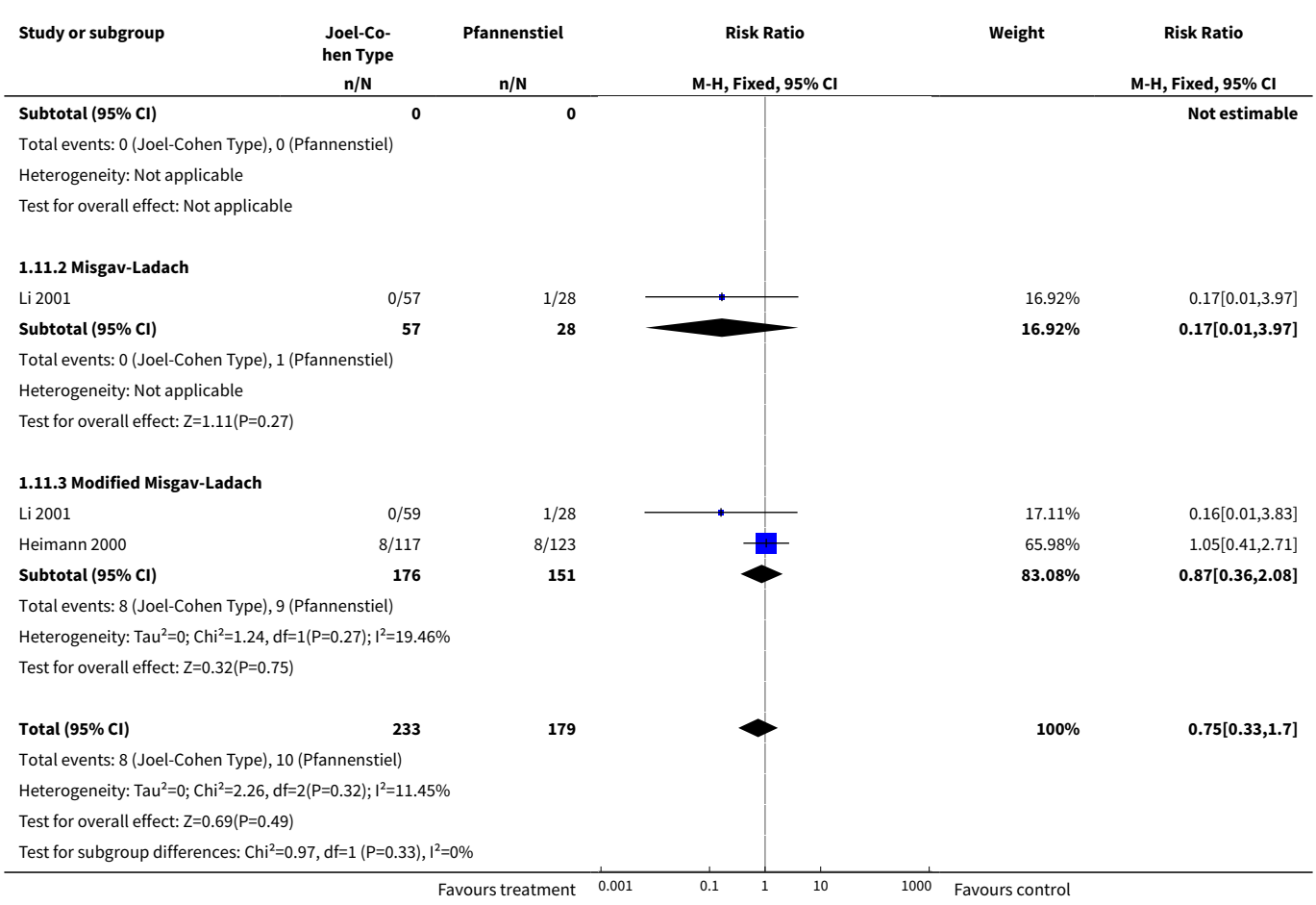


Analysis 1.10. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 10 Wound haematoma.

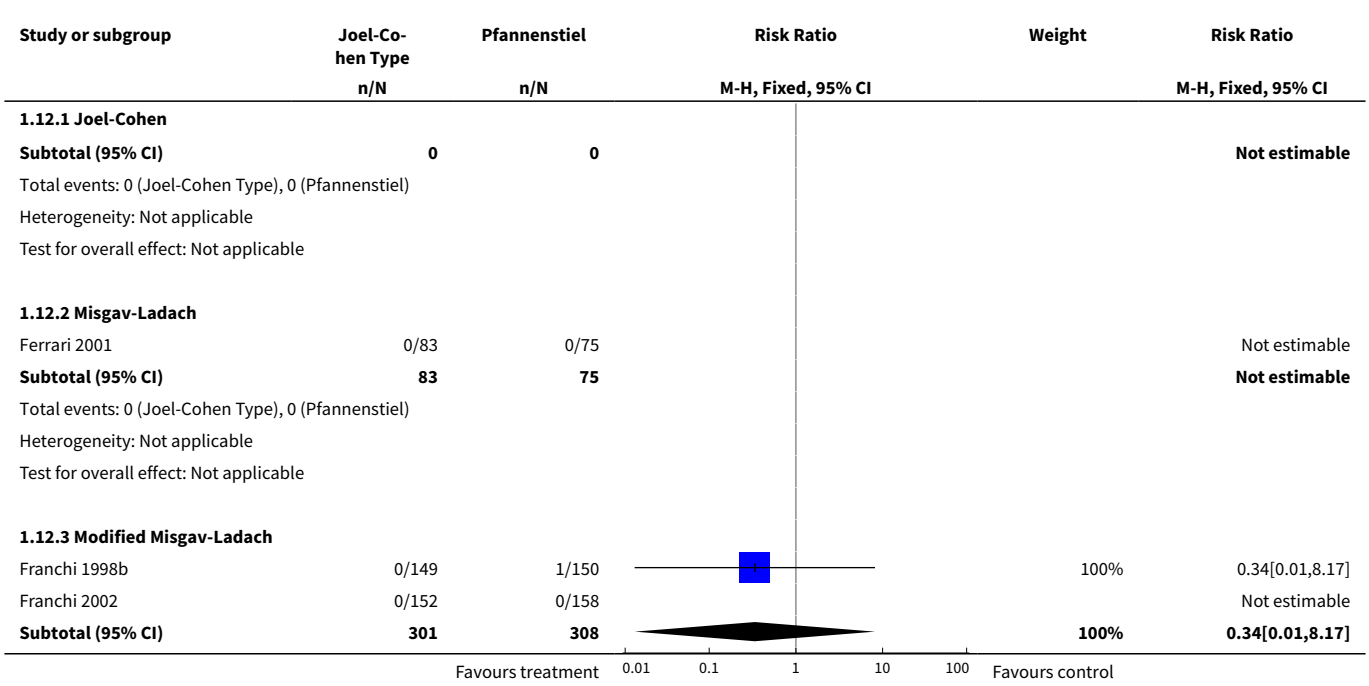


Analysis 1.11. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 11 Wound breakdown.

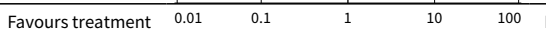




Analysis 1.12. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 12 Endometritis.

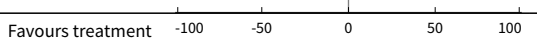


Study or subgroup	Joel-Cohen Type n/N	Pfannenstiel n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
Total events: 0 (Joel-Cohen Type), 1 (Pfannenstiel)					
Heterogeneity: Tau²=0; Chi²=0, df=0(P<0.0001); I²=100%					
Test for overall effect: Z=0.67(P=0.5)					
Total (95% CI)	**384**	**383**		**100%**	**0.34[0.01,8.17]**
Total events: 0 (Joel-Cohen Type), 1 (Pfannenstiel)					
Heterogeneity: Tau²=0; Chi²=0, df=0(P<0.0001); I²=100%					
Test for overall effect: Z=0.67(P=0.5)					
Test for subgroup differences: Not applicable					



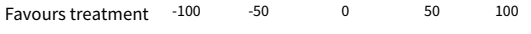
Analysis 1.13. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 13 Time to mobilisation (hours).

Study or subgroup	Joel-Cohen Type N	Mean(SD)	Pfannenstiel N	Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
1.13.1 Joel-Cohen							
Subtotal ***	**0**		**0**				**Not estimable**
Heterogeneity: Not applicable							
Test for overall effect: Not applicable							
1.13.2 Misgav-Ladach							
Darj 1999	25	14.5 (7)	25	13.1 (6.3)		50.41%	1.4[-2.3,5.1]
Ferrari 2001	83	40.8 (13.2)	75	48 (12.5)		49.59%	-7.2[-11.21,-3.19]
Subtotal ***	**108**		**100**			**100%**	**-2.86[-11.29,5.56]**
Heterogeneity: Tau²=33.11; Chi²=9.55, df=1(P=0); I²=89.53%							
Test for overall effect: Z=0.67(P=0.51)							
1.13.3 Modified Misgav-Ladach							
Subtotal ***	**0**		**0**				**Not estimable**
Heterogeneity: Not applicable							
Test for overall effect: Not applicable							
Total ***	**108**		**100**			**100%**	**-2.86[-11.29,5.56]**
Heterogeneity: Tau²=33.11; Chi²=9.55, df=1(P=0); I²=89.53%							
Test for overall effect: Z=0.67(P=0.51)							
Test for subgroup differences: Not applicable							

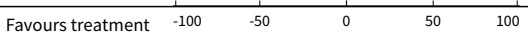


Analysis 1.14. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 14 Time to oral intake (hours).

Study or subgroup	Joel-Cohen Type N	Mean(SD)	Pfannenstiel N	Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
1.14.1 Joel-Cohen							
Mathai 2002	51	10.7 (3.3)	50	12.8 (5.5)		22.28%	-2.1[-3.87,-0.33]

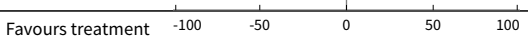


Study or subgroup	Joel-Cohen Type N	Mean(SD)	Pfannenstiel N	Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
Subtotal ***	**51**		**50**			**22.28%**	**-2.1[-3.87,-0.33]**
Heterogeneity: Not applicable							
Test for overall effect: Z=2.32(P=0.02)							
1.14.2 Misgav-Ladach							
Darj 1999	25	3.6 (2.2)	25	3 (1.6)		23.3%	0.6[-0.45,1.65]
Li 2001	57	16.7 (6.9)	28	23.5 (8.6)		18.25%	-6.8[-10.45,-3.15]
Ferrari 2001	83	33.6 (11)	75	38.4 (12.5)		18.16%	-4.8[-8.49,-1.11]
Subtotal ***	**165**		**128**			**59.72%**	**-3.43[-8.58,1.71]**
Heterogeneity: Tau^2=18.33; Chi^2=20.68, df=2(P<0.0001); I^2=90.33%							
Test for overall effect: Z=1.31(P=0.19)							
1.14.3 Modified Misgav-Ladach							
Li 2001	59	15.3 (7.8)	28	23.5 (8.6)		18.01%	-8.2[-11.96,-4.44]
Subtotal ***	**59**		**28**			**18.01%**	**-8.2[-11.96,-4.44]**
Heterogeneity: Not applicable							
Test for overall effect: Z=4.28(P<0.0001)							
Total ***	**275**		**206**			**100%**	**-3.92[-7.13,-0.71]**
Heterogeneity: Tau^2=11.23; Chi^2=38.21, df=4(P<0.0001); I^2=89.53%							
Test for overall effect: Z=2.39(P=0.02)							
Test for subgroup differences: Chi^2=8.29, df=1 (P=0.02), I^2=75.88%							

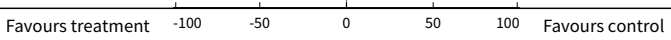


Analysis 1.15. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 15 Time to return of bowel function (hours).

