Methods of vascular occlusion for elective liver resections (Review)

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[Intervention Review]

Methods of vascular occlusion for elective liver resections

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ABSTRACT

Background

Vascular occlusion is used to reduce blood loss during liver resection surgery. Various methods of vascular occlusion have been suggested.

Objectives

To compare the benefits and harms of different methods of vascular occlusion during elective liver resection.

Search strategy

We searched *The Cochrane Hepato-Biliary Group Controlled Trials Register,* the *Cochrane Central Register of Controlled Trials* (*CENTRAL*) in *The Cochrane Library*, *MEDLINE, EMBASE,* and *Science Citation Index Expanded* until August 2008.

Selection criteria

We included randomised clinical trials comparing different methods of vascular occlusion during elective liver resections (irrespective of language or publication status).

Data collection and analysis

Two authors independently assessed trials for inclusion and independently extracted the data. We calculated the risk ratio or mean difference with 95% confidence intervals using fixed-effect and random-effects models based on intention-to-treat or available data analysis.

Main results

Ten trials including 657 patients compared different methods of vascular occlusion. All trials were of high risk of bias. Only one or two trials were included under each comparison. There was no statistically significant differences in mortality, liver failure, or other morbidity between any of the comparisons.

Hepatic vascular occlusion does not decrease the blood transfusion requirements. It decreases the cardiac output and increases the systemic vascular resistance. In the comparison between continuous portal triad clamping and intermittent portal triad clamping, four of the five liver failures occurred in patients with chronic liver diseases undergoing the liver resections using continuous portal triad

clamping. In the comparison between selective inflow occlusion and portal triad clamping, all four patients with liver failure occurred in the selective inflow occlusion group. There was no difference in any of the other important outcomes in any of the comparisons.

Authors' conclusions

In elective liver resection, hepatic vascular occlusion cannot be recommended over portal triad clamping. Intermittent portal triad clamping seems to be better than continuous portal triad clamping at least in patients with chronic liver disease. There is no evidence to support selective inflow occlusion over portal triad clamping. The optimal method of intermittent portal triad clamping is not clear. There is no evidence for any difference between the ischaemic preconditioning followed by vascular occlusion and intermittent vascular occlusion for liver resection in patients with non-cirrhotic livers. Further randomised trials of low risk of bias are needed to determine the optimal technique of vascular occlusion.

PLAIN LANGUAGE SUMMARY

Further trials are necessary to find the optimal method of vascular occlusion in liver resection

More than 1000 elective liver resections (planned operation) are performed annually in the United Kingdom alone. When liver resection is performed, the inflow of blood to the liver can be blocked (vascular occlusion), thereby potentially reducing the blood loss. When employed during liver resection, the vascular occlusion is generally achieved by occluding the hepatic artery and portal vein (blood vessels which supply the blood to the liver) either continuously or intermittently (when varying periods of occlusion and no occlusion are carried out in cycles till liver resection is complete). This is called portal triad clamping. However, there are many variations to this technique. These include hepatic vascular exclusion, where in addition to the occlusion of hepatic artery and portal vein, the veins draining blood from the liver are occluded with an intention of further decreasing the blood loss; selective inflow occlusion when only the vessels supplying the portion of the liver to be resected is occluded; and ischaemic preconditioning, where in order to prepare the liver for lack of blood flow, a vascular occlusion is performed briefly, after which the blood flow is re-established (reperfusion). This review is aimed at evaluating the different methods of vascular occlusion in liver resection.

Ten trials including 657 patients were included in this review. All were of high risk of bias (systematic error) and play of chance (random error). Only one or two trials were included under each comparison. There was no difference in mortality, liver failure, or post-operative complications between any of the comparisons. Hepatic vascular occlusion does not decrease the blood transfusion requirements. It decreases the cardiac output (amount of blood pumped by the heart in one second) and increases the systemic vascular resistance (resistance to the flow of blood in the vessels), which may have potential problems in patients with heart disorders.

Although there was no statistically significant difference in the incidence of liver failure between continuous portal triad clamping and intermittent portal triad clamping (5/60; 8.5% versus 0/61), most of them occurred in patients with chronic liver diseases undergoing the liver resections using continuous portal triad clamping.

There was no benefit in selective inflow occlusion compared to portal triad clamping. There was no statistically significant difference in the incidence of liver failure between the two groups (4/41; 9.8% versus 0/39), but all patients with liver failure occurred in the selective inflow occlusion group.

There were no significant differences in any of the important outcomes between the different methods of intermittent portal triad clamping or between ischaemic preconditioning followed by continuous vascular occlusion and intermittent vascular occlusion in non-cirrhotic patients undergoing liver resections.

Further randomised trials of low risk of bias are needed to determine the optimal technique of vascular occlusion.

BACKGROUND

Description of the condition

Elective liver resection is performed mainly for benign and malignant liver tumours (Belghiti 1993). The malignant tumours may arise primarily within the liver (hepatocellular carcinoma and cholangiocarcinoma) or be metastases from malignancies of other organs (Belghiti 1993). More than 1000 elective liver resections are performed annually in the United Kingdom alone (HES 2005).
The liver is subdivided into eight Couinaud segments (Couinaud 1999), which can be removed either individually or by right hemi-hepatectomy (Couinaud segments 5 to 8), left hemi-hepatectomy (segments 2 to 4), right trisectionectomy (segments 4 to 8), or left trisectionectomy (segments 2 to 5 and 8 1) (Strasberg 2000). Although every liver resection is considered major surgery, only resection of three or more segments is considered a major liver resection (Belghiti 1993).
Blood loss during liver resection is one of the important factors affecting the peri-operative outcomes of patients (Shimada 1998; Yoshimura 2004; Ibrahim 2006). Various methods have been attempted to reduce the blood loss during liver resection. These include lowering the central venous pressure (Wang 2006), hypoventilation (Hasegawa 2002), and occluding the blood flow to the liver using a finger or an atraumatic clamp (Pringle manoeuvre) (Pringle 1908; Belghiti 1996).

Description of the intervention

Vascular occlusion can be total vascular exclusion (clamping of both inflow and outflow vessels) (Belghiti 1996) or portal triad clamping (clamping only the inflow tract) (Belghiti 1996; Belghiti 1999; Capussotti 2006). Outflow obstruction could be by occlusion of inferior vena cava (Belghiti 1996) or by occlusion of major hepatic veins (Azoulay 2006). The vascular occlusion could be complete (hepatic pedicle clamping) (Figueras 2005) or selective (only the vessels to the resected side are clamped) (Figueras 2005). The clamping could be continuous (Belghiti 1999; Capussotti 2006) or intermittent (Franco 1989; Elias 1991; Belghiti 1999; Capussotti 2006).

How the intervention might work

Outflow obstruction by occlusion of inferior vena cava or major hepatic veins can potentially result in a greater decrease in blood loss by decreasing the bleeding from the veins. For this, both the infrahepatic inferior vena cava and suprahepatic inferior vena cava or major hepatic veins have to be occluded. The selective vascular occlusion has been proposed so that only the blood supply to the hemi-liver that is to be resected can be cut-off without occlusion of the blood supply to the hemi-liver that is to be retained. The purpose is to reap the benefits of vascular occlusion (ie, decreasing the blood loss) without suffering the potential harms of vascular occlusion (ie, liver damage). Intermittent clamping has been proposed to increase the resection time under vascular occlusion without increasing the liver damage by briefly restoring blood supply to the liver before the next cycle of vascular occlusion.

Why it is important to do this review

The optimal method of vascular occlusion is not clear. This is an update of a part of a split Cochrane review (Gurusamy 2007).

OBJECTIVES

To compare the benefits and harms of different methods of vascular occlusion during elective liver resections.

METHODS

Criteria for considering studies for this review

Types of studies

Only randomised clinical trials (irrespective of language, blinding, or publication status) were considered for this review. Quasi-randomised studies (where the method of allocating participants to a treatment are not strictly random (eg, date of birth, hospital record number, alternation), cohort studies, and case-control studies were excluded.

Types of participants

Patients who were about to undergo elective liver resection surgery for benign or malignant liver tumour irrespective of whether the tumour was on a background of cirrhotic, steatotic, or normal liver.

Types of interventions

We included trials comparing one method of vascular occlusion versus another method of vascular occlusion.
Trials comparing vascular occlusion versus no vascular occlusion and those assessing a period of ischaemic pre-conditioning before vascular occlusion were excluded from this review and were considered in two other separate reviews (Gurusamy 2009a; Gurusamy 2009b).
Co-interventions were allowed provided that they are used equally in the intervention arms.

Types of outcome measures

Primary outcomes

1. Mortality.
   i) Peri-operative.
   ii) At maximal follow-up.
2. Liver failure.
3. Peri-operative morbidity.

4. Transfusion requirements (whole blood or red cells).

Secondary outcomes

1. Hospital stay.
2. Intensive therapy unit stay.
3. Operating time.
4. Peri-operative haemodynamic variables (blood pressure, cardiac output, stroke volume, systemic vascular resistance).
5. Operative blood loss.
   i) Transection.
   ii) Total operative blood loss.
6. Markers of liver function (bilirubin, prothrombin time).
7. Biochemical markers of liver injury (aspartate aminotransferase (AST), alanine aminotransferase (ALT)).

Search methods for identification of studies

We searched *The Cochrane Hepato-Biliary Group Controlled Trials Register,* the *Cochrane Central Register of Controlled Trials* (*CENTRAL*) in *The Cochrane Library, MEDLINE, EMBASE,* and *Science Citation Index Expanded* (Royle 2003) until August 2008. We have given the search strategies in Appendix 1 with the time span for the searches.
We also searched the references of the identified trials to identify further relevant trials.

Electronic searches

We searched *The Cochrane Hepato-Biliary Group Controlled Trials Register* (Gluud 2008), the *Cochrane Central Register of Controlled Trials* (*CENTRAL*) in *The Cochrane Library, MEDLINE, EMBASE,* and *Science Citation Index Expanded* (Royle 2003) until August 2008. We have given the search strategies in Appendix 1 with the time span for the searches.

Searching other resources

We also searched the references of the identified trials to identify further relevant trials.

Data collection and analysis

We followed the instructions given in the *Cochrane Handbook for Systematic Reviews of Intervention* (Higgins 2008) and the *Cochrane Hepato-Biliary Group Module* (Gluud 2008). We imputed the standard deviation from P-values according to the instructions given in the *Cochrane Handbook for Systematic Reviews of Intervention* (Higgins 2008) and used the median for the meta-analysis when mean was not available. If it was not possible to calculate the standard deviation from P-value or confidence intervals, we imputed the standard deviation as the highest standard deviation noted for that group under that outcome.

Selection of studies

KG and HS or YK identified the trials for inclusion, independent of each other. We have also listed the excluded trials with the reasons for the exclusion.

Data extraction and management

KG and HS or YK extracted the data for the review independently. In addition, the authors extracted the population characteristics (sex, age, percentage of major liver resections, and the presence of chronic liver disease) and the co-interventions used in each trial. We assessed the methodological quality of the trials independently, without masking of the trial names. We sought any unclear or missing information by contacting the authors of the individual trials. If there was any doubt whether the trials share the same patients - completely or partially (by identifying common authors and centres) - we contacted the authors of the trials whether the trial report had been duplicated.
We resolved any differences in opinion through discussion.

Assessment of risk of bias in included studies

Methodological quality was defined as the confidence that the design and the report of the randomised clinical trial would restrict bias in the comparison of the intervention (Moher 1998). According to empirical evidence (Schulz 1995; Moher 1998; Kjaergard 2001; Wood 2008), the methodological quality of the trials was assessed based on sequence generation, allocation concealment, blinding of participants, personnel, and outcome assessors, incomplete outcome data, selective outcome reporting, and other sources of bias. Quality components were classified as follows:

Sequence generation

- Low risk of bias (the methods used is either adequate (eg, computer generated random numbers, table of random numbers) or unlikely to introduce confounding).
- Uncertain risk of bias (there is insufficient information to assess whether the method used is likely to introduce confounding).
- High risk of bias (the method used (eg, quasi-randomised trials) is improper and likely to introduce confounding).

Allocation concealment

- Low risk of bias (the method used (eg, central allocation) is unlikely to induce bias on the final observed effect).
- Uncertain risk of bias (there is insufficient information to assess whether the method used is likely to induce bias on the estimate of effect).
- High risk of bias (the method used (eg, open random allocation schedule) is likely to induce bias on the final observed effect).

Blinding of participants, personnel, and outcome assessors

It is difficult to blind the surgeons to the groups. Thus only blinding of patients and outcomes assessors were considered for assessing the risk of bias.

- Low risk of bias (blinding was performed adequately, or the outcome measurement is not likely to be influenced by lack of blinding).
- Uncertain risk of bias (there is insufficient information to assess whether the type of blinding used is likely to induce bias on the estimate of effect).
- High risk of bias (no blinding or incomplete blinding, and the outcome or the outcome measurement is likely to be influenced by lack of blinding).

Incomplete outcome data

- Low risk of bias (the underlying reasons for missingness are unlikely to make treatment effects departure from plausible values, or proper methods have been employed to handle missing data).
- Uncertain risk of bias (there is insufficient information to assess whether the missing data mechanism in combination with the method used to handle missing data is likely to induce bias on the estimate of effect).
- High risk of bias (the crude estimate of effects (eg, complete case estimate) will clearly be biased due to the underlying reasons for missingness, and the methods used to handle missing data are unsatisfactory).

Selective outcome reporting

- Low risk of bias (the trial protocol is available and all of the trial's pre-specified outcomes that are of interest in the review have been reported or similar).
- Uncertain risk of bias (there is insufficient information to assess whether the magnitude and direction of the observed effect is related to selective outcome reporting).
- High risk of bias (not all of the trial's pre-specified primary outcomes have been reported or similar).

Other bias

Baseline imbalance

- Low risk of bias (there was no baseline imbalance in important characteristics).
- Uncertain risk of bias (the baseline characteristics were not reported).
- High risk of bias (there was an baseline imbalance due to chance or due to imbalanced exclusion after randomisation).

Early stopping

- Low risk of bias (sample size calculation was reported and the trial was not stopped or the trial was stopped early by a formal stopping rule at a point where the likelihood of observing an extreme intervention effect due to chance was low).
- Uncertain risk of bias (sample size calculations were not reported and it is not clear whether the trial was stopped early or not).
- High risk of bias (the trial was stopped early due to an informal stopping rule or the trial was stopped early by a formal stopping rule at a point where the likelihood of observing an extreme intervention effect due to chance was high).

Academic bias

- Low risk of bias (the author of the trial has not conducted previous trials addressing the same interventions).
- Uncertain risk of bias (It is not clear if the author has conducted previous trials addressing the same interventions).
- High risk of bias (the author of the trial has conducted previous trials addressing the same interventions).

We considered trials which were classified as low risk of bias in sequence generation, allocation concealment, blinding, incomplete data, and selective outcome reporting as low bias-risk trials.

Measures of treatment effect

For dichotomous outcomes, we calculated the risk ratio with 95% confidence interval (CI). For continuous outcomes, we calculated mean difference (MD) with 95% CI. We planned to calculate standardised mean difference (SMD) in case we found the same outcome reported in different ways (eg, units of blood or volume of blood in ml; prothrombin time or prothrombin activity). However, we found no such outcomes. We also calculated the risk difference with 95% CI and planned to report the results if they were different from risk ratio. We identified no such results.

Unit of analysis issues

All the trials included in this review were with simple, parallel group design and the unit of analysis was each patient recruited into the trial.

Dealing with missing data

We performed the analysis on an 'intention-to-treat' basis (Newell 1992) whenever possible. Otherwise, we adopted the 'available data analysis'.

Assessment of heterogeneity

Heterogeneity was explored by chi-squared test with significance set at P value 0.10, and the quantity of heterogeneity was measured by I^2 (Higgins 2002). An I^2 of > 30% was considered statistically significant heterogeneity.

Assessment of reporting biases

We used a funnel plot to explore bias (Egger 1997; Macaskill 2001). Asymmetry in funnel plot of trial size against treatment effect was used to assess bias. We could not perform linear regression approach described by Egger et al to determine the funnel

plot asymmetry because of the small number of trials included in the review (Egger 1997).

Data synthesis

We performed the meta-analyses according to the recommendations of The Cochrane Collaboration (Higgins 2008). We used the software package RevMan 5 provided by the Cochrane Collaboration (RevMan 2008). We used a random-effects model (DerSimonian 1986) and a fixed-effect model (DeMets 1987). In case of discrepancy between the two models, we reported both results; otherwise we have reported only the results from the fixed-effect model.

Subgroup analysis and investigation of heterogeneity

We planned the following sub-group analysis.

- Low bias-risk trials compared to high bias-risk trials.
- Major compared to minor resections (if the remnant liver is smaller, liver function may be poorer).
- Cirrhotics compared to non-cirrhotic livers (if the remnant liver is cirrhotic, liver function may be poorer).

However, we did not perform any subgroup analysis because of the few trials included in each comparison.

Sensitivity analysis

In case we found 'zero-event' trials for statistically significant outcomes, we intended to perform a sensitivity analysis with and without empirical continuity correction factors as suggested by Sweeting 2004 et al. However, we did not find any such outcomes.

RESULTS

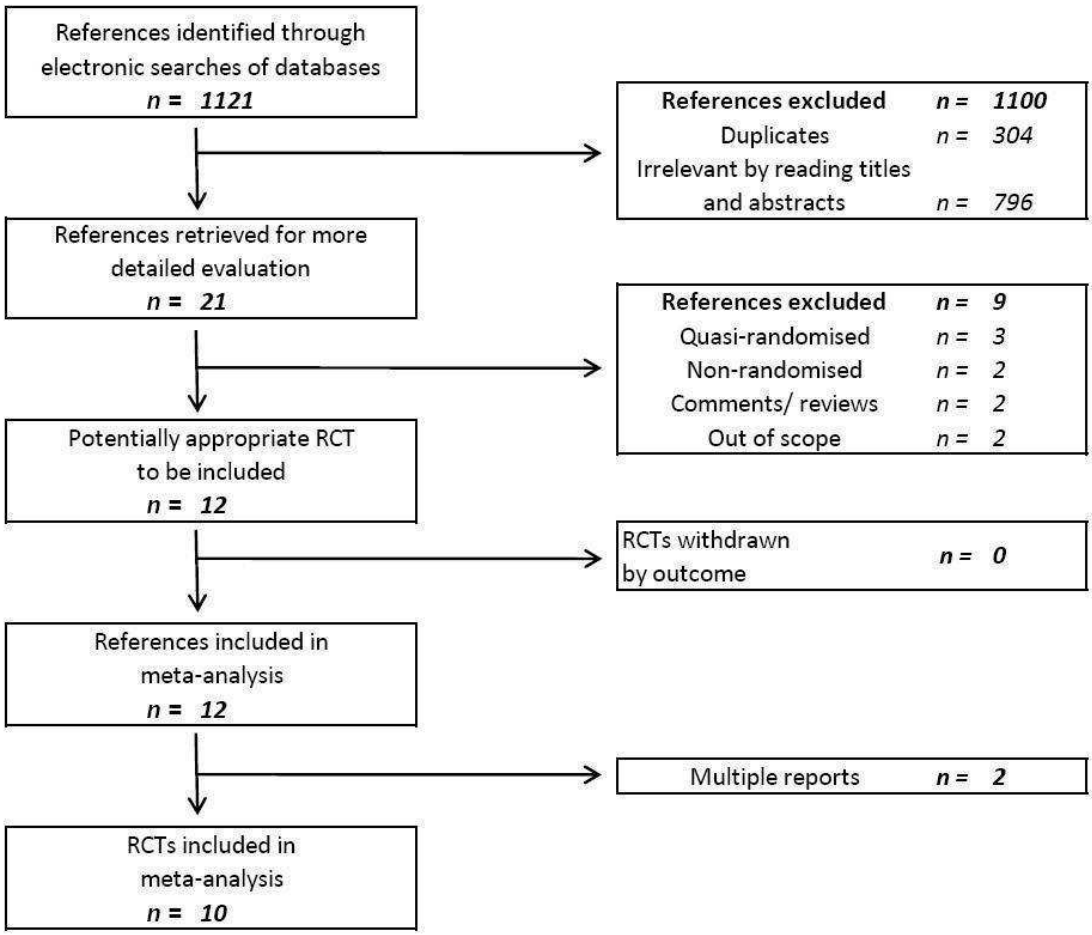
Description of studies

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

Results of the search

We identified a total of 1121 references through the electronic searches of *The Cochrane Hepato-Biliary Group Controlled Trials Register* and the *Cochrane Central Register of Controlled Trials* (*CENTRAL*) in *The Cochrane Library* (n = 134), *MEDLINE* (n = 425), *EMBASE* (n = 367), *Science Citation Index Expanded* (n = 185), and LILACS (n = 10). We have shown the flow of references in Figure 1. We excluded 304 duplicates and 798 clearly irrelevant references through reading abstracts. Nineteen references were retrieved for further assessment. Two references were identified through scanning reference lists of the identified randomised trials. Both were conference abstracts of published trials (Figueras 2005; Brooks 2007). Of the 21 references, we excluded nine because of the reasons listed under the table 'Characteristics of excluded studies'. In total, 12 publications describing 10 randomised trials fulfilled the inclusion criteria.

Figure 1. Reference flow chart



RCT = Randomised clinical trial

Included studies

All the ten randomised trials were completed trials and could provide data for the analyses. Details of the trials and the outcomes reported in individual trials are shown in the table 'Characteristics of included studies'. All the trials assessed the different methods of vascular occlusion in open liver resections. There were a total of five comparisons.

Hepatic vascular exclusion versus portal triad clamping

Two trials randomised 170 patients to hepatic vascular exclusion (n = 88) versus portal triad clamping (n = 82) (Belghiti 1996 (52 patients); Chen 2006 (118 patients)). The mean age of participants was 42.3 years. The proportions of females, major liver resections, and cirrhotic livers were 26.5%, 90.6%, and 69.4%. In one trial, hepatic vascular exclusion was performed by occluding the infrahepatic and suprahepatic inferior vena cava (Belghiti 1996). In the other trial, hepatic vascular exclusion was performed by occluding the infrahepatic inferior vena cava and by occluding the middle hepatic veins draining the section of liver to be resected (Chen 2006).