Study or subgroup	Joel-Cohen Type N	Mean(SD)	Pfannenstiel N	Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
1.15.1 Joel-Cohen							
Subtotal ***	**0**		**0**				**Not estimable**
Heterogeneity: Not applicable							
Test for overall effect: Not applicable							
1.15.2 Misgav-Ladach							
Darj 1999	25	71.7 (43.4)	25	50.3 (18.7)		14.65%	21.4[2.88,39.92]
Li 2001	57	20.9 (9.5)	28	31.7 (8.9)		42.5%	-10.8[-14.92,-6.68]
Subtotal ***	**82**		**53**			**57.15%**	**3.98[-27.47,35.43]**
Heterogeneity: Tau^2=471.57; Chi^2=11.07, df=1(P=0); I^2=90.96%							
Test for overall effect: Z=0.25(P=0.8)							
1.15.3 Modified Misgav-Ladach							
Li 2001	59	19.4 (8.5)	28	31.7 (8.9)		42.85%	-12.3[-16.25,-8.35]
Subtotal ***	**59**		**28**			**42.85%**	**-12.3[-16.25,-8.35]**
Heterogeneity: Not applicable							
Test for overall effect: Z=6.11(P<0.0001)							
Total ***	**141**		**81**			**100%**	**-6.72[-15.26,1.81]**
Heterogeneity: Tau^2=40.24; Chi^2=12.17, df=2(P=0); I^2=83.56%							

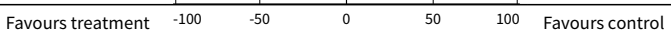


Study or subgroup	Joel-Cohen Type N	Mean(SD)	Pfannenstiel N	Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
Test for overall effect: Z=1.54(P=0.12)							
Test for subgroup differences: Chi²=1.01, df=1 (P=0.31), I²=1.35%							



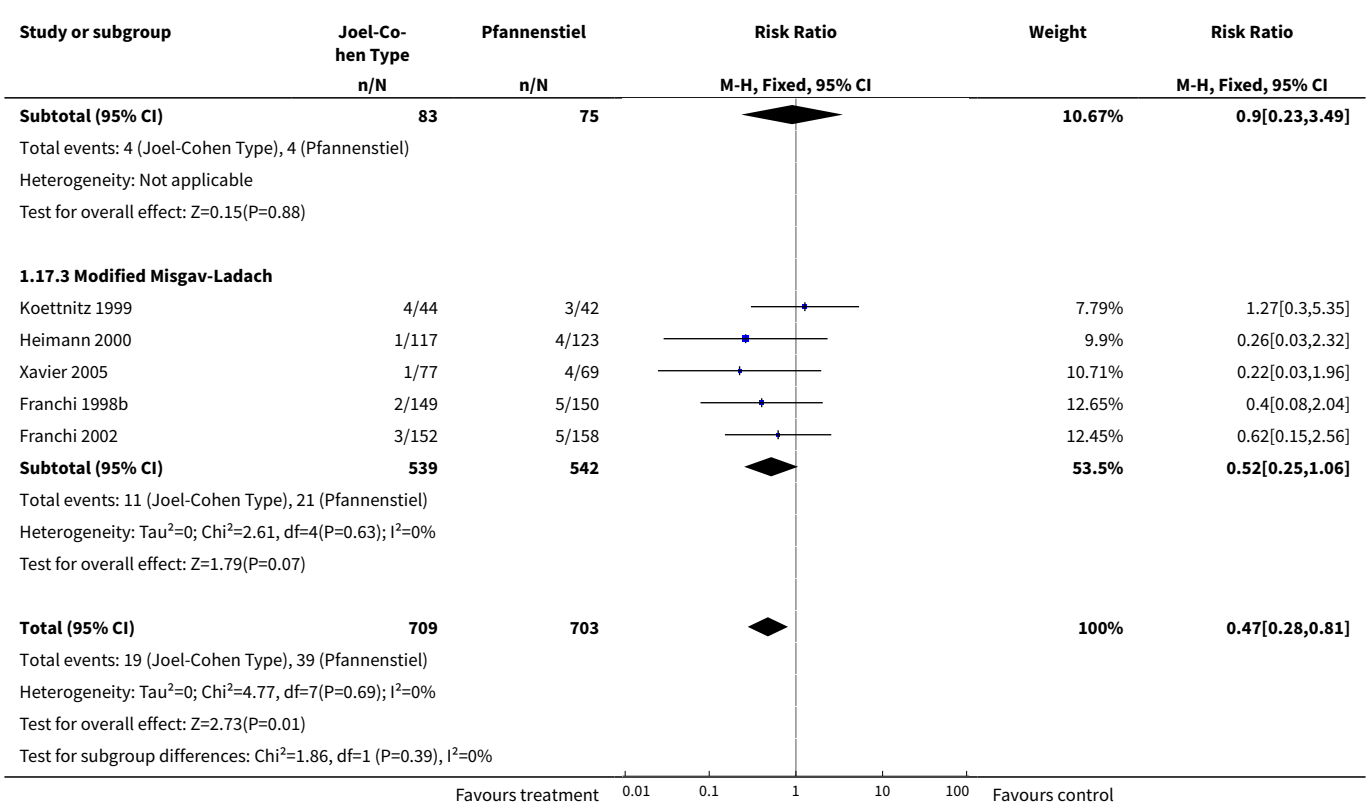
Analysis 1.16. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 16 Time to breastfeeding initiation (hours).

Study or subgroup	Joel-Cohen Type N	Mean(SD)	Pfannenstiel N	Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
1.16.1 Joel-Cohen							
Mathai 2002	51	6.9 (9.9)	50	12.4 (27.6)		100%	-5.5[-13.62,2.62]
Subtotal ***	**51**		**50**			**100%**	**-5.5[-13.62,2.62]**
Heterogeneity: Not applicable							
Test for overall effect: Z=1.33(P=0.18)							
1.16.2 Misgav-Ladach							
Subtotal ***	**0**		**0**				**Not estimable**
Heterogeneity: Not applicable							
Test for overall effect: Not applicable							
1.16.3 Modified Misgav-Ladach							
Subtotal ***	**0**		**0**				**Not estimable**
Heterogeneity: Not applicable							
Test for overall effect: Not applicable							
Total ***	**51**		**50**			**100%**	**-5.5[-13.62,2.62]**
Heterogeneity: Not applicable							
Test for overall effect: Z=1.33(P=0.18)							
Test for subgroup differences: Not applicable							

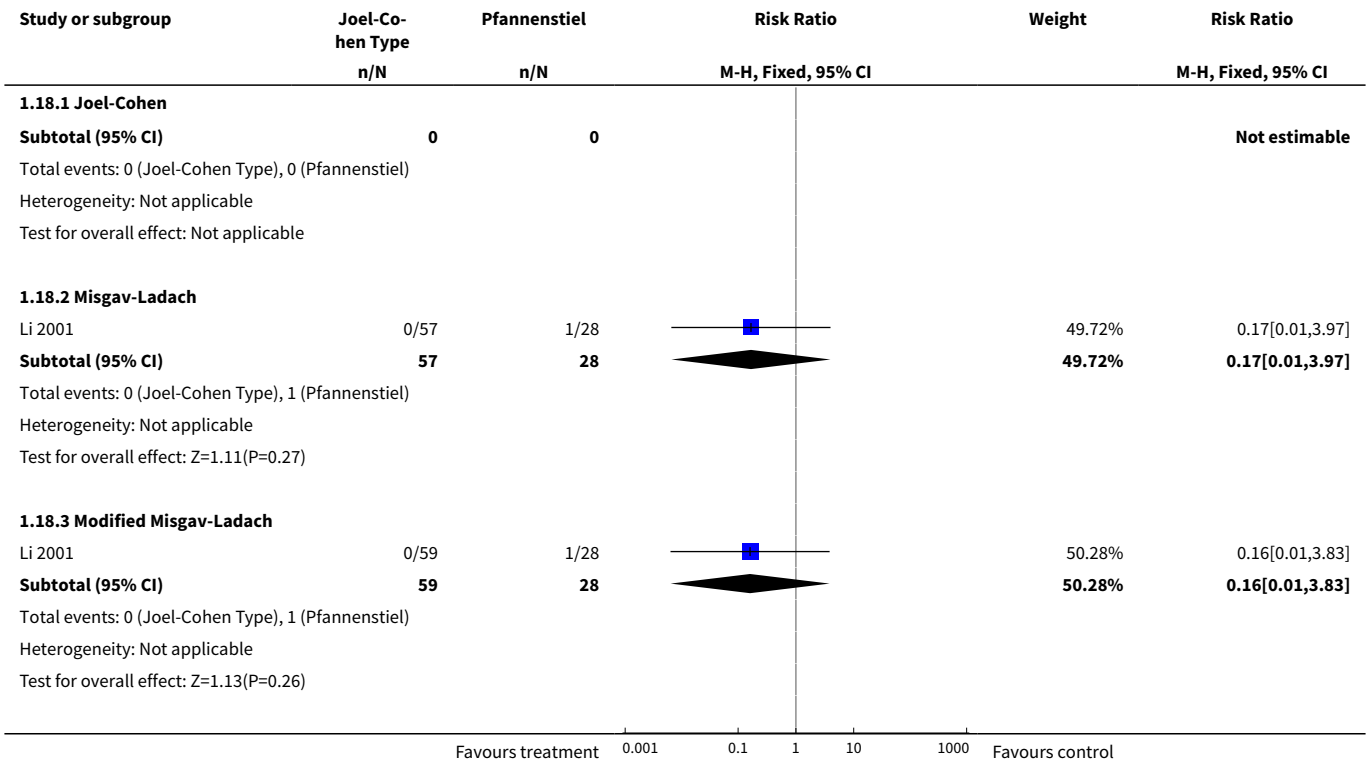


Analysis 1.17. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 17 Fever treated with antibiotics or as defined by trial authors.

Study or subgroup	Joel-Cohen Type n/N	Pfannenstiel n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
1.17.1 Joel-Cohen					
Wallin 1999b	1/36	2/36		5.08%	0.5[0.05,5.27]
Mathai 2002	3/51	12/50		30.76%	0.25[0.07,0.82]
Subtotal (95% CI)	**87**	**86**		**35.84%**	**0.28[0.1,0.81]**
Total events: 4 (Joel-Cohen Type), 14 (Pfannenstiel)					
Heterogeneity: Tau²=0; Chi²=0.28, df=1(P=0.6); I²=0%					
Test for overall effect: Z=2.34(P=0.02)					
1.17.2 Misgav-Ladach					
Ferrari 2001	4/83	4/75		10.67%	0.9[0.23,3.49]



Analysis 1.18. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 18 Repeat operative procedures on the wound.



Study or subgroup	Joel-Cohen Type n/N	Pfannenstiel n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
Total (95% CI)	**116**	**56**		**100%**	**0.16[0.02,1.54]**
Total events: 0 (Joel-Cohen Type), 2 (Pfannenstiel)					
Heterogeneity: Tau²=0; Chi²=0, df=1(P=0.99); I²=0%					
Test for overall effect: Z=1.58(P=0.11)					
Test for subgroup differences: Chi²=0, df=1 (P=0.99), I²=0%					

Favours treatment 0.001 0.1 1 10 1000 Favours control

Analysis 1.19. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 19 Postoperative pain as measured by trial authors.