Intermittent portal triad clamping versus continuous portal triad clamping

Two trials randomised 121 patients to continuous portal triad clamping (n = 60) versus intermittent portal triad clamping (n = 61) (Belghiti 1999 (86 patients); Capussotti 2003 (35 patients)). The mean age of participants was 54.4 years. The proportions of females, major liver resections and cirrhotic livers were 40.5%, 38.8%, and 49.6%.

Selective vascular occlusion versus portal triad clamping

Two trials randomised 138 patients to selective vascular occlusion (n = 71) versus portal triad clamping (n = 67) (Wu 2002 (58 patients); Figueras 2005 (80 patients)). Both trials used intermittent vascular occlusion. The mean age of participants was 59.1 years. The proportions of females was 22.5%. One trial included only minor liver resections (Figueras 2005). The proportion of major liver resections in the other trial was 34.5% (Wu 2002). One trial included only cirrhotic patients (Wu 2002). The proportion of cirrhotic patients was 48.8% in the other trial (Figueras 2005).

Different methods of intermittent portal triad clamping

Two trials assessed intermittent portal triad clamping with different clamping and unclamping periods. One trial randomised 108 patients to intermittent portal triad clamping of 30/5 (ie, 30 minutes clamping and 5 minutes unclamping) cycles (n = 48), and intermittent portal triad clamping of 15/5 cycles (n = 44) (Esaki 2006). There were 16 post-randomisation drop-outs as no hepatectomy was performed in 8 patients; and 8 patients did not meet the inclusion criteria. The mean age of the participants was 62 years. The proportions of females and major liver resections were 30.4% and 19.6%. This trial included only non-cirrhotic patients. Another trial randomised 13 patients to intermittent portal triad clamping of 20/10 cycles (n = 4) and intermittent portal triad clamping of 10/5 cycles (n = 5) (Brooks 2007). There were 4 post-randomisation drop-outs (reasons not stated). The proportions of females and major liver resections were 33.3% and 77.8%. This trial also included only non-cirrhotic patients.

Ischaemic pre-conditioning followed by continuous vascular occlusion versus intermittent vascular occlusion

Two trials randomised 127 patients to ischaemic pre-conditioning followed by continuous vascular occlusion (n = 63) versus intermittent vascular occlusion (n = 64) (Petrowsky 2006 (73 patients); Smyrniotis 2006 (54 patients)). The mean age of participants was 59.7 years. The proportions of females was 40.2%. Both trials included patients with non-cirrhotic livers undergoing major liver resections only. In one trial, portal triad clamping was used in both groups (Petrowsky 2006). In the other trial hepatic vascular exclusion (major hepatic veins method) was used in both groups (Smyrniotis 2006).

Excluded studies

Nine studies were excluded. Three were quasi-randomised studies (Smyrniotis 2002; Smyrniotis 2003a; Smyrniotis 2003b). Four were not randomised clinical trials (Cheung 1996; Konigsrainer 2006; Man 2002; Sugimoto 2003). Two trials were out of this review's scope because of the reasons mentioned in the table 'Characteristics of excluded studies'.

Risk of bias in included studies

The risk of bias in the included trials is summarised in Figure 2 and Figure 3. All trials had some kind of methodological inadequacy and following the methodological components, we classified them as trials with high risk of bias.

Figure 2. Methodological quality graph: review authors' judgements about each methodological quality item presented as percentages across all included studies.

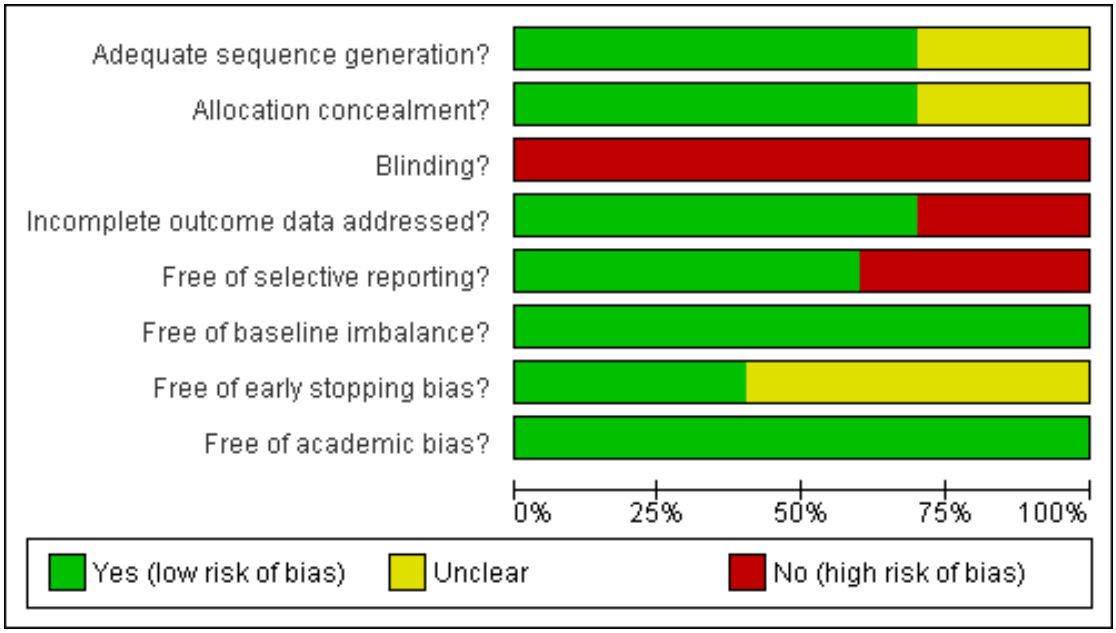
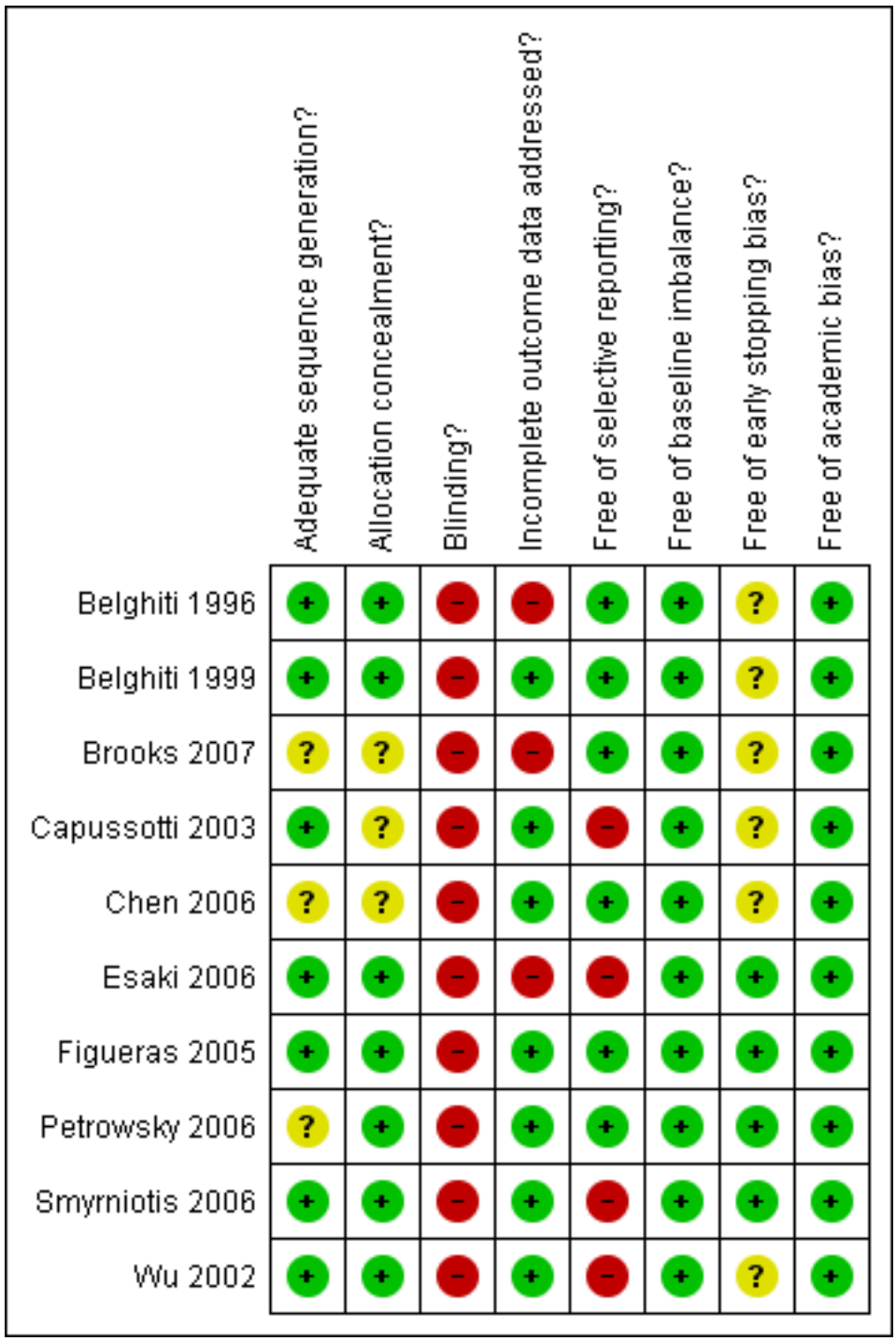


Figure 3. Methodological quality summary: review authors' judgements about each methodological quality item for each included study.



Allocation

Seven trials (70%) had adequate sequence generation (Belghiti 1996; Belghiti 1999; Wu 2002; Capussotti 2003; Figueras 2005; Esaki 2006; Smyrniotis 2006). Seven trials (70%) had adequate allocation concealment (Belghiti 1996; Belghiti 1999; Wu 2002; Figueras 2005; Esaki 2006; Petrowsky 2006; Smyrniotis 2006). Thus, six trials (60%) had low risk of bias due to allocation (Belghiti 1996; Belghiti 1999; Wu 2002; Figueras 2005; Esaki 2006; Smyrniotis 2006).

Blinding

None of the trials reported any blinding.

Follow up and exclusions

Seven trials (70%) were free from bias due to incomplete outcome data (Belghiti 1999; Wu 2002; Capussotti 2003; Figueras 2005; Chen 2006; Petrowsky 2006; Smyrniotis 2006).

Selective reporting

Six trials (60%) reported the primary outcomes and hence were considered to be free from bias (Belghiti 1996; Belghiti 1999; Figueras 2005; Chen 2006; Petrowsky 2006; Brooks 2007).

Other potential sources of bias

There was no baseline imbalance in any of the trials. Four trials (40%) reported sample size calculations and the trialists recruited the intended number of participants (Figueras 2005; Esaki 2006; Petrowsky 2006;

Effects of interventions

Secondary outcomes

Hospital stay and Intensive therapy unit stay

There was no difference in the hospital stay between the two groups (mean difference -0.34; 95% CI -2.92 to 2.24). Intensive therapy unit stay was not reported in any of the trials included under this category (Analysis 3.6).

Operating time

There was no difference in the operating time between the two groups (mean difference 8.69; 95% CI -10.12 to 27.50) (Analysis 3.7).