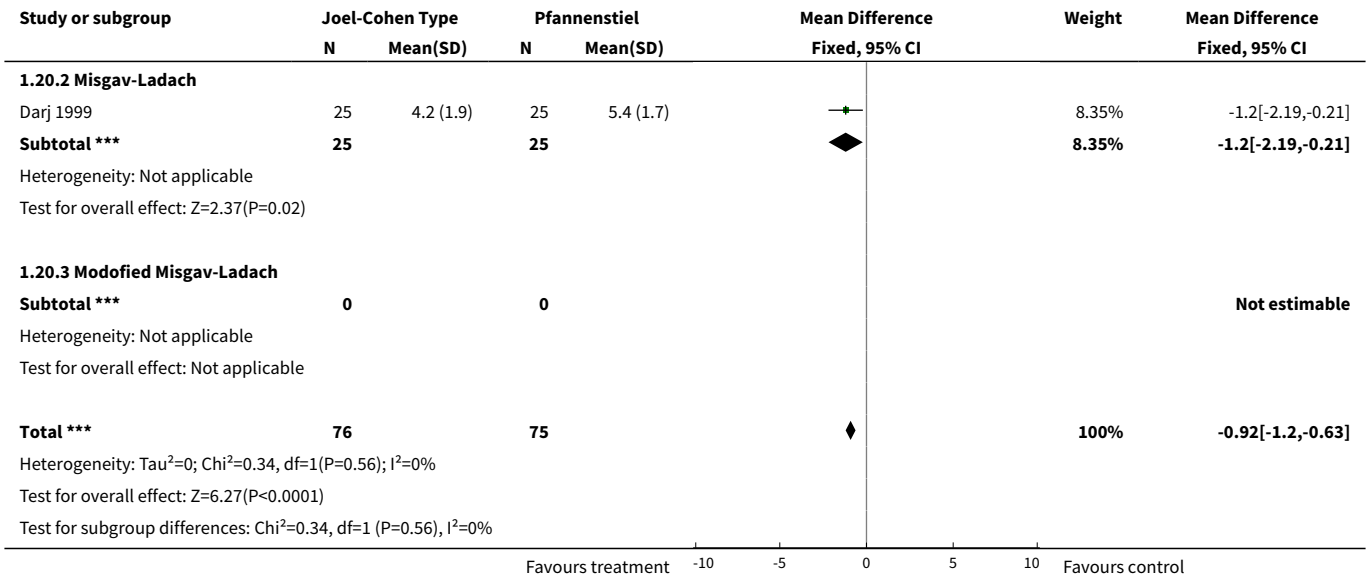
Study or subgroup	Joel-Cohen Type N	Mean(SD)	Pfannenstiel N	Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
1.19.1 Joel-Cohen							
Subtotal ***	**0**		**0**				**Not estimable**
Heterogeneity: Not applicable							
Test for overall effect: Not applicable							
1.19.2 Misgav-Ladach							
Li 2001	57	12.5 (9.5)	28	25.5 (14.5)		48.91%	-13[-18.91,-7.09]
Subtotal ***	**57**		**28**			**48.91%**	**-13[-18.91,-7.09]**
Heterogeneity: Not applicable							
Test for overall effect: Z=4.31(P<0.0001)							
1.19.3 Modofied Misgav-Ladach							
Li 2001	59	10.2 (8.4)	28	25.5 (14.5)		51.09%	-15.3[-21.08,-9.52]
Subtotal ***	**59**		**28**			**51.09%**	**-15.3[-21.08,-9.52]**
Heterogeneity: Not applicable							
Test for overall effect: Z=5.19(P<0.0001)							
Total ***	**116**		**56**			**100%**	**-14.18[-18.31,-10.04]**
Heterogeneity: Tau²=0; Chi²=0.3, df=1(P=0.59); I²=0%							
Test for overall effect: Z=6.72(P<0.0001)							
Test for subgroup differences: Chi²=0.3, df=1 (P=0.59), I²=0%							

Favours treatment -100 -50 0 50 100 Favours control

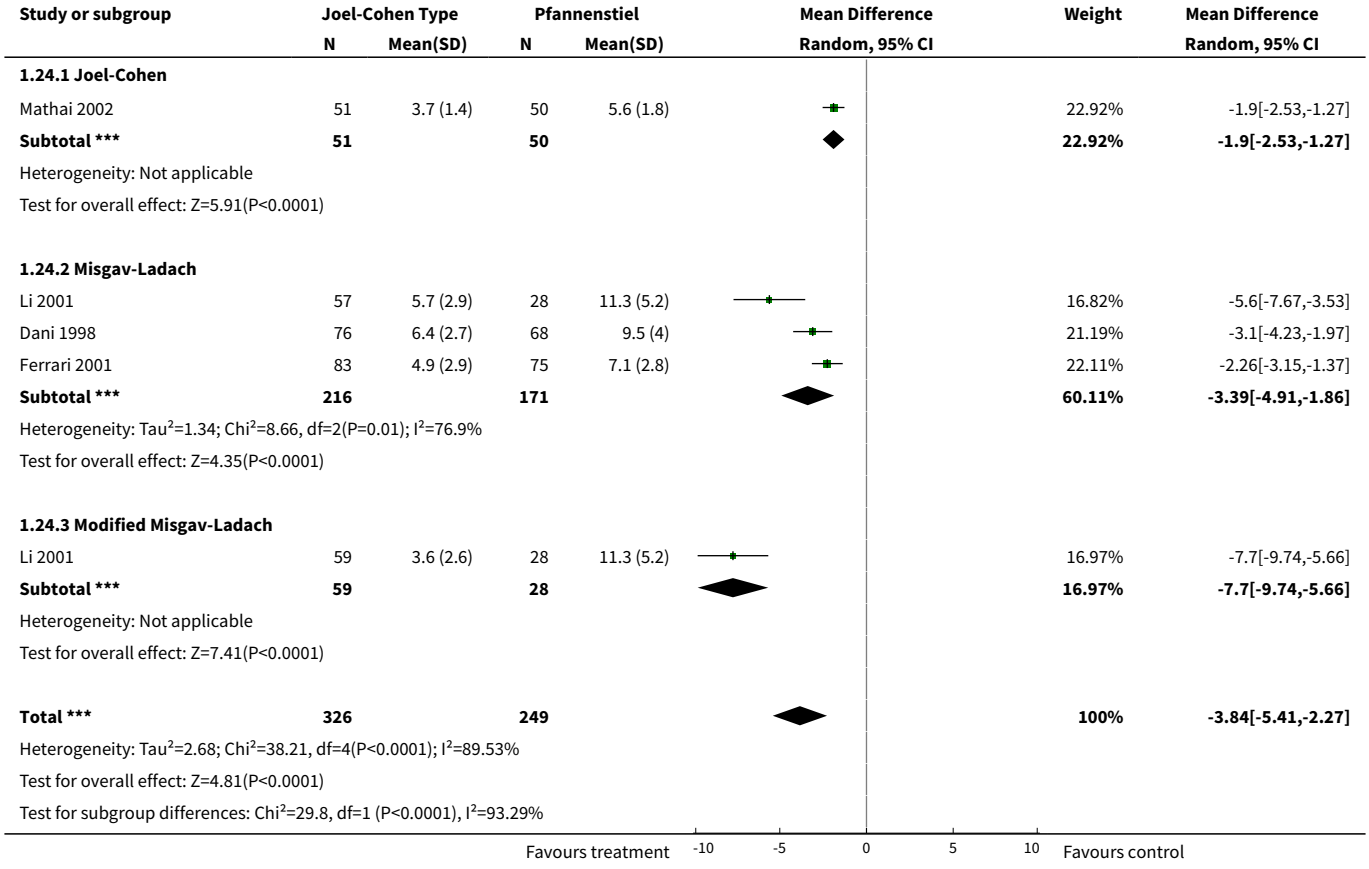
Analysis 1.20. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 20 Number of analgesic injections.

Study or subgroup	Joel-Cohen Type N	Mean(SD)	Pfannenstiel N	Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
1.20.1 Joel-Cohen							
Mathai 2002	51	2.1 (0.6)	50	2.9 (0.9)		91.65%	-0.89[-1.19,-0.59]
Subtotal ***	**51**		**50**			**91.65%**	**-0.89[-1.19,-0.59]**
Heterogeneity: Not applicable							
Test for overall effect: Z=5.84(P<0.0001)							

Favours treatment -10 -5 0 5 10 Favours control

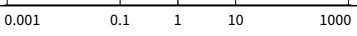


Analysis 1.24. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 24 Time from skin incision to delivery (minutes).



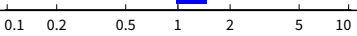
Analysis 1.28. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 28 Apgar score < 7 at 5 minutes.

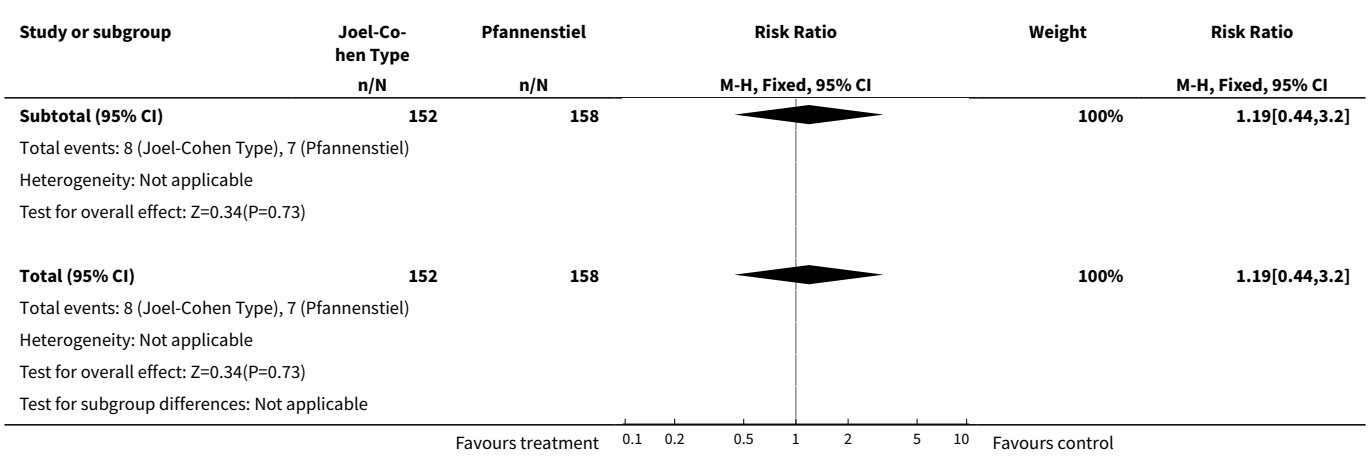
Study or subgroup	Joel-Cohen Type n/N	Pfannenstiel n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
1.28.1 Joel-Cohen					
Subtotal (95% CI)	**0**	**0**			**Not estimable**
Total events: 0 (Joel-Cohen Type), 0 (Pfannenstiel)					
Heterogeneity: Not applicable					
Test for overall effect: Not applicable					
1.28.2 Misgav-Ladach					
Ferrari 2001	0/83	2/75		100%	0.18[0.01,3.71]
Subtotal (95% CI)	**83**	**75**		**100%**	**0.18[0.01,3.71]**
Total events: 0 (Joel-Cohen Type), 2 (Pfannenstiel)					
Heterogeneity: Not applicable					
Test for overall effect: Z=1.11(P=0.27)					
1.28.3 Modified Misgav-Ladach					
Subtotal (95% CI)	**0**	**0**			**Not estimable**
Total events: 0 (Joel-Cohen Type), 0 (Pfannenstiel)					
Heterogeneity: Not applicable					
Test for overall effect: Not applicable					
Total (95% CI)	**83**	**75**		**100%**	**0.18[0.01,3.71]**
Total events: 0 (Joel-Cohen Type), 2 (Pfannenstiel)					
Heterogeneity: Not applicable					
Test for overall effect: Z=1.11(P=0.27)					
Test for subgroup differences: Chi^2=0, df=1 (P<0.0001), I^2=100%					