Peri-operative haemodynamic variables

There was no difference in the mean arterial pressure between the two groups (mean difference -2.70; 95% CI -8.88 to 3.48) (Analysis 3.8).

Blood loss

There was no significant difference in the transection blood loss (mean difference -241.00 ml; 95% CI -539.63 to 57.63) or total operative blood loss (mean difference -174.56 ml; 95% CI -742.06 to 392.95) between the groups (Analysis 3.9).

Enzyme markers of liver function

There was no statistically significant difference in the bilirubin level at any time between the two groups. The prothrombin activity was not reported in either trial included under this outcome (Wu 2002; Figueras 2005) (Analysis 3.10).

Enzyme markers of liver injury

There was no difference in the AST or ALT levels on the first, third, and fifth post-operative days. The levels of AST and ALT were slightly lower in the selective group than portal triad clamping group on the seventh post-operative day (AST: mean difference -20.00 IU/litre; 95% CI -36.45 to -3.55 and ALT: mean difference -20.00 IU/litre; 95% CI -30.30 to -9.70) (Analysis 3.11; Analysis 3.12).

Different methods of intermittent portal triad clamping: 30 minutes versus 15 minutes

Primary outcomes

Mortality and morbidity

There was no mortality in either group. Liver failure was not reported in the only trial included in this review (Esaki 2006).There was no difference in any other morbidity between the two groups (Analysis 4.1; Analysis 4.2) (Table 1).

Table 1. Mortality and causes

Study	Intervention	Causes	Control	Causes
HVE versus PTC				
Belghiti 1996	0	-	1	Renal failure
Chen 2006	0	-	1	Hepatic failure

Table 1. Mortality and causes (*Continued*)

CONTINUOUS versus INTERMITTENT PTC				
Belghiti 1999	2	Liver failure (cirrhotic livers)	0	-
Capussotti 2003	2	1 - case of portal vein thrombosis 1 - Bleeding from cut surface. (No details of whether low CVP was used).	0	-
PTC - SELECTIVE versus TOTAL				
Figueras 2005	1	Liver insufficiency (in cirrhotic liver)	0	-
Wu 2002	0	-	0	-
INTERMITTENT PTC - 30 minutes vs 15 minutes				
Esaki 2006	0	-	0	-
IPC versus INTERMITTENT vascular occlusion				
Petrowsky 2006	1	Intestinal ischaemia	0	-
Smyrniotis 2006	0	-	0	-

HVE = hepatic vascular exclusion
PTC = portal triad clamping
IPC = ischaemic pre-conditioning

Transfusion requirements

There was no difference in the number of patients requiring blood transfusion (risk ratio 0.92; 95% CI 0.24 to 3.45) or the mean number of red cells units transfused (mean difference 0.00 units; 95% CI -3.27 to 3.27) or fresh frozen plasma (mean difference 1.00 units; 95% CI -2.48 to 4.48) (Analysis 4.3; Analysis 1.5).

Secondary outcomes

Hospital stay and Intensive therapy unit stay

There was no difference in the hospital stay between the two groups (mean difference 0.00 days; 95% CI -2.45 to 2.45). Intensive therapy unit stay was not reported (Analysis 4.6).

Operating time

It was lower in the 30 minutes group than the 15 minutes group (mean difference -52.00 minutes; 95% CI -101.91 to -2.09) (Analysis 4.7).

Peri-operative haemodynamic variables

This outcome was not reported.

Blood loss

There was no significant difference in the transection blood loss (mean difference -1.30 ml/cm^2; 95% CI -2.85 to 0.25) or total operative blood loss (mean difference 39.00 ml; 95% CI -1.50 to 79.50) between the groups (Analysis 4.8).

Enzyme markers of liver function

There was no statistically significant difference in the bilirubin level or prothrombin activity at any time between the two groups (Analysis 4.9; Analysis 4.10).

Enzyme markers of liver injury

There was no difference in the AST or ALT levels at any time between the two groups (Analysis 4.11; Analysis 4.12).

Different methods of intermittent portal triad clamping: 20 minutes versus 10 minutes

The only outcomes of interest reported in the only trial included under this category was bilirubin (Analysis 5.1) and alanine transaminase (Analysis 5.2) on the second post operative day. There was no difference between the two groups in these enzyme levels.

Ischaemic pre-conditioning followed by continuous vascular occlusion versus intermittent vascular occlusion

Primary outcomes

Mortality and morbidity

There was no statistically significant difference in mortality (risk ratio 3.08; 95% CI 0.13 to 73.24), liver failure (risk ratio 0.21; 95% CI 0.01 to 4.14), or any other morbidity between the two groups (Analysis 6.1; Analysis 6.3) (Table 1).

Transfusion requirements

There was no difference in the number of patients requiring blood transfusion (risk ratio 0.84; 95% CI 0.40 to 1.78) or the mean number of units transfused (mean difference -0.69 units; 95% CI -1.55 to 0.17) (Analysis 6.4; Analysis 6.5).

Secondary outcomes

Hospital stay and Intensive therapy unit stay

There was no difference in the hospital stay (mean difference -0.10 days; 95% CI -2.79 to 2.60) or intensive therapy unit stay (mean difference 1.26 days; 95% CI -0.66 to 3.18) between the two groups (Analysis 6.6; Analysis 6.7).

Operating time

There was no difference in the operating time between the two groups (mean difference -13.82 minutes; 95% CI -51.17 to 23.54) (Analysis 6.8).

Peri-operative haemodynamic variables

This outcome was not reported.

Blood loss

There was no significant difference in the transection blood loss (mean difference -104.00; 95% CI -228.46 to 20.46) between the groups. The total operative loss was lower in the IPC group (mean difference -164.73; 95% CI -271.83 to -57.64) (Analysis 6.9).

Enzyme markers of liver function

There was no statistically significant difference in the bilirubin level or prothrombin activity at any time between the two groups (Analysis 6.10; Analysis 6.11).

Enzyme markers of liver injury

There was no difference in the AST or ALT levels at any time between the groups (Analysis 6.12; Analysis 6.13).

Subgroup analysis

We did not perform subgroup analysis because all the trials were of high risk of bias and because of the few trials included in each comparison.

Variations in statistical analysis

Adopting the random-effects model or calculating the risk difference did not change the results.

Bias exploration

Because of the few trials included under each comparison, we did not explore bias.

DISCUSSION

Summary of main results

In a review comparing vascular occlusion and no vascular occlusion in elective liver resections, we found that vascular occlusion is safe and reduces blood loss in liver resections (Gurusamy 2009a). In this review, we assessed the different methods of vascular occlusion. We found that hepatic vascular exclusion does not provide any additional benefit and could be potentially harmful in patients with cardiac disorders. We also found that continuous vascular

occlusion can be potentially harmful in patients with chronic liver diseases. There were no difference in any of the important outcomes in the other comparisons.

Hepatic vascular exclusion versus portal triad clamping

The main reasons for occluding the outflow in addition to the inflow occlusion is to decrease the risk of retrograde bleeding from the hepatic veins and to decrease the risk of air embolism (Smyrniotis 2003a). However, patients can be subjected to haemodynamic changes resulting in haemodynamic intolerance. Also, retrograde blood perfusion through hepatic veins contributes to the hepatic viability and attenuates ischaemia/reperfusion injury (Smyrniotis 2003a).

The two trials included under this comparison used different methods to achieve the hepatic vascular occlusion. Both trials used portal triad clamping and clamping of the infrahepatic inferior vena cava. However, one trial achieved outflow occlusion by clamping the suprahepatic inferior vena cava (Belghiti 1996) and the other trial achieved outflow occlusion by clamping the hepatic veins draining the side that was resected (Chen 2006). The results from the trial that employed suprahepatic inferior vena cava occlusion generally favoured the portal triad clamping in many of the secondary outcomes while the trial that employed occlusion of the hepatic veins draining the side that was resected generally favoured the hepatic vascular exclusion group.

There was no difference in mortality, liver failure, other morbidity, or transfusion requirements between the two groups. There were two patients with air embolism in the portal triad clamping group detected only by intra-operative capnography and were not clinically significant. While the mean difference in the operating time was not statistically significant, individually both the trials demonstrated statistically significantly higher operating time in the hepatic vascular exclusion group than portal triad clamping group (Belghiti 1996; Chen 2006). This is likely to be related to the time taken to achieve control of the outflow. There was a significant difference in the haemodynamic changes caused by hepatic vascular exclusion and portal triad clamping. The difference in change in cardiac index is more than one litre/min/m^2 (baseline value about 4 litres/min/m^2) (Belghiti 1996). The difference in change in systemic vascular resistance is about 400 dynes.seconds/cm^2 (baseline value about 925 dynes.sec/cm^2) (Belghiti 1996). This may be important in patients who suffer from cardiac conditions. However, it must be noted that only the trial that employed suprahepatic inferior vena cava clamping reported cardiac index and systemic vascular resistance.

The occasional difference noted in the enzymes representing liver function and liver damage was small and mostly clinically insignificant as there was no difference in these enzymes at other times, and there was no difference in the incidence of liver failure. These differences are likely to have arisen due to the inclusion of the trial that favoured the hepatic vascular exclusion group (Chen 2006) under these outcomes without the inclusion of the other trial, which favoured the portal triad clamping group (Belghiti 1996) because the latter did not report these outcomes.

The hospital stay was higher in the hepatic vascular exclusion group than portal triad clamping group. However, the trial favouring hepatic vascular exclusion group was not included in this outcome, and it is difficult to draw conclusions based on one trial.

Because of the lack of significant benefit with the potential for harm in patients with cardiac disease, hepatic vascular exclusion cannot be recommended over portal triad clamping.

Portal triad clamping: continuous versus intermittent

While intermittent portal triad clamping enables prolonged operating time under vascular occlusion, there are concerns that it may induce a series of ischaemia/reperfusion injuries (Belghiti 1999).There are also concerns that intermittent portal triad clamping may increase intra-operative blood loss by restoring blood supply intermittently (Belghiti 1999). There was no statistically significant difference in any of the outcomes between the two groups. There were totally four deaths and four patients with liver failure in the trials included under this category. All the deaths and liver failure occurred in the continuous group. Two of these deaths were reported by Belghiti et al (Belghiti 1999) and the two patients had chronic liver disease and died of liver failure (bridging fibrosis or cirrhosis). The duration of ischaemia was 30 minutes and 33 minutes. Belghiti et al also reported another two patients with liver failure, who survived. Of these, one had chronic liver disease and another had 40% steatosis. Although the liver enzyme levels are not reported separately for patients with chronic liver disease in this report, the authors state that when only livers with chronic liver disease were included, the transaminase levels were significantly higher in the continuous portal triad clamping than in the intermittent portal triad clamping. When only livers with chronic liver disease were included for analysis, the serum bilirubin levels were also significantly higher in the continuous portal triad clamping than in the intermittent portal triad clamping. Thus, it appears that livers with chronic disease seem not to tolerate continuous vascular clamping as well as normal livers. It must be noted that the other trial, which included only cirrhotic livers did not find any significant difference in the liver enzymes or bilirubin.

Considering that intermittent portal triad clamping does not increase the total blood loss, the operating time, and the predisposition of the cirrhotic and steatotic livers to ischaemic injury, intermittent portal triad clamping seems to be better than continuous portal triad clamping at least in patients with chronic liver disease. Also considering that ultra-structural changes occur in livers exposed to ischaemia and reperfusion even after 30 minutes of continuous vascular occlusion (Wilasrusmee 2004), intermittent portal triad clamping allows the surgeon sufficient time to perform the resection under vascular control.

Inflow occlusion: total versus selective

The rationale behind occluding the blood supply to only the hemi-liver in which resection is to be carried out is that the other hemi-liver is spared of the effects of ischaemia/reperfusion injury (Figueras 2005).

There was no statistically significant difference in any of the outcomes. However, the only cases of hepatic insufficiency were in the selective inflow occlusion (4 patients, out of which 3 were temporary and the other patient died). In cirrhotic patients, there is no difference in the peak levels of the enzyme markers of liver injury or in morbidity. Thus, there is no evidence to support selective inflow occlusion over total inflow occlusion routinely.

Different methods of intermittent portal triad clamping

30 minutes versus 15 minutes

There was no significant difference in the morbidity, blood loss, transfusion requirements, liver function tests, or hospital stay between the groups. The operating time was lower in the 30-minutes group. Further trials are necessary to confirm this finding.

20 minutes versus 10 minutes

There was no difference between the two groups in bilirubin or aspartate transaminase on the second post-operative day. This is a small trial with the outcomes reported in only nine patients. No inference can be drawn from the results.

Ischaemic preconditioning followed by continuous vascular occlusion versus intermittent vascular occlusion

There was no difference in any of the outcomes other than total operative loss between the two groups. The difference was less than 200 ml which is unlikely to be of any clinical significance. It should be noted that neither trial included cirrhotic patients. There is no evidence for any difference between the techniques for liver resection in patients with non-cirrhotic livers.

Difficulty in the interpretation of the data

The main difficulty that we faced in this review is the heterogeneity in the patients included in the included trials. Some trials included major and minor liver resections and included normal and cirrhotic livers. Because of the few trials included under different comparisons, subgroup analysis could not be performed for many comparisons. It must also be noted that the outcomes, which include only one trial should be interpreted as level Ib evidence or level Ib- evidence rather than as level Ia or level Ia- evidence (CEBM 2001).

Other limitations of the review

We were only able to find few trials on each relevant comparison and these trials included few participants and few outcome measures. This increases the risks of type I as well as type II errors (random errors).

Although a number of trials used adequate methodologies for randomisation, none of them employed blinding of participants or observers. Thus, all the trials included in this review were of high risk of bias (systematic errors).

There were no randomised clinical trials assessing the different methods of vascular occlusion in the laparoscopic liver resection. The haemodynamic changes during portal triad clamping in the laparoscopic liver resection is different from those during open elective liver resection (Decailliot 2005). So, this review is applicable only for open liver resection. Information on pre-operative chemotherapy was available only in two trials. Pre-operative chemotherapy causes steatohepatitis (Clavien 2007). These patients may have to be considered on par with those who have a background liver disease, and only the results applicable for patients with cirrhosis may be applicable in these patients.

We followed the Cochrane Handbook for this review. There were no language, publication status, or sample size restrictions. Thus, we minimised the bias due to selection of trials. However, we have used median for the meta-analysis when the mean was not available. We have also imputed the standard deviation from P-values according to the formulae stated in the Cochrane Handbook. If the trials stated a P-value < 0.05, we calculated the standard deviation using a P-value = 0.05. If standard deviation could not be calculated because the trial reports just state that there was no statistical significance without mentioning the exact P-value, we used the highest standard deviation among the other trials included in the outcome. This imputation of standard deviation may have introduced bias.

AUTHORS' CONCLUSIONS

Implications for practice

This review is applicable only for open liver resection. Because of the lack of significant benefit with the potential for harm in patients with cardiac disease, hepatic vascular exclusion cannot be recommended over portal triad clamping. Intermittent portal triad clamping seems to be better than continuous portal triad clamping at least in patients with chronic liver disease. There is no evidence to support selective inflow occlusion over total inflow occlusion routinely. The optimal method of intermittent vascular occlusion is not clear. There is no evidence for any difference between the ischaemic preconditioning followed by vascular occlusion and intermittent vascular occlusion for liver resection in patients with non-cirrhotic livers.

Implications for research

Further trials are necessary to determine the safety, benefits, and harms of different methods of vascular occlusion in major and minor liver resections; in normal and cirrhotic livers; in open and laparoscopic liver resections; and in patients who underwent preoperative chemotherapy, and in those who did not undergo chemotherapy. Stratification based on these factors can be adopted for this purpose. These trials should be adequately powered to identify the benefits and harms of the different methods of vascular occlusion. These trials should include outcome measures related to safety, blood transfusion requirements, and cost measures such as operating time, intensive therapy unit stay, and hospital stay. This would require multicentric trials in most instances. The inclusion of cirrhotic patients or those with severe steatosis in these trials should be carefully considered if one of the arms is continuous vascular occlusion as the morbidity appears to be higher in these patients if subjected to continuous vascular occlusion.

Further trials are necessary to assess the advantages and disadvantages of remote ischaemic preconditioning.

Trials need to be conducted and reported according to the CONSORT Statement (www.consort-statement.org).

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

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

Belghiti 1996

Methods	Randomised clinical trial. Sequence generation: adequate. Allocation concealment: adequate. Blinding: inadequate. Free from 'incomplete outcome data' bias: inadequate. Free from 'selective outcome reporting': adequate. Free from 'baseline imbalance' bias: adequate. Free from 'early stopping' bias: unclear. Free from 'academic' bias: adequate. Free from 'source of funding' bias: unclear.

Belghiti 1996 (*Continued*)

Participants	Country: France. Number randomised: 52 (4 from each group crossed over). Mean age: 46 years. Females: 31 (43.3%). Major liver resections: 52 (100%). Cirrhotic livers: 0 (0%). Parenchymal transection: clamp-crush, CUSA. Inclusion criteria: 1. Non-cirrhotic. 2. Major liver resections. Exclusion criteria: Involvement of hepatic veins or the vena cava (ie, narrowing of the vessel lumen by the tumour) or both by imaging.
Interventions	Participants were randomly assigned to two groups. Group 1: HVE (IVC) (n = 28). occlusion of IVC below and above liver. Group 2: continuous PTC (n = 24).
Outcomes	The outcomes reported were peri-operative mortality, morbidity, blood transfusion requirements, hospital stay, operating time, peri-operative haemodynamic variables, operative blood loss, and liver function tests.
Notes	Reasons for post-randomisation drop-out: 4 in each group crossed over. These patients were included for mortality, morbidity, and hospital stay as this was reported in these patients. These patients were not included for any of the other outcomes including blood transfusion requirements.. Additional information was provided by authors in January 2007.

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Yes	Adequate. Quote: "the random sequence was generated using a table number randomization".
Allocation concealment?	Yes	Adequate. Quote: "the allocation concealment was performed using sealed envelops".
Blinding? All outcomes	No	Inadequate.

Belghiti 1996 (*Continued*)

Incomplete outcome data addressed? All outcomes	No	Inadequate. Quote: These eight patients who required crossing over to the other group were not considered for analysis of surgical complications, hemodynamic response, blood loss, and liver and renal tolerance.. Comment: 4 in each group crossed over. These patients were included for mortality, morbidity, and hospital stay as this was reported in these patients. These patients were not included for any of the other outcomes..
Free of selective reporting?	Yes	Adequate. Comment: All important outcomes were reported.
Free of baseline imbalance?	Yes	Adequate. Comment: Patients were well matched for important characteristics.
Free of early stopping bias?	Unclear	Unclear.
Free of academic bias?	Yes	Adequate. Comment: No previous published report of the same intervention by the author.

Belghiti 1999

Methods	Randomised clinical trial. Sequence generation: adequate. Allocation concealment: adequate. Blinding: inadequate. Free from 'incomplete outcome data' bias: adequate. Free from 'selective outcome reporting': adequate. Free from 'baseline imbalance' bias: adequate. Free from 'early stopping' bias: unclear. Free from 'academic' bias: adequate. Free from 'source of funding' bias: unclear.
Participants	Country: France. Number randomised: 86. Mean age: 51 years. Females: 41 (47.7%). Major liver resections: 39 (45.3%). Cirrhotic livers: 25 (29.1%). Parenchymal transection: CUSA. Inclusion criteria: Elective resections.

Belghiti 1999 (*Continued*)

	Exclusion criteria: 1. Total vascular exclusion required because of involvement of the cavo-suprahepatic junction or the inferior vena cava. 2. Simultaneous bilio-enteric anastomosis or associated gastrointestinal procedures.
Interventions	Participants were randomly assigned to two groups. Group 1: Continuous PTC (n = 42). Group 2: Intermittent PTC (n = 63). 15 minutes clamp; 5 minutes unclamp
Outcomes	The outcomes reported were peri-operative mortality, morbidity, blood transfusion requirements, hospital stay, blood loss, and liver function tests.
Notes	Additional information was provided by authors in January 2007.

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Yes	Adequate. Quote: "the random sequence was generated using a table number randomization".
Allocation concealment?	Yes	Adequate. Quote: "the allocation concealment was performed using sealed envelops".
Blinding? All outcomes	No	Inadequate.
Incomplete outcome data addressed? All outcomes	Yes	Adequate. Comment: There were no post-randomisation drop-outs.
Free of selective reporting?	Yes	Adequate. Comment: All important outcomes were reported.
Free of baseline imbalance?	Yes	Adequate. Comment: Patients were well matched for important characteristics.
Free of early stopping bias?	Unclear	Unclear.

Belghiti 1999 (*Continued*)

Free of academic bias?	Yes	Adequate. Comment: No previous published report of the same intervention by the author.

Brooks 2007

Methods	Randomised clinical trial. Sequence generation: unclear. Allocation concealment: unclear. Blinding: inadequate. Free from 'incomplete outcome data' bias: inadequate. Free from 'selective outcome reporting': inadequate. Free from 'baseline imbalance' bias: adequate. Free from 'early stopping' bias: unclear. Free from 'academic' bias: adequate. Free from 'source of funding' bias: unclear.
Participants	Country: UK. Sample size: 13. Post-randomisation drop-out: 4. Revised sample size: 9. Females: 3 (33.3%). Mean age: 67.8 years. Major liver resections: 7 (77.8%). Cirrhotic patients: 0 (0%). Parenchymal transection: not stated. Inclusion criteria: Elective liver resection for colorectal metastases. Exclusion criteria: 1. Patients with American Society of Anesthesiologists > grade 2. 2. Preexisting parenchymal liver disease. 3. Non-metastatic disease.
Interventions	The participants were randomly assigned to two groups. Group 1: intermittent PTC (n = 4). 20 minutes clamp;10 minutes unclamp. Group 2: intermittent PTC (n = 5). 10 minutes clamp; 5 minutes unclamp.
Outcomes	The outcomes reported were liver function tests.
Notes	Reasons for post-randomisation drop-out: not stated. Additional information was sought from authors in September 2008. No replies were received.