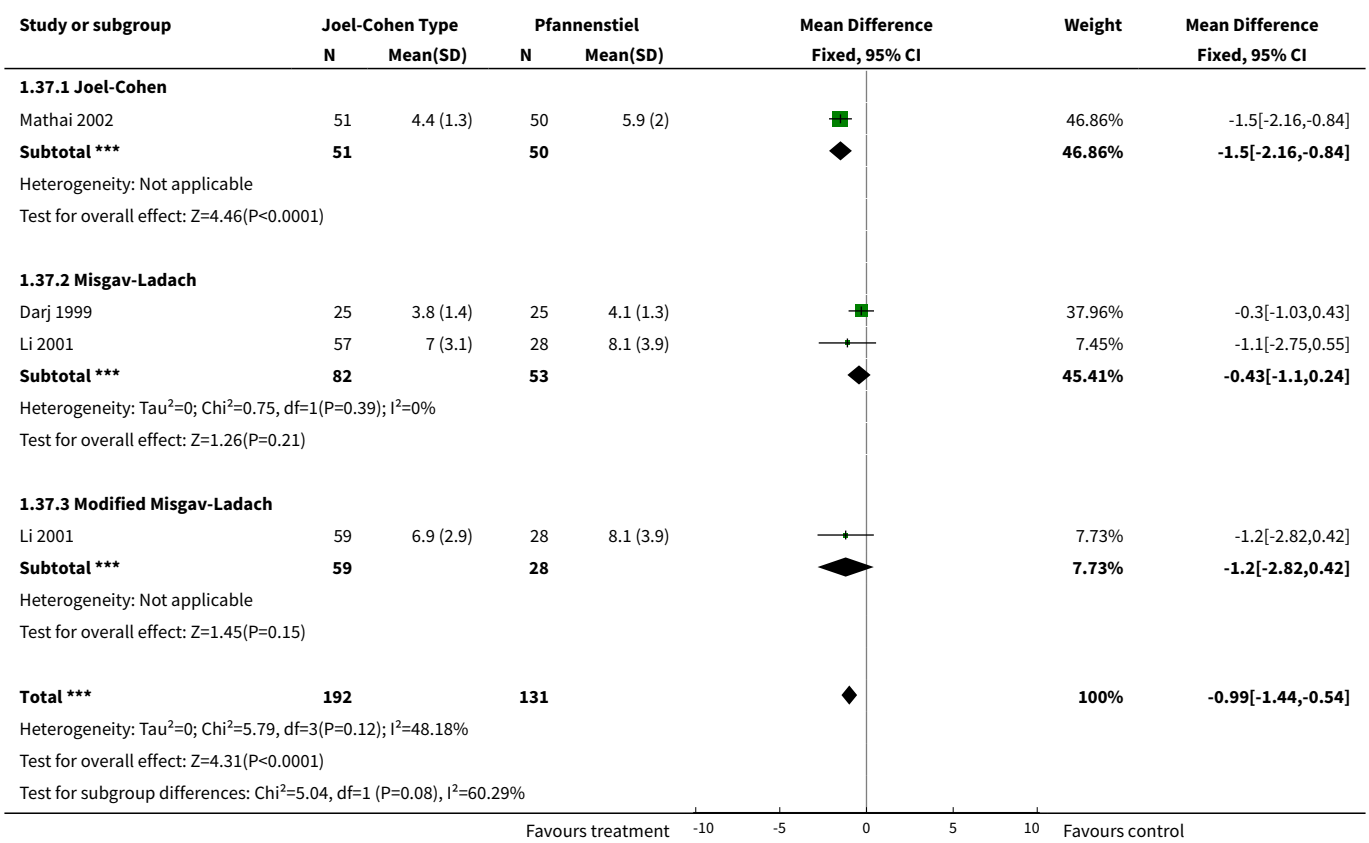
Analysis 1.29. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 29 Neonatal intensive care admission.

Study or subgroup	Joel-Cohen Type n/N	Pfannenstiel n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
1.29.1 Joel-Cohen					
Subtotal (95% CI)	**0**	**0**			**Not estimable**
Total events: 0 (Joel-Cohen Type), 0 (Pfannenstiel)					
Heterogeneity: Not applicable					
Test for overall effect: Not applicable					
1.29.2 Misgav-Ladach					
Subtotal (95% CI)	**0**	**0**			**Not estimable**
Total events: 0 (Joel-Cohen Type), 0 (Pfannenstiel)					
Heterogeneity: Not applicable					
Test for overall effect: Not applicable					
1.29.3 Modified Misgav-Ladach					
Franchi 2002	8/152	7/158		100%	1.19[0.44,3.2]





Analysis 1.37. Comparison 1 Joel-Cohen based versus Pfannenstiel (all trials), Outcome 37 Length of postoperative stay for mother (days).

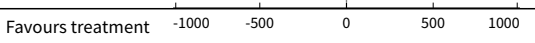


Comparison 4. Joel-Cohen based versus traditional (lower midline incision) (all trials)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2 Blood loss	1	339	Mean Difference (IV, Fixed, 95% CI)	-93.0 [-132.72, -53.28]
3 Blood transfusions	0	0	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
4 Operating time	1	339	Mean Difference (IV, Fixed, 95% CI)	-7.30 [-8.32, -6.28]
8 Postoperative anaemia	1	339	Risk Ratio (M-H, Fixed, 95% CI)	0.60 [0.22, 1.62]
9 Wound infection	1	339	Risk Ratio (M-H, Fixed, 95% CI)	1.14 [0.68, 1.91]
11 Wound breakdown	1	339	Risk Ratio (M-H, Fixed, 95% CI)	0.34 [0.04, 3.19]
12 Endometritis	1	400	Risk Ratio (M-H, Fixed, 95% CI)	2.5 [0.49, 12.74]
13 Time to mobilistion	1	339	Mean Difference (IV, Fixed, 95% CI)	-16.06 [-18.22, -13.90]
17 Fever treated with antibiotics or as defined by trialists	1	339	Risk Ratio (M-H, Fixed, 95% CI)	1.38 [0.75, 2.54]
37 Length of postoperative hospital stay for mother	1	339	Mean Difference (IV, Fixed, 95% CI)	-0.82 [-1.08, -0.56]

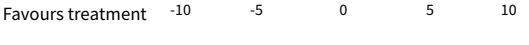
Analysis 4.2. Comparison 4 Joel-Cohen based versus traditional (lower midline incision) (all trials), Outcome 2 Blood loss.

Study or subgroup	Misgav-Ladach N	Misgav-Ladach Mean(SD)	Lower midline N	Lower midline Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Bjorklund 2000	169	354 (165)	170	447 (206)		100%	-93[-132.72,-53.28]
Total ***	**169**		**170**			**100%**	**-93[-132.72,-53.28]**
Heterogeneity: Not applicable							
Test for overall effect: Z=4.59(P<0.0001)							

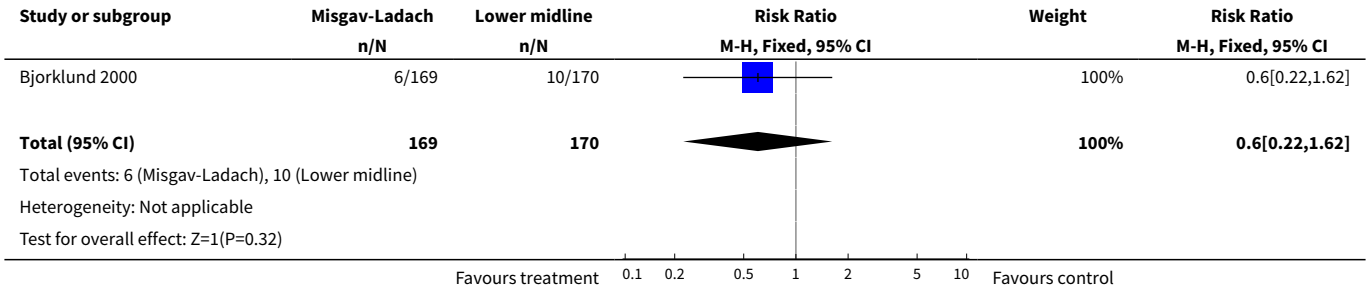


Analysis 4.4. Comparison 4 Joel-Cohen based versus traditional (lower midline incision) (all trials), Outcome 4 Operating time.

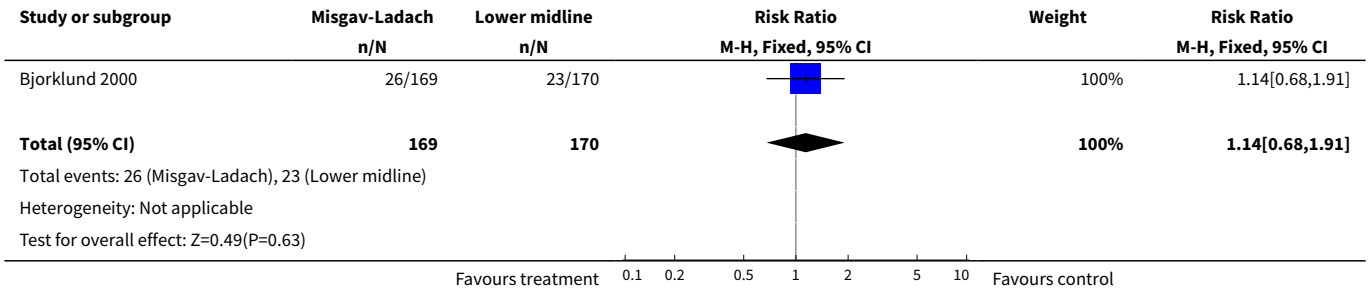
Study or subgroup	Misgav-Ladach N	Misgav-Ladach Mean(SD)	Lower midline N	Lower midline Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Bjorklund 2000	169	25.3 (4.6)	170	32.6 (5)		100%	-7.3[-8.32,-6.28]
Total ***	**169**		**170**			**100%**	**-7.3[-8.32,-6.28]**
Heterogeneity: Not applicable							
Test for overall effect: Z=13.99(P<0.0001)							



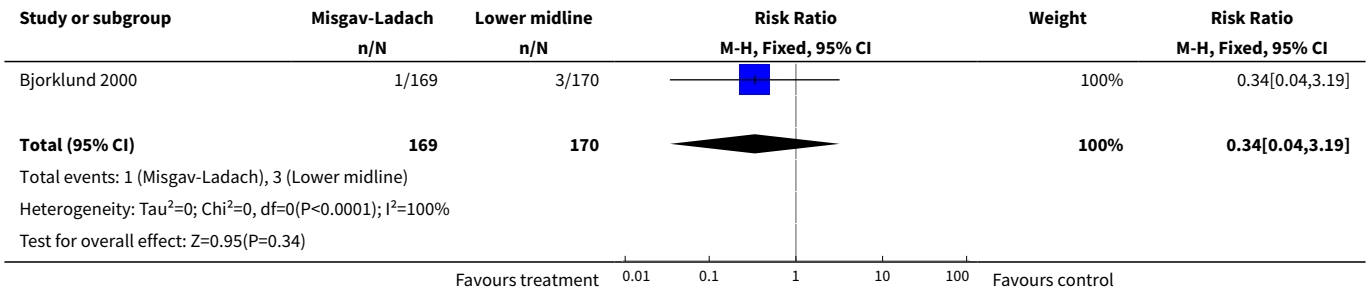
Analysis 4.8. Comparison 4 Joel-Cohen based versus traditional (lower midline incision) (all trials), Outcome 8 Postoperative anaemia.



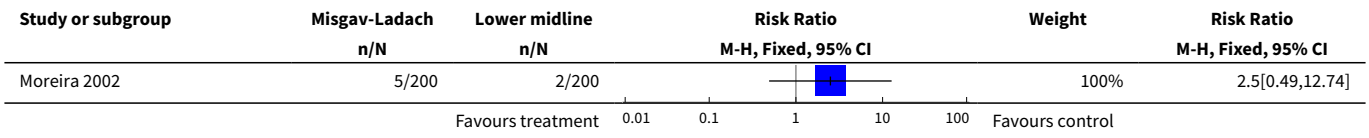
Analysis 4.9. Comparison 4 Joel-Cohen based versus traditional (lower midline incision) (all trials), Outcome 9 Wound infection.

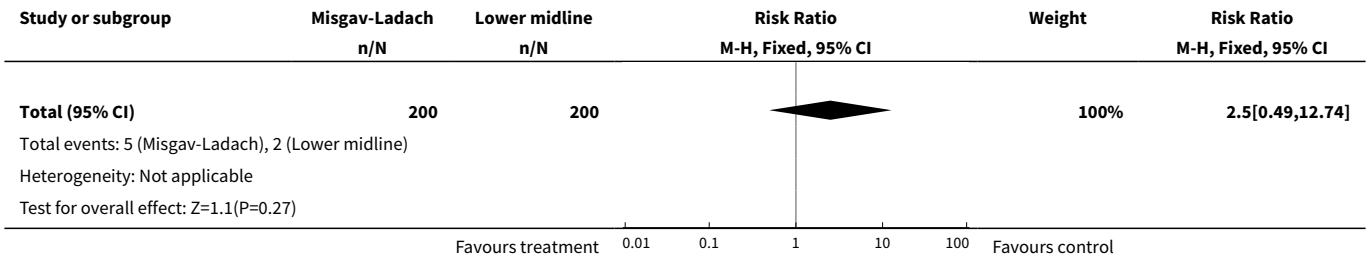


Analysis 4.11. Comparison 4 Joel-Cohen based versus traditional (lower midline incision) (all trials), Outcome 11 Wound breakdown.