Brooks 2007 (*Continued*)

Risk of bias		
Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Unclear	Unclear.
Allocation concealment?	Unclear	Unclear.
Blinding? All outcomes	No	Inadequate.
Incomplete outcome data addressed? All outcomes	No	Inadequate. Comment: The outcomes of only 9 patients were reported..
Free of selective reporting?	Yes	Adequate. Comment: All important outcomes were reported.
Free of baseline imbalance?	Yes	Adequate. Comment: Patients were well matched for important characteristics.
Free of early stopping bias?	Unclear	Unclear.
Free of academic bias?	Yes	Adequate. Comment: No previous published report of the same intervention by the author.

Capussotti 2003

Methods	Randomised clinical trial. Sequence generation: adequate. Allocation concealment: unclear. Blinding: inadequate. Free from 'incomplete outcome data' bias: adequate. Free from 'selective outcome reporting': inadequate. Free from 'baseline imbalance' bias: adequate. Free from 'early stopping' bias: unclear. Free from 'academic' bias: adequate. Free from 'source of funding' bias: unclear.
Participants	Country: Italy. Number randomised: 35. Mean age: 52.8 years. Females: 8 (22.9%). Major liver resections: 8 (22.9%).

Capussotti 2003 (*Continued*)

	Cirrhotic livers: 35 (100%). Parenchymal transection: clamp-crush. Inclusion criteria: 1. < 75 years. 2. HCC. 3. Cirrhotic. 4. Child A.
Interventions	Participants were randomly assigned to two groups. Group 1: Continuous PTC (Continuous) (n = 18). Group 2: Intermittent PTC (n = 17). 15 minutes clamp; 5 minutes unclamp
Outcomes	The outcomes reported were peri-operative mortality, blood transfusion requirements, operating time, blood loss, and liver function tests.
Notes	Additional information was sought from authors in September 2006 and September 2008. No replies were received.

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Yes	Adequate. Quote: "randomization to the type of clamping was assigned by computer-generated random numbers".
Allocation concealment?	Unclear	Unclear.
Blinding? All outcomes	No	Inadequate.
Incomplete outcome data addressed? All outcomes	Yes	Adequate. Comment: There were no post-randomisation drop-outs.
Free of selective reporting?	No	Inadequate. Comment: Some important outcomes such as peri-operative morbidity were not reported.
Free of baseline imbalance?	Yes	Adequate. Comment: Patients were well matched for important characteristics.
Free of early stopping bias?	Unclear	Unclear.

Capussotti 2003 (*Continued*)

Free of academic bias?	Yes	Adequate. Comment: No previous published report of the same intervention by the author.

Chen 2006

Methods	Randomised clinical trial. Sequence generation: unclear. Allocation concealment: unclear. Blinding: inadequate. Free from 'incomplete outcome data' bias: adequate. Free from 'selective outcome reporting': adequate. Free from 'baseline imbalance' bias: adequate. Free from 'early stopping' bias: unclear. Free from 'academic' bias: adequate. Free from 'source of funding' bias: adequate.
Participants	Country: China. Number randomised: 118. Mean age: 40.6 years. Females: 14 (11.9%). Major liver resections: 102 (86.4%). Cirrhotic livers: 118 (100%). Parenchymal transection: clamp-crush. Inclusion criteria: 1. Cirrhosis. 2. HCC. 3. Tumour > 5 cm in diameter. 4. Tumour located in the central portion of the liver. Exclusion criteria: 1. Direct invasion of the hepatic hilar plate. 2. Uncontrolled ascites.
Interventions	Participants were randomly assigned to two groups. Group 1: HVE (IVC) (n = 60). Occlusion of IVC below and occlusion of middle hepatic veins draining the section of liver to be resected. Group 2: PTC (n = 58).
Outcomes	The outcomes reported were peri-operative mortality, morbidity, blood transfusion requirements, operating time, peri-operative haemodynamic variables, blood loss, and liver function tests.
Notes	Additional information was sought from authors in March 2007 and September 2008. No replies were received.

Chen 2006 (*Continued*)

Risk of bias		
Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Unclear	Unclear.
Allocation concealment?	Unclear	Unclear.
Blinding? All outcomes	No	Inadequate.
Incomplete outcome data addressed? All outcomes	Yes	Adequate. Quote: "If abdominal exploration was negative for extrahepatic spread and liver resection was indicated, the patients were randomly allocated to either the CIO or the MTHVE groups". Comment: "This avoided post-randomisation drop-outs".
Free of selective reporting?	Yes	Adequate. Comment: All important outcomes were reported.
Free of baseline imbalance?	Yes	Adequate. Comment: Patients were well matched for important characteristics.
Free of early stopping bias?	Unclear	Unclear.
Free of academic bias?	Yes	Adequate. Comment: No previous published report of the same intervention by the author.

Esaki 2006

Methods	Randomised clinical trial. Sequence generation: adequate. Allocation concealment: adequate. Blinding: inadequate. Free from 'incomplete outcome data' bias: inadequate. Free from 'selective outcome reporting': inadequate. Free from 'baseline imbalance' bias: adequate. Free from 'early stopping' bias: adequate. Free from 'academic' bias: adequate. Free from 'source of funding' bias: unclear.

Esaki 2006 (*Continued*)

Participants	Country: Japan. Number randomised: 92. Mean age: 62 years. Females: 28 (30.4%). Major liver resections: 18 (19.6%). Cirrhotic livers: 0 (0%). Parenchymal transection: clamp-crush. Inclusion criteria: 1. Elective hepatectomy. 2. < 75 years of age. 3. Adequate cardiopulmonary and renal function. Exclusion criteria: Preoperative diagnosis of HCC.
Interventions	Participants were randomly assigned to two groups. Group 1: Intermittent PTC (n = 48). 30 minutes clamp; 5 minutes unclamp. Group 2: Intermittent PTC (n = 44). 15 minutes clamp; 5 minutes unclamp.
Outcomes	The outcomes reported were peri-operative mortality, morbidity, blood transfusion requirements, hospital stay, operating time, operative blood loss, and liver function tests.
Notes	Reasons for post-randomisation drop-out: No hepatectomy 8 patients; not eligible 8 patients. Additional information was provided by authors in March 2007.

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Adequate. Quote: "Block randomization, which was made with using personal computer by data center not associated with surgeons or patients at all, was individually performed by telephone calls soon after confirmation of the inclusion criteria".
Allocation concealment?	Yes	Adequate. Quote: "Block randomization, which was made with using personal computer by data center not associated with surgeons or patients at all, was individually performed by telephone calls soon after confirmation of the inclusion criteria".
Blinding? All outcomes	No	Inadequate.

Esaki 2006 (*Continued*)

Incomplete outcome data addressed? All outcomes	No	Inadequate. Quote: "After randomization, 11 patients were excluded from the SG and five from the PG". Comment: Post-randomisation drop-outs were related to the outcomes.
Free of selective reporting?	No	Inadequate. Comment: Some important outcomes like liver failure were not reported.
Free of baseline imbalance?	Yes	Adequate. Comment: Patients were well matched for important characteristics.
Free of early stopping bias?	Yes	Adequate. Comment: The trialists recruited the intended number of people.
Free of academic bias?	Yes	Adequate. Comment: No previous published report of the same intervention by the author.

Figueras 2005

Methods	Randomised clinical trial. Sequence generation: adequate. Allocation concealment: adequate. Blinding: inadequate. Free from 'incomplete outcome data' bias: adequate. Free from 'selective outcome reporting': adequate. Free from 'baseline imbalance' bias: adequate. Free from 'early stopping' bias: adequate. Free from 'academic' bias: adequate. Free from 'source of funding' bias: adequate.
Participants	Country: Spain. Number randomised: 80. Mean age: 61.8 years. Females: 21 (26.2%). Major liver resections: 0 (0%). Cirrhotic livers: 39 (48.8%). Parenchymal transection: clamp-crush, CUSA. Inclusion criteria: Minor hepatic resections only. Exclusion criteria: 1. Gastro-intestinal anastomosis.

Figueras 2005 (*Continued*)

	2. Contralateral hepatic resection.
Interventions	Participants were randomly assigned to two groups. Group 1: Intermittent PTC (n = 39). 15 minutes clamp; 5 minutes unclamp. Group 2: Intermittent selective inflow occlusion (n=41). 15 minutes clamp; 5 minutes unclamp.
Outcomes	The outcomes reported were peri-operative mortality, morbidity, blood transfusion requirements, hospital stay, operating time, operative blood loss, and liver function tests.
Notes	AST and ALT were reported in graphs. There is discrepancy between the graph and the text. So, these details were not obtained from graph. Additional information related to randomisation was provided by authors in September 2006.

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Adequate. Quote: "The distribution of the groups was performed at the beginning of the study with a random table with stratification of the patients for cirrhosis".
Allocation concealment?	Yes	Adequate. Quote: "Randomization was performed using sealed envelopes".
Blinding? All outcomes	No	Inadequate.
Incomplete outcome data addressed? All outcomes	Yes	Adequate. Quote: "Because intraoperative ultrasonography might reveal new tumoral nodules and, therefore, lead to changes in the technique of surgical resection, potential study patients were not randomized until full hepatic exploration had been completed".
Free of selective reporting?	Yes	Adequate. Comment: All important outcomes were reported.
Free of baseline imbalance?	Yes	Adequate. Comment: Patients were well matched for important characteristics.

Figueras 2005 (*Continued*)

Free of early stopping bias?	Yes	Adequate. Comment: The trialists recruited the intended number of people.
Free of academic bias?	Yes	Adequate. Comment: No previous published report of the same intervention by the author.

Petrowsky 2006

Methods	Randomised clinical trial. Sequence generation: unclear. Allocation concealment: adequate. Blinding: inadequate. Free from 'incomplete outcome data' bias: adequate. Free from 'selective outcome reporting': adequate. Free from 'baseline imbalance' bias: adequate. Free from 'early stopping' bias: adequate. Free from 'academic' bias: adequate. Free from 'source of funding' bias: unclear.
Participants	Country: Switzerland Number randomised: 73. Median age: 57.7 years. Females: 35 (47.9%). Major liver resections: 73 (100%). Cirrhotic livers: 0 (0%). Parenchymal transection: clamp-crush technique. Inclusion criteria: 1. Major liver resection. 2. 30 minutes of ischaemia time. Exclusion criteria: 1. Living donors for liver transplantation. 2. Combined local ablation such as radiofrequency or cryoablation. 3. Need for total vascular hepatic exclusion. 4. Major concomitant extrahepatic procedure.
Interventions	Participants were randomly assigned to two groups. Group 1: Ischaemic preconditioning (n = 36). 10 minutes clamping followed by 10 minutes unclamp followed by continuous PTC. Group 2: Intermittent PTC (n = 37). 15 minutes clamp; 5 minutes unclamp.
Outcomes	The outcomes reported were peri-operative mortality, morbidity, blood transfusion requirements, hospital stay, ITU stay, operating time, blood loss, and liver function tests.

Petrowsky 2006 (*Continued*)

Notes	Additional information related to randomisation was sought from the authors in March 2007 but the answers were not clear.

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Unclear	Unclear.
Allocation concealment?	Yes	Adequate. Quote: "sealed random envelope technique".
Blinding? All outcomes	No	Inadequate.
Incomplete outcome data addressed? All outcomes	Yes	Adequate. Comment: There were no post-randomisation drop-outs.
Free of selective reporting?	Yes	Adequate. Comment: All important outcomes were reported.
Free of baseline imbalance?	Yes	Adequate. Comment: Patients were well matched for important characteristics.
Free of early stopping bias?	Yes	Adequate. Comment: The trialists recruited the intended number of people.
Free of academic bias?	Yes	Adequate. Comment: No previous published report of the same intervention by the author.

Smyrniotis 2006

Methods	Randomised clinical trial. Sequence generation: adequate. Allocation concealment: adequate. Blinding: inadequate. Free from 'incomplete outcome data' bias: adequate. Free from 'selective outcome reporting': inadequate. Free from 'baseline imbalance' bias: adequate. Free from 'early stopping' bias: adequate. Free from 'academic' bias: adequate. Free from 'source of funding' bias: unclear.
Participants	Country: Greece. Number randomised: 54. Median age: 62.5 years. Females: 16 (29.6%). Major liver resections: 27 (50%). Cirrhotic livers: 0 (0%). Parenchymal transection: sharp transection. Inclusion criteria: Liver resection for liver malignancy. Exclusion criteria: 1. Cirrhosis. 2. Serious co-morbidity.
Interventions	Participants were randomly assigned to two groups. Group 1: Ischaemic preconditioning (n = 27). 10 minutes clamping followed by 10 minutes unclamp followed by continuous HVE (major hepatic veins). Group 2: Intermittent HVE (major hepatic veins) (n = 27). 15 minutes clamp; 5 minutes unclamp.
Outcomes	The outcomes reported were peri-operative mortality, morbidity, blood transfusion requirements, hospital stay, ITU stay, operating time, blood loss, and liver function tests.
Notes	Additional information related to randomisation was provided by authors in March 2007.

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Adequate. Quote: "In our studies we use computer-generated random numbers".

Smyrniotis 2006 (*Continued*)

Allocation concealment?	Yes	Adequate. Quote: "Randomization was performed by the sealed-envelope method".
Blinding? All outcomes	No	Inadequate.
Incomplete outcome data addressed? All outcomes	Yes	Adequate. Comment: There were no post-randomisation drop-outs.
Free of selective reporting?	No	Inadequate. Comment: Some important outcomes like liver failure were not reported.
Free of baseline imbalance?	Yes	Adequate. Comment: Patients were well matched for important characteristics.
Free of early stopping bias?	Yes	Adequate. Comment: The trialists recruited the intended number of people.
Free of academic bias?	Yes	Adequate. Comment: No previous published report of the same intervention by the author.

Wu 2002

Methods	Randomised clinical trial. Sequence generation: adequate. Allocation concealment: adequate. Blinding: inadequate. Free from 'incomplete outcome data' bias: adequate. Free from 'selective outcome reporting': inadequate. Free from 'baseline imbalance' bias: adequate. Free from 'early stopping' bias: unclear. Free from 'academic' bias: adequate. Free from 'source of funding' bias: adequate.
Participants	Country: Taiwan. Number randomised: 58. Mean age: 55.3 years Females: 10 (17.2%). Major liver resections: 20 (34.5%) Cirrhotic livers: 58 (100%) Parenchymal transection: clamp-crush

Wu 2002 (*Continued*)

	Inclusion criteria: 1. Cirrhotic 2. Tumour location - Central (4,5,8) 3. Must have resection of segment 5. Exclusion criteria: 1. Previous bile operations 2. Pre-operative therapy 3. Patients needing total vascular exclusion 4. Patients with poor liver function (Indocyanine green 15 min retention rate > 50%, Bilirubin 4 mg/dl or prothrombin time < 75% of control levels.
Interventions	Participants were randomly assigned to two groups. Group 1: Intermittent PTC (n = 28). 15 minutes clamp; 5 minutes declamp. Group 2: Intermittent selective inflow occlusion (n = 30). 30 minutes clamp; 5 minutes declamp.
Outcomes	The outcomes reported were peri-operative mortality, morbidity, blood transfusion requirements, hospital stay, operating time, blood loss, and liver function tests.
Notes	Additional information related to randomisation was provided by authors in November 2006.

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Yes	Adequate. Quote: "The random sequence was made by computerized random sequence at the beginning of the study".
Allocation concealment?	Yes	Adequate. Quote: "randomization was performed by opening a sealed envelope".
Blinding? All outcomes	No	Inadequate.
Incomplete outcome data addressed? All outcomes	Yes	Adequate. Comment: There were no post-randomisation drop-outs.
Free of selective reporting?	No	Inadequate. Comment: Some important outcomes such as liver failure were not reported.

Wu 2002 (*Continued*)

Free of baseline imbalance?	Yes	Adequate. Comment: Patients were well matched for important characteristics.
Free of early stopping bias?	Unclear	Unclear.
Free of academic bias?	Yes	Adequate. Comment: No previous published report of the same intervention by the author.

ATP = adenosine tri phosphate.
CD18 = integrin on resting polymorphonuclear cells.
CUSA = cavitron ultrasound surgical aspirator.
e-nos = endothelial nitrogen oxide synthase.
ET-1 = endothelin -1.
HCC = hepatocellular carcinoma.
HVE = hepatic vascular exclusion.
IPC = ischaemic pre-conditioning.
ITU = intensive therapy unit.
IVC = inferior vena cava.
PTC = portal triad clamping.

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

Cheung 1996	Not a randomised clinical trial.
Figueras 2003	Compares selective vascular occlusion by dividing the vessels separately at the hilum or by en bloc transection of the vessels by a surgical stapler.
Kato 2008	Only the infrahepatic IVC was clamped without clamping of suprahepatic inferior vena cava or major hepatic veins. So, this was not a trial assessing hepatic vascular exclusion.
Konigsrainer 2006	Letter to editor and not a randomised clinical trial.
Man 2002	Randomised selection of patients for electron microscopy but not randomisation of patients.
Smyrniotis 2002	Quasi-randomised (random sequence generated by hospital number).
Smyrniotis 2003a	Quasi-randomised (random sequence generated by hospital number).
Smyrniotis 2003b	Quasi-randomised (random sequence generated by hospital number).

(*Continued*)

Sugimoto 2003	Letter to editor and not a randomised clinical trial.

IVC = inferior vena cava.

DATA AND ANALYSES

Comparison 1. Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Mortality	2	170	Risk Ratio (M-H, Fixed, 95% CI)	0.30 [0.03, 2.86]
2 Liver failure	2	170	Risk Ratio (M-H, Fixed, 95% CI)	0.97 [0.14, 6.64]
3 Peri-operative morbidity	2		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
3.1 Re-operation	1	52	Risk Ratio (M-H, Fixed, 95% CI)	2.59 [0.11, 60.69]
3.2 Abdominal collections	2	170	Risk Ratio (M-H, Fixed, 95% CI)	2.03 [0.75, 5.49]
3.3 Wound infection	1	118	Risk Ratio (M-H, Fixed, 95% CI)	0.97 [0.06, 15.09]
3.4 Ascites	1	118	Risk Ratio (M-H, Fixed, 95% CI)	0.64 [0.19, 2.17]
3.5 Haematoma	1	52	Risk Ratio (M-H, Fixed, 95% CI)	1.71 [0.17, 17.76]
3.6 Pulmonary complications	2	170	Risk Ratio (M-H, Fixed, 95% CI)	1.46 [0.76, 2.82]
3.7 Air embolism	1	44	Risk Ratio (M-H, Fixed, 95% CI)	0.17 [0.01, 3.31]
4 Number needing transfusion	2	162	Risk Ratio (M-H, Random, 95% CI)	0.63 [0.13, 3.14]
5 Number of units transfused	1	44	Mean Difference (IV, Fixed, 95% CI)	-0.40 [-2.58, 1.78]
6 Hospital stay (days)	1	52	Mean Difference (IV, Fixed, 95% CI)	5.01 [0.06, 9.94]
7 Operating time (minutes)	2	162	Mean Difference (IV, Random, 95% CI)	27.95 [-24.66, 80.57]
8 Haemodynamic changes	2		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
8.1 Mean Arterial Pressure (MAP) mmHg	2	162	Mean Difference (IV, Fixed, 95% CI)	-3.29 [-8.15, 1.58]
8.2 Cardiac Index (L/ min/ sq. m)	1	44	Mean Difference (IV, Fixed, 95% CI)	-1.30 [-1.78, -0.82]
8.3 Systemic Vascular Resistance (SVR) dyne.s.cm^-5	1	44	Mean Difference (IV, Fixed, 95% CI)	752.01 [504.98, 999.02]
9 Blood loss (ml)	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
9.1 Transection blood loss	1	118	Mean Difference (IV, Random, 95% CI)	-330.01 [-407.25, -252.75]
9.2 Operative blood loss	2	162	Mean Difference (IV, Random, 95% CI)	-185.48 [-682.89, 311.92]
10 Bilirubin (micromole/litre)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
10.1 First post-operative day	1	118	Mean Difference (IV, Fixed, 95% CI)	-3.40 [-6.61, -0.19]
10.2 Third post-operative day	1	118	Mean Difference (IV, Fixed, 95% CI)	Not estimable
10.3 Fifth post-operative day	1	118	Mean Difference (IV, Fixed, 95% CI)	Not estimable
11 Prothrombin activity (percentage of normal)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
11.1 First post-operative day	1	44	Mean Difference (IV, Fixed, 95% CI)	5.01 [-2.79, 12.79]
11.2 Fifth post-operative day	1	40	Mean Difference (IV, Fixed, 95% CI)	5.01 [-4.61, 14.61]
12 AST (aspartate transaminase) (IU/litre)	2		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
12.1 First post-operative day	2	162	Mean Difference (IV, Fixed, 95% CI)	-2.65 [-80.08, 74.78]
12.2 Third post-operative day	1	118	Mean Difference (IV, Fixed, 95% CI)	-60.01 [-93.15, -26.85]
12.3 Fifth post-operative day	2	162	Mean Difference (IV, Fixed, 95% CI)	-8.57 [-19.76, 2.61]

13 ALT (alanine transaminase) (IU/litre)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
13.1 First post-operative day	1	118	Mean Difference (IV, Fixed, 95% CI)	-130.01 [-285.75, 25.75]
13.2 Third post-operative day	1	118	Mean Difference (IV, Fixed, 95% CI)	-230.00 [-346.63, -113.37]
13.3 Fifth post-operative day	1	118	Mean Difference (IV, Fixed, 95% CI)	Not estimable

Comparison 2. Portal triad clamping: 'continuous' versus 'intermittent'