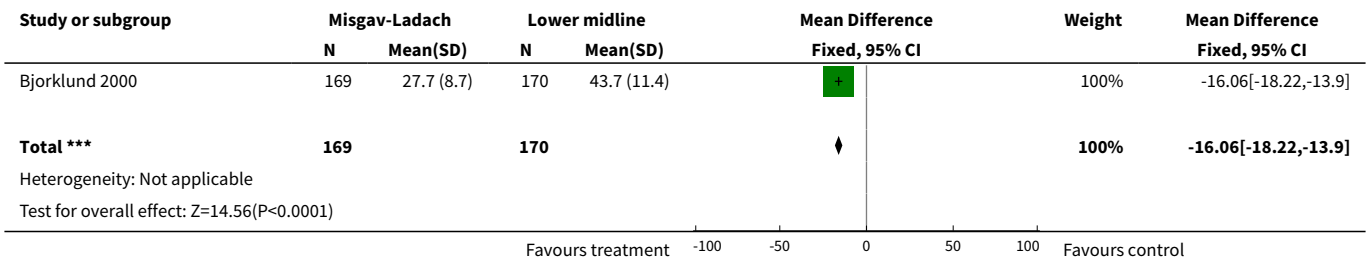


Analysis 4.12. Comparison 4 Joel-Cohen based versus traditional (lower midline incision) (all trials), Outcome 12 Endometritis.

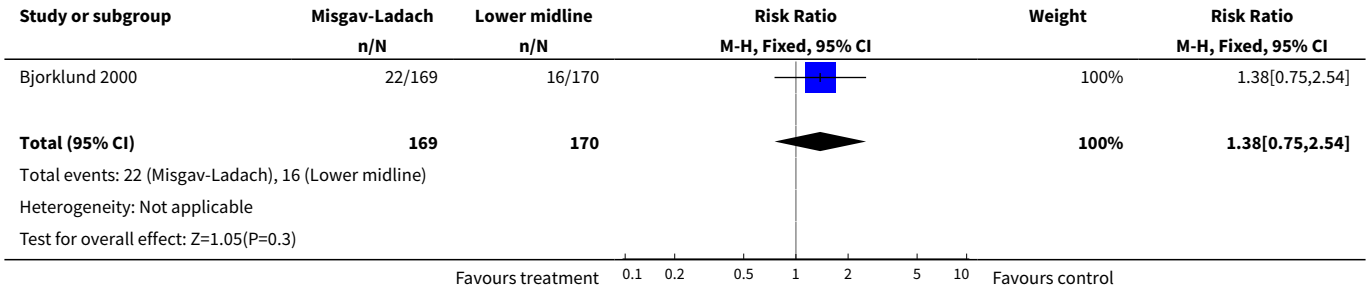




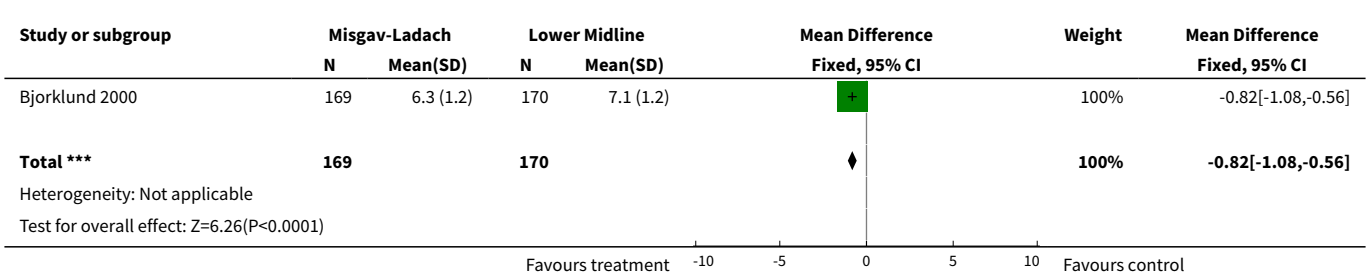
Analysis 4.13. Comparison 4 Joel-Cohen based versus traditional (lower midline incision) (all trials), Outcome 13 Time to mobilistion.



Analysis 4.17. Comparison 4 Joel-Cohen based versus traditional (lower midline incision) (all trials), Outcome 17 Fever treated with antibiotics or as defined by trialists.



Analysis 4.37. Comparison 4 Joel-Cohen based versus traditional (lower midline incision) (all trials), Outcome 37 Length of postoperative hospital stay for mother.

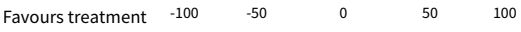


Comparison 7. Misgav-Ladach versus modified Misgav-Ladach (all trials)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2 Blood loss	1	116	Mean Difference (IV, Fixed, 95% CI)	14.0 [-0.70, 28.70]
4 Operating time	1	116	Mean Difference (IV, Fixed, 95% CI)	-0.80 [-2.98, 1.38]
14 Time to oral intake	1	116	Mean Difference (IV, Fixed, 95% CI)	1.40 [-1.28, 4.08]
15 Time to return of bowel function	1	116	Mean Difference (IV, Fixed, 95% CI)	1.5 [-1.78, 4.78]
19 Postoperative pain as measured by trial authors	1	116	Mean Difference (IV, Fixed, 95% CI)	2.30 [-0.97, 5.57]
24 Time from skin incision to delivery	1	116	Mean Difference (IV, Fixed, 95% CI)	2.1 [1.10, 3.10]
37 Length of postoperative hospital stay for mother	1	116	Mean Difference (IV, Fixed, 95% CI)	0.10 [-0.99, 1.19]

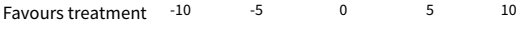
Analysis 7.2. Comparison 7 Misgav-Ladach versus modified Misgav-Ladach (all trials), Outcome 2 Blood loss.

Study or subgroup	Misgav-Ladach N	Misgav-Ladach Mean(SD)	Modified Misgav-Lad N	Modified Misgav-Lad Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Li 2001	57	142 (45)	59	128 (35)		100%	14[-0.7,28.7]
Total ***	**57**		**59**			**100%**	**14[-0.7,28.7]**
Heterogeneity: Not applicable							
Test for overall effect: Z=1.87(P=0.06)							

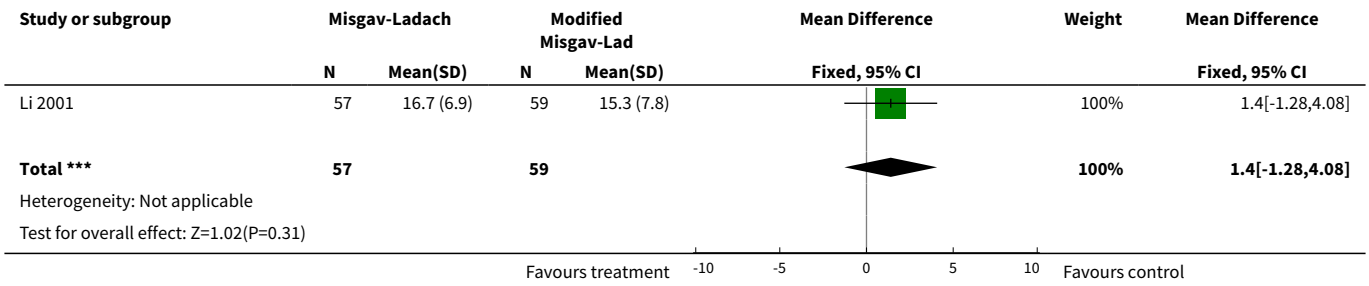


Analysis 7.4. Comparison 7 Misgav-Ladach versus modified Misgav-Ladach (all trials), Outcome 4 Operating time.

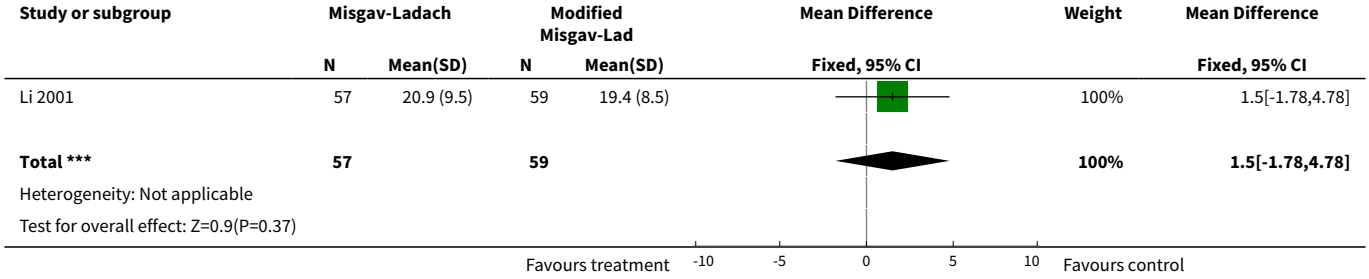
Study or subgroup	Misgav-Ladach N	Misgav-Ladach Mean(SD)	Modified Misgav-Lad N	Modified Misgav-Lad Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Li 2001	57	27.5 (6.5)	59	28.3 (5.4)		100%	-0.8[-2.98,1.38]
Total ***	**57**		**59**			**100%**	**-0.8[-2.98,1.38]**
Heterogeneity: Not applicable							
Test for overall effect: Z=0.72(P=0.47)							



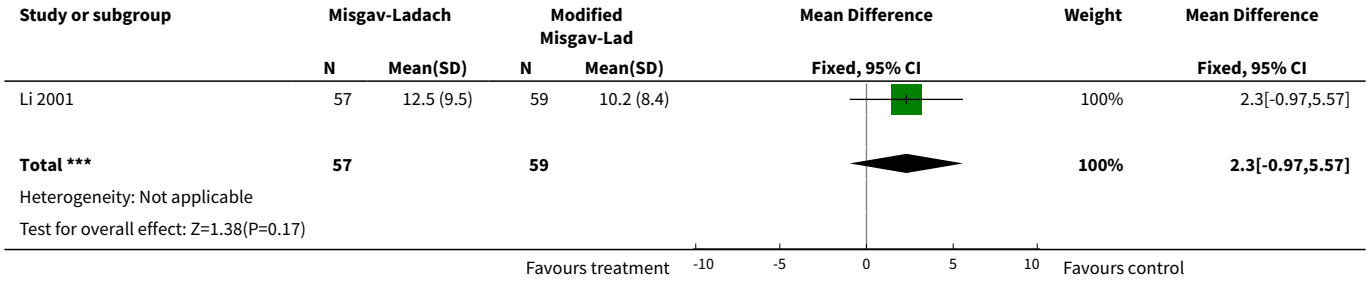
Analysis 7.14. Comparison 7 Misgav-Ladach versus modified Misgav-Ladach (all trials), Outcome 14 Time to oral intake.



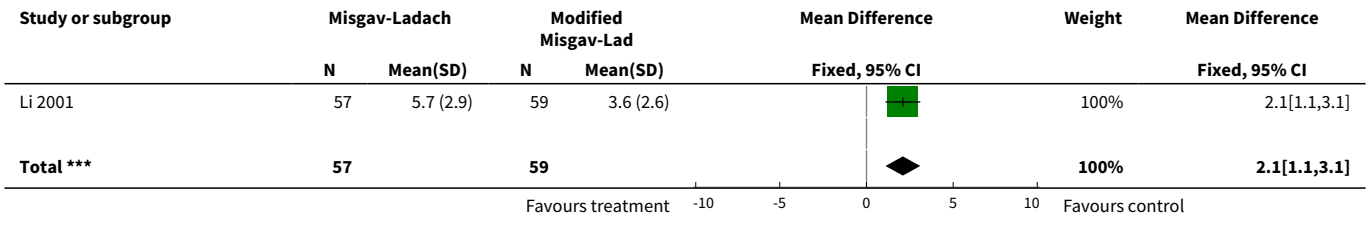
Analysis 7.15. Comparison 7 Misgav-Ladach versus modified Misgav-Ladach (all trials), Outcome 15 Time to return of bowel function.

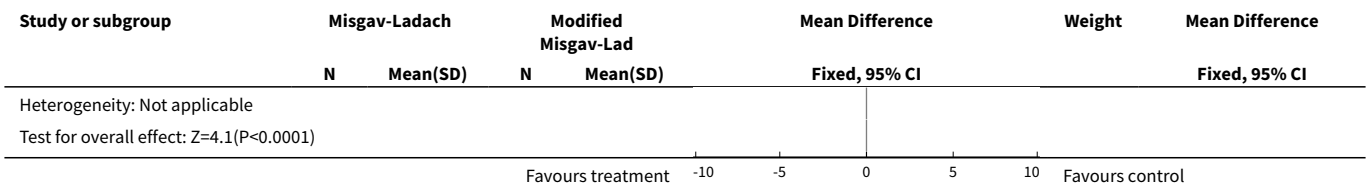


Analysis 7.19. Comparison 7 Misgav-Ladach versus modified Misgav-Ladach (all trials), Outcome 19 Postoperative pain as measured by trial authors.

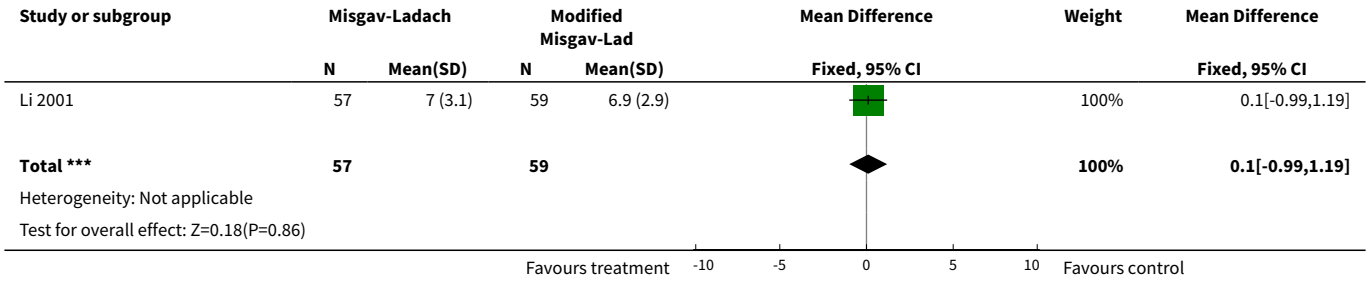


Analysis 7.24. Comparison 7 Misgav-Ladach versus modified Misgav-Ladach (all trials), Outcome 24 Time from skin incision to delivery.





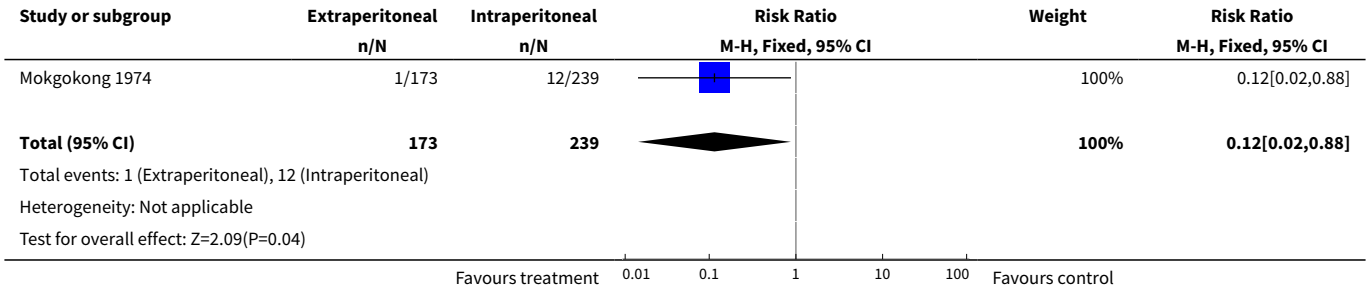
Analysis 7.37. Comparison 7 Misgav-Ladach versus modified Misgav-Ladach (all trials), Outcome 37 Length of postoperative hospital stay for mother.



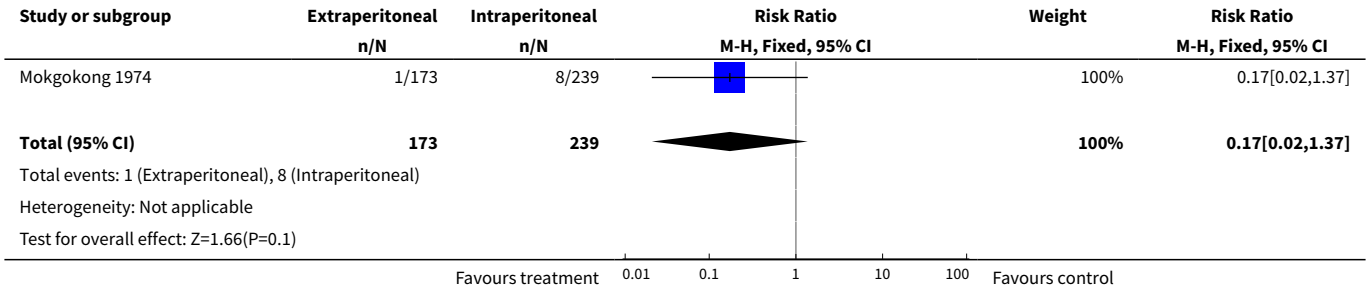
Comparison 10. Extraperitoneal versus intraperitoneal caesarean section

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Serious complications	1	412	Risk Ratio (M-H, Fixed, 95% CI)	0.12 [0.02, 0.88]
5 Maternal mortality	1	412	Risk Ratio (M-H, Fixed, 95% CI)	0.17 [0.02, 1.37]
17 Fever treated with antibiotics or as defined by trialists	1	412	Risk Ratio (M-H, Fixed, 95% CI)	0.42 [0.27, 0.65]
18 Repeat operative procedures on the wound	1	412	Risk Ratio (M-H, Fixed, 95% CI)	1.50 [0.70, 3.20]

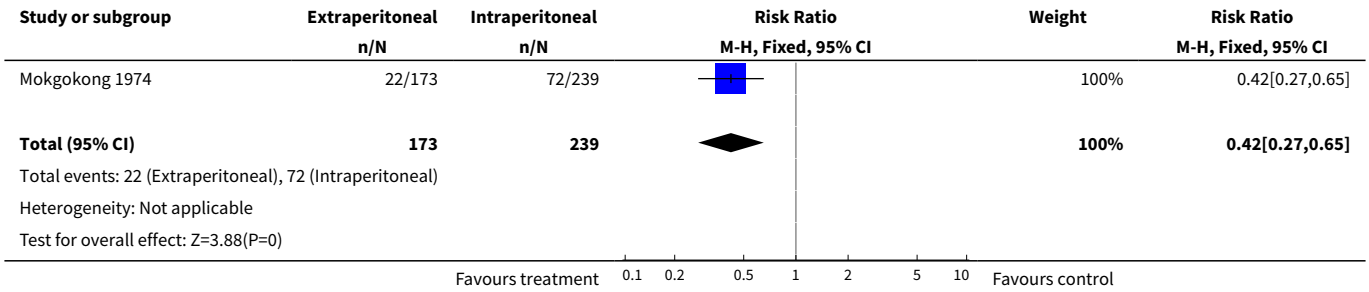
Analysis 10.1. Comparison 10 Extraperitoneal versus intraperitoneal caesarean section, Outcome 1 Serious complications.



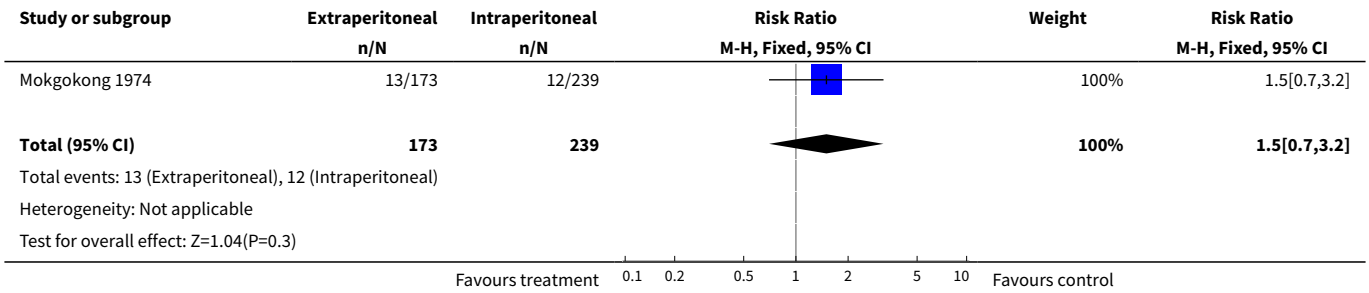
Analysis 10.5. Comparison 10 Extraperitoneal versus intraperitoneal caesarean section, Outcome 5 Maternal mortality.



Analysis 10.17. Comparison 10 Extraperitoneal versus intraperitoneal caesarean section, Outcome 17 Fever treated with antibiotics or as defined by trialists.



Analysis 10.18. Comparison 10 Extraperitoneal versus intraperitoneal caesarean section, Outcome 18 Repeat operative procedures on the wound.



ADDITIONAL TABLES

Table 1. Summary of Cochrane reviews on various aspects of caesarean section techniques

Review	Main results	Practice	Research

Table 1. Summary of Cochrane reviews on various aspects of caesarean section techniques *(Continued)*

Preoperative hair removal to reduce surgical site infection. Tanner J, Woodlings D, Moncaster K. 11 RCTs. 2 studies, 411 participants compared the Joel-Cohen incision with the Pfannenstiel incision.	No statistically significant difference in surgical site infections (SSI) was found comparing hair removal using either depilatory cream or razors with no hair removal (3 trials, 625 people). There were significantly more SSIs when people were shaved compared with either clipping (3 trials, 3193 people; RR 2.02, 95%.CI 1.21 to 3.36) or hair removal using a depilatory cream (7 trials, 1213 people; RR 1.54, 95%CI 1.05 to 2.24). No difference in SSIs was found between shaving (1 trial) or clipping (1 trial) on the day of surgery compared with the day before surgery.	There is no evidence that hair removal prior to surgery reduced SSI. If it is necessary to remove hair then both clipping and depilatory creams results in fewer SSIs than shaving using a razor. There is no difference in SSIs when patients are shaved or clipped one day before surgery or on the day of surgery.	No trials were found that compared clipping with a depilatory cream. No trials were identified which compared clipping with no hair removal. No trials were found that compared depilatory cream at different times or that compared hair removal in different settings.
Preoperative bathing or showering with skin antiseptics to prevent surgical site infection. Webster J, Osborne S. 6 trials, 10,007 participants.	The antiseptic used in all trials was 4% chlorhexidine gluconate. In 3 trials involving 7691 participants bathing with chlorhexidine compared with a placebo did not result in a statistically significant reduction in SSIs, (RR = 0.91 (95% CI 0.80 to 1.04). When only trials of high quality were included in this comparison, the RR of SSI was 0.95 (95% CI 0.82 to 1.10). 3 trials of 1443 participants compared bar soap with chlorhexidine; when combined there was no difference in the risk of SSIs (RR 1.02, 95% CI 0.57 to 1.84). 2 trials of 1092 patients compared bathing with chlorhexidine with no washing, 1 large study found a statistically significant difference in favour of bathing with chlorhexidine (RR 0.36, 95% CI 0.17 to 0.79). The second smaller study found no difference between patients who washed with chlorhexidine and those who did not wash preoperatively.	This review provides no clear evidence of benefit for preoperative showering or bathing with chlorhexidine over other wash products, to reduce surgical site infection.	More research is needed in this area.
Double gloving to reduce surgical cross-infection. Tanner J, Parkinson H. 2 trials on surgical site infections. 31 RCTs on glove perforations.	2 trials were found which addressed the primary outcome, namely, surgical site infections in patients. Both trials reported no infections. 14 trials of double gloving (wearing 2 pairs of surgical latex gloves) were pooled and showed that there were significantly more perforations to the single glove than the innermost of the double gloves (OR 4.10, 95% CI 3.30 to 5.09). 8 trials of indicator gloves (coloured latex gloves worn underneath latex gloves to more rapidly alert the team to perforations) showed that significantly fewer perforations were detected with single gloves compared with indicator gloves (OR 0.10, 95% CI 0.06 to 0.16) or with standard double glove compared with indicator gloves (OR 0.08, 95% CI 0.04 to 0.17). 2 trials of glove liners (a glove knitted with cloth or polymers worn between 2 pairs of latex gloves)(OR 26.36, 95% CI 7.91 to 87.82), 3 trials of knitted gloves (knitted glove worn on top of latex surgical gloves)(OR 5.76, 95% CI 3.25 to 10.20) and 1 trial of triple gloving (3 pairs of latex surgical gloves)(OR 69.41, 95% CI 3.89 to 1239.18) all compared with standard double gloves, showed there were significantly more perforations to the innermost glove of a standard double glove in all comparisons.	There is no direct evidence that additional glove protection worn by the surgical team reduces surgical site infections in patients, however the review has insufficient power for this outcome. The addition of a second pair of surgical gloves, triple gloving, knitted outer gloves and glove liners all significantly reduce perforations to the innermost glove. Perforation indicator systems results in significantly more innermost glove perforations being detected during surgery.	
Disposable surgical face masks for preventing surgical	In 1 small trial there was a trend towards masks being associated with fewer infections, whereas in 1 large trial there was no statistically significant difference in infection rates between the masked and unmasked group.	From the limited results it is unclear whether wearing surgical face masks results in any	Further research is required.

Table 1. Summary of Cochrane reviews on various aspects of caesarean section techniques *(Continued)*

wound infection in clean surgery. Lipp A, Edwards P. 2 RCTs, 1453 participants.		harm or benefit to the patient undergoing clean surgery. From the limited results it is unclear whether wearing surgical face masks results in any harm or benefit to the patient undergoing clean surgery.	
Antibiotic prophylaxis for cesarean section. F Smaill, GJ Hofmeyr. 81 trials.	Use of prophylactic antibiotics in women undergoing caesarean section substantially reduced the incidence of episodes of fever, endometritis, wound infection, urinary tract infection and serious infection after caesarean section. The reduction in the risk of endometritis with antibiotics was similar across different patient groups: RR for endometritis for elective caesarean section (number of women = 2037) was 0.38 (95% CI 0.22 to 0.64); the RR for non-elective caesarean section (n = 2132) was 0.39 (95% CI 0.34 to 0.46); and the RR for all patients (n = 11,937) was 0.39 (95% CI 0.31 to 0.43). Wound infections were also reduced: for elective caesarean section (n = 2015) RR 0.73 (95% CI 0.53 to 0.99); for non-elective caesarean section (n = 2780) RR 0.36, 95% CI 0.26 to 0.51]; and for all patients (n = 11,142) RR 0.41 (95% CI 0.29 to 0.43).	The reduction of endometritis by two thirds to three quarters and a decrease in wound infections justifies a policy of recommending prophylactic antibiotics to women undergoing elective or non-elective caesarean section.	
Antibiotic prophylaxis regimens and drugs for cesarean section. L Hopkins, F Smaill. 51 trials.	The following results refer to reductions in the incidence of endometritis. Both ampicillin and first-generation cephalosporins have similar efficacy with an odds ratio (OR) of 1.27 (95% CI: 0.84 to 1.93). In comparing ampicillin with second or third-generation cephalosporins the OR was 0.83 (95% CI 0.54 to 1.26) and in comparing a first-generation cephalosporin with a second or third-generation agent the OR was 1.21 (95% CI 0.97-1.51). A multiple dose regimen for prophylaxis appears to offer no added benefit over a single dose regimen; OR 0.92 (95% CI 0.70 to 1.23). Systemic and lavage routes of administration appear to have no difference in effect; OR 1.19 (95% CI 0.81 to 1.73).	Both ampicillin and first generation cephalosporins have similar efficacy in reducing postoperative endometritis. There does not appear to be added benefit in utilizing a more broad spectrum agent or a multiple dose regimen.	There is a need for an appropriately designed randomised trial to test the optimal timing of administration (immediately after the cord is clamped versus preoperative).
Regional versus general anaesthesia for caesarean section. BB Afolabi, FEA Lesi, NA Merah. 16 trials, 1586 women.	Women who had either epidural anaesthesia or spinal anaesthesia were found to have a significantly lower difference between pre and postoperative haematocrit (WMD 1.70, 95% CI 0.47 to 2.93, 1 trial, 231 women) and (WMD 3.10, 95% CI 1.73 to 4.47, 1 trial, 209 women). Compared to GA, women having either an epidural anaesthesia or spinal had a lower estimated maternal blood loss (WMD - 126.98 millilitres, 95% CI -225.06 to -28.90, 2 trials, 256 women) and (WMD -84.79 millilitres, 95% CI -126.96 to -42.63, 2 trials, 279 women). More women preferred to have GA for subsequent procedures when compared with epidural (OR 0.56, 95% CI 0.32 to 0.96, 1 trial, 223 women) or spinal (OR 0.44, 95% CI 0.24 to 0.81, 221 women). The incidence of nausea was also less for this group of women compared with epidural (OR 3.17, 95% CI 1.64 to 6.14, 3 trials, 286 women) or spinal (OR 23.22, 95% CI 8.69 to 62.03, 209 women).	There is not enough evidence from this review to show that either regional or general anaesthesia is superior to the other in terms of major maternal or neonatal outcomes. Thus, the choice of one over the other lies with other criteria such as estimated blood loss which appears to be reduced with the use of regional anaesthesia, and client satisfaction and nausea and vomiting which appear to be reduced with general anaesthesia.	Further research to evaluate neonatal morbidity and maternal outcomes, such as satisfaction with technique, will be useful.

Table 1. Summary of Cochrane reviews on various aspects of caesarean section techniques *(Continued)*

	No significant difference was seen in terms of neonatal Apgar scores of 6 or less and of 4 or less at 1 and 5 minutes and need for neonatal resuscitation with oxygen.		
Spinal versus epidural anaesthesia for caesarean section. K Ng, J Parsons, AM Cyna, P Middleton. 10 trials, 751 women.	No difference was found between spinal and epidural techniques with regards to failure rate (RR 0.98, 95% CI 0.23 to 4.24; 4 studies), need for additional intraoperative analgesia (RR 0.88, 95% CI 0.59 to 1.32; 5 studies), need for conversion to general anaesthesia intraoperatively, maternal satisfaction, need for postoperative pain relief and neonatal intervention. Women receiving spinal anaesthesia for caesarean section showed reduced time from start of the anaesthetic to start of the operation (WMD 7.91 minutes less (95% CI -11.59 to -4.23; 4 studies), but increased need for treatment of hypotension RR 1.23 (95% CI 1.00 to 1.51; 6 studies).	Both spinal and epidural techniques are shown to provide effective anaesthesia for caesarean section. Both techniques are associated with moderate degrees of maternal satisfaction. Spinal anaesthesia has a shorter onset time, but treatment for hypotension is more likely if spinal anaesthesia is used. No conclusions can be drawn about intraoperative side-effects and postoperative complications because they were of low incidence or not reported, or both.	More research is needed on intraoperative side-effects and postoperative complications of spinal and epidural anaesthesia.
Abdominal surgical incisions for caesarean section. M Mathai, GJ Hofmeyr. 2 studies, 411 participants compared the Joel-Cohen incision with the Pfannenstiel incision.	65% reduction in reported postoperative morbidity with the Joel-Cohen incision. 1 of the trials reported reduced postoperative analgesic requirements; operating time; delivery time; total dose of analgesia in the first 24 hours; estimated blood loss; postoperative hospital stay for the mother; and increased time to the first dose of analgesia compared to the Pfannenstiel group. No other significant differences were found in either trial. 2 studies compared muscle cutting incisions with Pfannenstiel incision. 1 study (68 women) comparing Mouchel incision with Pfannenstiel incision did not contribute data to this review. The other study (97 participants) comparing the Maylard muscle-cutting incision with the Pfannenstiel incision, reported no difference in febrile morbidity; need for blood transfusion; wound infection; physical tests on muscle strength at 3 months postoperative and postoperative hospital stay.	The Joel-Cohen incision has clinical and cost-saving benefits.	Opinions of women and caregivers, severe immediate morbidity or long-term morbidity and mortality among mothers and infants were not evaluated. There is a also need to study if these procedures can be done safely under local anaesthesia in settings where safe general or regional anaesthesia is not available.
Tocolysis for assisting delivery at caesarean section. JM Dodd, K Reid. 1 RCT, 97 women.	Maternal and infant health outcomes were not reported.	There is currently insufficient information available from randomised trials to support or refute the routine or selective use of tocolytic agents to facilitate infant birth at the time of caesarean section.	Research is needed in this area.
Closure versus non-closure of the peritoneum at caesarean section.	Non-closure of the peritoneum reduced operating time whether both or either layer was not sutured. For both layers, the operating time was reduced by 6.05 minutes. There was significantly less postoperative fever and reduced	Leaving the peritoneum unsutured is not likely to be hazardous in the short term and may in	Further research on the long-term benefits or complications of non-closure

Table 1. Summary of Cochrane reviews on various aspects of caesarean section techniques *(Continued)*

AA Bamigboye, GJ Hofmeyr. Interventions – comparison of leaving the visceral or parietal peritoneum, or both, unsutured at caesarean section with a technique which involves suturing the peritoneum. 14 trials, 2908 women.	postoperative stay in hospital and reduced number of postoperative analgesic doses for visceral peritoneum and for both layer non-closure.	fact, be of benefit. The long-term implications are not certain.	of the peritoneum at caesarean section is needed.
Techniques and materials for closure of the abdominal wall in caesarean section. ER Anderson, S Gates.	The risk of haematoma or seroma was reduced with fat closure compared with non-closure (RR) 0.52, 95% CI 0.33 to 0.82), as was the risk of 'wound complication' (RR 0.68, 95% CI 0.52 to 0.88). No difference in the risk of wound infection alone or other short-term outcomes was found. No long-term outcomes were reported. There was no difference in the risk of wound infection between blunt needles and sharp needles in 1 small study. No studies were found examining suture techniques or materials for closure of the rectus sheath or subcutaneous fat.	Closure of the subcutaneous fat may reduce wound complications but it is unclear to what extent these differences affect the wellbeing and satisfaction of the women concerned.	Further trials are justified to investigate whether the apparent increased risk of haematoma or seroma with non-closure of the subcutaneous fat is real. These should use a broader range of short- and long-term outcomes, and ensure that they are adequately powered to detect clinically important differences. Further research comparing blunt and sharp needles is justified, as are trials evaluating suturing materials and suturing techniques for the rectus sheath.
Techniques and materials for skin closure in caesarean section. F Alderdice, D McKenna, J Dornan. Interventions – comparison of the effects of skin closure techniques and materials on maternal outcomes and time taken to perform a caesarean section. 1 RCT, 66 women.	While operating time was significantly shorter when using staples, the use of absorbable subcuticular suture resulted in less postoperative pain and yielded a better cosmetic result at the postoperative visit.	There is currently no conclusive evidence about how the skin should be closed after caesarean section. The choice of technique and materials should be made by women in consultation with their obstetrician based on the limited information currently available.	Future studies should concentrate on minimizing scarring and infection and long-term maternal morbidity and scar appearance as well as an ability of scar to withstand rupture in future pregnancies.

Table 1. Summary of Cochrane reviews on various aspects of caesarean section techniques *(Continued)*

Techniques for caesarean section. GJ Hofmeyr, M Mathai, A Shah, N Novikova. Comparison of the effects of complete methods of caesarean section not covered in the reviews of individual aspects of caesarean section technique. To summarise the findings of reviews of individual aspects of caesarean section technique. 14 studies, 2929 women.	Shorter operating time, time to mobilisation, postoperative hospital stay and less blood loss in Misgav-Ladach group in comparison to traditional (lower midline) CS. Comparison of Misgav-Ladach and Pfannenstiel techniques for CS revealed advantages of the former technique in relation to such outcomes as time from skin incision to delivery of baby, blood loss, postoperative pain score, time to oral intake. Joel-Cohen CS technique was found to have advantages in comparison to Pfannenstiel technique, e.g. shorter operating time, less significant blood loss, shorter time to oral intake was shorter, shorter time from skin incision to delivery, shorter time to mobilization, less use of analgesia, shorter length of postoperative mothers hospital stay. 6 trials, which included 1026 women, significantly decreased number of cases of fever treated with antibiotics. The advantages of modified Misgav-Ladach technique over Pfannenstiel technique were seen in shorter operating time, shorter time from skin incision to delivery of baby, shorter time to oral intake, shorter time to return of bowel function, and less postoperative pain. The only advantage of modified Misgav-Ladach technique over Misgav-Ladach technique was shorter time from skin incision to delivery of baby. Extraperitoneal CS in women with severe intrauterine sepsis had less number of serious complications in comparison to intraperitoneal technique. Other outcomes that favoured extraperitoneal CS were the rate of fever treated with antibiotics. More women in a group, which had extraperitoneal CS, had repeat procedures on the wound in comparison to these who had intraperitoneal CS.	Available evidence suggests that Misgav-Ladach, modified Misgav-Ladach and Joel-Cohen CS techniques have advantages over Pfannenstiel and traditional (lower midline) CS techniques in relation to short-term outcomes. There is no evidence in relation to long-term outcomes. Extraperitoneal CS has advantages over intraperitoneal CS in septic women in relation to serious maternal mortality and febrile morbidity.	Further research of the long-term outcomes after different CS techniques is needed. The study of women and caregivers satisfaction with surgery as well as healthcare facilities use will be useful. None of the studies compared Joel-Cohen and Misgav-Ladach CS techniques.
Wound drainage for CS. Gates S, Anderson ER. 7 trials (1993 women).	No difference in the risk of wound infection, other wound complications, febrile morbidity or endometritis in women who had wound drains compared with those who did not. There was some evidence that caesarean sections may be about 5 minutes shorter and that blood loss may be slightly lower when drains were not used.	There is no evidence in the 7 small trials included to suggest that the routine use of wound drains at CS confers any benefit on the women involved. These trials do not answer the question of whether wound drainage is of benefit when haemostasis is not felt to be adequate.	Further large trials are justified to examine the role of different types of wound drain at CS, comparing the use of drains in women with different degrees of obesity and in women having first or repeat CS and intrapartum or prelabour CS, women's views and experience of drains.
Tissue adhesives for closure of surgical incision. Coutthard P, Worthington H, Esopsito M, van der Elst M, van Waes OJF.	No differences were found between various tissue adhesives and sutures (8 trials) for dehiscence, infection, satisfaction with cosmetic appearance when assessed by patients' or surgeons' general satisfaction. Nor were differences found between a tissue adhesive and tapes (2 trials) for infection, patients' assessment of cosmetic appearance, patient satisfaction or surgeon satisfaction.	Surgeons may consider the use of tissue adhesives as an alternative to sutures or adhesive tape for the closure of incisions in the operating room.	There is a need for trials in all areas but in particular to include patients that require incision closure in areas of high tension

Table 1. Summary of Cochrane reviews on various aspects of caesarean section techniques *(Continued)*

8 RCT, 630 patients.	A statistically significant difference was found for surgeons' assessment of cosmetic appearance with mean difference 13 (95% CI 5 to 21), the higher mean rating for the tissue adhesive group.		and patients of general health that may impair wound healing.
Removal of nail polish and finger rings to prevent surgical infection. Arrowsmith VA, Maunder JA, Sargent RJ, Taylor R.	No RCTs that compared the wearing of finger rings with the removal of finger rings. No trials of nail polish wearing/removal that measured patient outcomes, including surgical infection. 1 small RCT, which evaluated the effect of nail polish on the number of bacterial colony forming units on the hands after preoperative hand washing (also called surgical scrubbing). Nurses were allocated to: unpolished nails, freshly applied nail polish (less than 2 days old), or old nail polish (more than 4 days old). Both before and after surgical scrubbing, there was no significant difference in the number of bacteria on the hands.	Not enough evidence about whether people working in operating theatres can wear nail polish or rings on their fingers without increasing patients' infection rates.	Trials in this area are required.
Preoperative skin antiseptics for preventing surgical wound infections after clean surgery. Edwards PS, Lipp A, Holmes A. 3 RCTs.	There was significant heterogeneity in the comparisons and the results could not be pooled. In 1 study, infection rates were significantly lower when skin was prepared using chlorhexidine compared with iodine. There was no evidence of a benefit in 4 trials associated with the use of iodophor impregnated drapes.	There is insufficient research examining the effects of preoperative skin antiseptics to allow conclusions to be drawn regarding their effects on postoperative surgical wound infections.	Further research is needed.
Early compared with delayed oral fluids and food after caesarean section. L Mangesi, GJ Hofmeyr. 6 RCTs.	Early oral fluids or food were associated with: reduced time to first food intake (1 study, 118 women; the intervention was a slush diet and food was introduced according to clinical parameters; WMD - 7.20 hours, 95% CI -13.26 to -1.14); reduced time to return of bowel sounds (1 study, 118 women; -4.30 hours, -6.78 to -1.82); reduced postoperative hospital stay following surgery under regional analgesia (2 studies, 220 women; - 0.75 days, -1.37 to -0.12 - random-effects model); and a trend to reduced abdominal distension (3 studies, 369 women; RR 0.78, 95% CI 0.55 to 1.11). No significant differences were identified with respect to nausea, vomiting, time to bowel action/passing flatus, paralytic ileus and number of analgesic doses.	There was no evidence from the limited randomised trials reviewed, to justify a policy of withholding oral fluids after uncomplicated CS.	Further research is justified.
Prophylaxis for venous thromboembolic disease in pregnancy and the early postnatal period. S Gates, P Brocklehurst, LJ Davis. 8 trials, 649 women.	It was not possible to assess the effects of any of these interventions on most outcomes, especially rare outcomes such as death, thromboembolic disease and osteoporosis, because of small sample sizes and the small number of trials making the same comparisons.	There is insufficient evidence on which to base recommendations for thromboprophylaxis during pregnancy and the early postnatal period.	Large scale randomised trials of currently-used interventions should be conducted.

Table 2. Routine caesarean section technique based on the best available evidence

Procedure	Best practice	Evidence

Table 2. Routine caesarean section technique based on the best available evidence *(Continued)*

Preoperative hair removal.	No difference in removal or not removal of hair, no difference in timing of removal (a day prior to surgery or on the day of surgery). If it is necessary to remove hair then both clipping and depilatory creams results in fewer surgical site infections than shaving using a razor.	Preoperative hair removal to reduce surgical site infection. Tanner J, Woodlings D, Moncaster K.
Preoperative bathing or showering with skin antiseptics.	No benefit for preoperative showering or bathing with chlorhexidine over other wash products.	Preoperative bathing or showering with skin antiseptics to prevent surgical site infection. Webster J, Osborne S.
Preoperative skin antiseptics.	Some advantage in chlorhexidine use over iodine.	Preoperative skin antiseptics for preventing surgical wound infections after clean surgery. Edwards PS, Lipp A, Holmes A.
Antibiotic prophylaxis.	Ampicillin or first-generation cephalosporins should be used to reduce infectious morbidity.	Antibiotic prophylaxis for caesarean section. F Smaill, GJ Hofmeyr; Antibiotic prophylaxis regimens and drugs for caesarean section. L Hopkins, F Smaill.
Double gloving.	Should be used to reduce perforation in innermost glove.	Double gloving to reduce surgical cross-infection. Tanner J, Parkinson H.
Disposable surgical face masks.	Unclear harm or benefit of wearing masks.	Disposable surgical face masks for preventing surgical wound infection in clean surgery. Lipp A, Edwards P.
Anaesthesia.	Not enough evidence on major complications. Regional anaesthesia associated with less blood loss and more discomfort than general anaesthesia. Spinal anaesthesia associated with quicker onset and more hypotension than epidural..	Regional versus general anaesthesia for caesarean section; BB Afolabi, FEA Lesi, NA Merah; Spinal versus epidural anaesthesia for caesarean section. K Ng, J Parsons, AM Cyna, P Middleton.
Lateral and/or head-down tilt.	Not enough evidence.	Cochrane review in this area is pending.
Abdominal wall opening.	Joel-Cohen or Misgav-Ladach techniques have advantages over Pfannenstiel and lower midline incisions.	Abdominal surgical incisions for caesarean section. M Mathai, GJ Hofmeyr.
Bladder peritoneum reflection.	Not enough evidence.	
Uterine incision.	Not enough evidence; transverse lower segment most widely used.	Surgical techniques involving the uterus at the time of caesarean section. [Protocol, review pending]. JM Dodd, ER Anderson, S Gates.
Uterine opening.	Not enough evidence; options: by scalpel, scissors, blunt dissection, or using absorbable staples.	Surgical techniques involving the uterus at the time of caesarean section. [Protocol, review pending]. JM Dodd, ER Anderson, S Gates.
Placental removal.	Cord traction associated with less blood loss and infection than manual removal.	Cochrane review in press.

Table 2. Routine caesarean section technique based on the best available evidence *(Continued)*

Uterine exteriorisation for repair.	No significant differences between intra- and extraperitoneal repairs.	Jacobs-Jokhan and Hofmeyr, Cochrane review.
Uterine closure.	Not enough evidence.	Surgical techniques involving the uterus at the time of caesarean section. [Protocol, review pending]. JM Dodd, ER Anderson, S Gates.
Peritoneal closure.	Leave peritoneum opened.	Closure versus non-closure of the peritoneum at caesarean section. AA Bamigboye, GJ Hofmeyr.
Fascia closure.	No evidence on methods or materials for closure of fascia.	Techniques and materials for closure of the abdominal wall in caesarean section. ER Anderson, S Gates.
Closure of subcutaneous tissue.	Closure reduces wound haematoma and seroma.	Techniques and materials for closure of the abdominal wall in caesarean section. ER Anderson, S Gates.
Drainage of the peritoneal cavity.	No evidence.	
Drainage of subcutaneous layer.	No difference in outcomes when used routinely.	Wound drainage for CS. Gates S, Anderson ER.
Skin closure.	Subcuticular suture or interrupted suture or staples or tissue adhesives depending on preference.	Tissue adhesives for closure of surgical incision. Couthard P, Worthington H, Esopsito M, van der Elst M, van Waes OJF.
Early compared with delayed oral fluids and food after caesarean section.	No evidence to justify withholding oral fluids after uncomplicated CS.	Early compared with delayed oral fluids and food after caesarean section. L Mangesi, GJ Hofmeyr.
Thromboprophylaxis.	No evidence.	Prophylaxis for venous thromboembolic disease in pregnancy and the early postnatal period. S Gates, P Brocklehurst, LJ Davis.

WHAT'S NEW

Date	Event	Description
15 February 2012	Amended	Search updated. Nineteen reports added to Studies awaiting classification (Belci 2005; CAESAR 2010; Chitra 2004; CORONIS 2007; Dupre 1994; El Hadidy 2008; Farajzadeh 2010; Gedikbasi 2011; Gutierrez 2008; Hohlagschwandtner 2002; Malvasi 2011; Nabhan 2008; Naki 2011; Pawar 2011; Poonam, 2006; Rengerink 2011; Studzinski 2002; Theodoridis 2011; Tuuli 2012).

HISTORY

Protocol first published: Issue 1, 2004
Review first published: Issue 1, 2008

Date	Event	Description
2 July 2010	Amended	Contact details edited.
14 January 2008	Amended	Updated the Declarations of interest statement for Matthews Mathai.
20 December 2007	Amended	Converted to new review format.
6 November 2007	New citation required and conclusions have changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

GJ Hofmeyr (GJH) prepared the first draft of the protocol. M Mathai (MM) contributed to subsequent drafts. N Novikova (NN) prepared the first draft of the review. GJH, MM, NN and A Shah contributed to data extraction and completion of the review. GJH is the guarantor of the review.

DECLARATIONS OF INTEREST

Matthews Mathai is author of a randomised trial of abdominal incisions for caesarean section.

The author is a staff member of the World Health Organization. The author alone is responsible for the views expressed in this publication and they do not necessarily represent the decisions or the stated policy of the World Health Organization.

SOURCES OF SUPPORT

Internal sources

- (GJH) Effective Care Research Unit, University of the Witwatersrand/Fort Hare, Eastern Cape Department of Health, South Africa.

External sources

- (GJH) World Health Organization (long-term Institutional Development Grant), Switzerland.
- NHS Programme for Research and Development, UK.

INDEX TERMS

Medical Subject Headings (MeSH)

Cesarean Section [adverse effects] [*methods]; Elective Surgical Procedures [methods]; Emergencies; Randomized Controlled Trials as Topic

MeSH check words

Female; Humans; Pregnancy