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Mortality	2	121	Risk Ratio (M-H, Fixed, 95% CI)	4.98 [0.60, 41.14]
2 Liver failure	2	121	Risk Ratio (M-H, Fixed, 95% CI)	6.05 [0.76, 48.20]
3 Peri-operative morbidity	1		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
3.1 Re-operation	1	86	Risk Ratio (M-H, Fixed, 95% CI)	5.23 [0.26, 105.89]
3.2 Abdominal collections	1	86	Risk Ratio (M-H, Fixed, 95% CI)	0.79 [0.19, 3.30]
3.3 Haematoma	1	86	Risk Ratio (M-H, Fixed, 95% CI)	1.05 [0.07, 16.21]
3.4 Pulmonary complications	1	86	Risk Ratio (M-H, Fixed, 95% CI)	1.05 [0.33, 3.36]
3.5 Biliary fistula	1	86	Risk Ratio (M-H, Fixed, 95% CI)	1.05 [0.07, 16.21]
3.6 Pancreatitis	1	86	Risk Ratio (M-H, Fixed, 95% CI)	0.35 [0.01, 8.33]
4 Number needing transfusion	2	121	Risk Ratio (M-H, Fixed, 95% CI)	0.91 [0.53, 1.58]
5 Number of units transfused	2	121	Mean Difference (IV, Fixed, 95% CI)	0.20 [-0.38, 0.79]
6 Hospital stay (in days)	1	86	Mean Difference (IV, Fixed, 95% CI)	-1.01 [-4.82, 2.82]
7 Operating time (in minutes)	1	35	Mean Difference (IV, Fixed, 95% CI)	-13.40 [-68.08, 41.28]
8 Blood loss	2		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
8.1 Transection	1	86	Mean Difference (IV, Fixed, 95% CI)	-248.00 [-387.14, -112.86]
8.2 Operative	2	121	Mean Difference (IV, Fixed, 95% CI)	-58.49 [-321.68, 204.71]
9 Bilirubin (micromole/litre)	2		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
9.1 First post-operative day	2	121	Mean Difference (IV, Fixed, 95% CI)	1.23 [-7.18, 9.63]
9.2 Second post-operative day	1	86	Mean Difference (IV, Fixed, 95% CI)	2.01 [-7.10, 11.10]
9.3 Third post-operative day	1	35	Mean Difference (IV, Fixed, 95% CI)	8.06 [-17.06, 34.06]
9.4 Fifth post-operative day	1	86	Mean Difference (IV, Fixed, 95% CI)	10.01 [-4.27, 24.27]
9.5 Seventh post-operative day	2	127	Mean Difference (IV, Fixed, 95% CI)	7.23 [-5.71, 20.17]
10 Prothrombin activity (percentage of normal)	2		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
10.1 First post-operative day	2	121	Mean Difference (IV, Fixed, 95% CI)	0.41 [-4.80, 5.62]
10.2 Second post-operative day	1	86	Mean Difference (IV, Fixed, 95% CI)	-1.01 [-7.76, 5.76]
10.3 Third post-operative day	1	35	Mean Difference (IV, Fixed, 95% CI)	-8.01 [-18.93, 2.93]
10.4 Fifth post-operative day	1	86	Mean Difference (IV, Fixed, 95% CI)	Not estimable
10.5 Seventh post-operative day	2	121	Mean Difference (IV, Fixed, 95% CI)	-2.67 [-8.32, 2.98]
11 AST (aspartate transaminase) (IU/litre)	2		Mean Difference (IV, Fixed, 95% CI)	Subtotals only

11.1 First post-operative day	2	121	Mean Difference (IV, Fixed, 95% CI)	12.38 [-68.95, 93.72]
11.2 Second post-operative day	1	86	Mean Difference (IV, Fixed, 95% CI)	134.01 [-3.59, 271.59]
11.3 Third post-operative day	1	35	Mean Difference (IV, Fixed, 95% CI)	-40.01 [-260.94, 180.94]
11.4 Fifth post-operative day	1	86	Mean Difference (IV, Fixed, 95% CI)	8.01 [-12.62, 28.62]
11.5 Seventh post-operative day	2	121	Mean Difference (IV, Fixed, 95% CI)	3.01 [-6.91, 12.94]
12 ALT (alanine transaminase) (IU/litre)	2		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
12.1 First post-operative day	2	121	Mean Difference (IV, Fixed, 95% CI)	10.00 [-92.00, 113.99]
12.2 Second post-operative day	1	86	Mean Difference (IV, Fixed, 95% CI)	98.01 [-40.90, 236.90]
12.3 Third post-operative day	1	35	Mean Difference (IV, Fixed, 95% CI)	-40.01 [-256.48, 176.48]
12.4 Fifth post-operative day	1	86	Mean Difference (IV, Fixed, 95% CI)	16.01 [-42.82, 74.82]
12.5 Seventh post-operative day	2	121	Mean Difference (IV, Fixed, 95% CI)	2.81 [-32.76, 38.39]

Comparison 3. Inflow occlusion: 'selective' versus 'total'

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Mortality	2	138	Risk Ratio (M-H, Fixed, 95% CI)	2.86 [0.12, 68.10]
2 Liver failure	1	80	Risk Ratio (M-H, Fixed, 95% CI)	8.57 [0.48, 154.15]
3 Peri-operative morbidity	2		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
3.1 Re-operation	1	80	Risk Ratio (M-H, Fixed, 95% CI)	Not estimable
3.2 Abdominal collections	2	138	Risk Ratio (M-H, Fixed, 95% CI)	1.74 [0.51, 5.94]
3.3 Wound infection	1	58	Risk Ratio (M-H, Fixed, 95% CI)	4.68 [0.23, 93.37]
3.4 Pulmonary complications	2	138	Risk Ratio (M-H, Fixed, 95% CI)	0.71 [0.16, 3.07]
3.5 Cardiac failure	1	80	Risk Ratio (M-H, Fixed, 95% CI)	4.76 [0.24, 96.16]
3.6 Portal vein thrombosis	1	80	Risk Ratio (M-H, Fixed, 95% CI)	4.76 [0.24, 96.16]
3.7 Bile leak	2	138	Risk Ratio (M-H, Fixed, 95% CI)	0.94 [0.31, 2.83]
3.8 Ascites	2	138	Risk Ratio (M-H, Fixed, 95% CI)	1.42 [0.42, 4.80]
4 Number needing transfusion	2	138	Risk Ratio (M-H, Random, 95% CI)	0.70 [0.20, 2.50]
5 Number of units transfused	1	80	Mean Difference (IV, Fixed, 95% CI)	-0.02 [-0.44, 0.40]
6 Hospital stay (in days)	2	138	Mean Difference (IV, Random, 95% CI)	-0.34 [-2.92, 2.24]
7 Operating time (min)	2	138	Mean Difference (IV, Fixed, 95% CI)	8.69 [-10.12, 27.50]
8 Hemodynamics change (10 min after release of clamping)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
8.1 Mean Arterial Pressure mmHg	1	80	Mean Difference (IV, Fixed, 95% CI)	-2.70 [-8.88, 3.48]
9 Blood loss (ml)	2	196	Mean Difference (IV, Random, 95% CI)	-165.35 [-475.60, 144.91]

9.1 Transection	1	58	Mean Difference (IV, Random, 95% CI)	-241.01 [-539.63, 57.63]
9.2 Operative	2	138	Mean Difference (IV, Random, 95% CI)	-174.56 [-742.06, 392.95]
10 Bilirubin (micromole/litre)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
10.1 First post-operative day	1	58	Mean Difference (IV, Fixed, 95% CI)	0.60 [-15.50, 16.70]
10.2 Third post-operative day	1	58	Mean Difference (IV, Fixed, 95% CI)	-3.40 [-18.77, 11.97]
10.3 Fifth post-operative day	1	58	Mean Difference (IV, Fixed, 95% CI)	-5.30 [-24.43, 13.83]
10.4 Seventh post-operative day	1	58	Mean Difference (IV, Fixed, 95% CI)	-4.20 [-25.01, 16.61]
11 AST (aspartate transaminase) (IU/litre)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
11.1 First post-operative day	1	58	Mean Difference (IV, Fixed, 95% CI)	-130.01 [-531.92, 271.92]
11.2 Third post-operative day	1	58	Mean Difference (IV, Fixed, 95% CI)	10.01 [-207.61, 227.61]
11.3 Fifth post-operative day	1	58	Mean Difference (IV, Fixed, 95% CI)	-10.01 [-120.67, 100.67]
11.4 Seventh post-operative day	1	58	Mean Difference (IV, Fixed, 95% CI)	-20.01 [-36.45, -3.55]
12 ALT (alanine transaminase) (IU/litre)	2		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
12.1 First post-operative day	2	138	Mean Difference (IV, Fixed, 95% CI)	41.95 [-57.52, 141.41]
12.2 Third post-operative day	1	58	Mean Difference (IV, Fixed, 95% CI)	-10.01 [-162.92, 142.92]
12.3 Fifth post-operative day	1	58	Mean Difference (IV, Fixed, 95% CI)	-40.00 [-136.58, 56.58]
12.4 Seventh post-operative day	1	58	Mean Difference (IV, Fixed, 95% CI)	-20.01 [-30.30, -9.70]

Comparison 4. 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Mortality	1	92	Risk Ratio (M-H, Fixed, 95% CI)	Not estimable
2 Peri-operative morbidity	1		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
2.1 Wound infection	1	92	Risk Ratio (M-H, Fixed, 95% CI)	2.76 [0.30, 25.47]
2.2 Pulmonary complications	1	92	Risk Ratio (M-H, Fixed, 95% CI)	0.92 [0.13, 6.23]
2.3 Bile leak	1	92	Risk Ratio (M-H, Fixed, 95% CI)	0.52 [0.16, 1.67]
2.4 Cholangitis	1	92	Risk Ratio (M-H, Fixed, 95% CI)	4.59 [0.23, 93.09]
2.5 Pancreatic fistula	1	92	Risk Ratio (M-H, Fixed, 95% CI)	0.31 [0.01, 7.32]
2.6 Bowel obstruction	1	92	Risk Ratio (M-H, Fixed, 95% CI)	2.76 [0.12, 65.92]
3 Number needing transfusion	1	92	Risk Ratio (M-H, Fixed, 95% CI)	0.92 [0.24, 3.45]
4 Number of units transfused	1	92	Mean Difference (IV, Fixed, 95% CI)	Not estimable

5 Number of units of FFP transfused	1	92	Mean Difference (IV, Fixed, 95% CI)	1.01 [-2.48, 4.48]
6 Hospital stay	1	92	Mean Difference (IV, Fixed, 95% CI)	Not estimable
7 Operating time	1	92	Mean Difference (IV, Fixed, 95% CI)	-50.00 [-101.91, -2.09]
8 Blood loss (ml)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
8.1 Transection (per sq cm)	1	92	Mean Difference (IV, Fixed, 95% CI)	-1.30 [-2.85, 0.25]
8.2 Operative	1	92	Mean Difference (IV, Fixed, 95% CI)	39.01 [-1.50, 79.50]
9 Bilirubin (micromole/litre)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
9.1 First post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	0.80 [-8.08, 9.68]
9.2 Second post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	0.90 [-7.98, 9.78]
9.3 Third post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	1.70 [-1.33, 4.73]
9.4 Fifth post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	1.70 [-1.65, 5.05]
9.5 Seventh post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	1.80 [-0.53, 4.13]
10 Prothrombin activity (percentage of normal)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
10.1 First post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	-4.80 [-11.59, 1.99]
10.2 Third post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	2.70 [-5.73, 11.13]
10.3 Seventh post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	0.60 [-7.83, 9.03]
11 AST (aspartate transaminase) (IU/litre)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
11.1 First post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	-37.00 [-169.90, 91.90]
11.2 Second post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	-10.01 [-25.14, 5.14]
11.3 Third post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	-4.01 [-13.41, 5.41]
11.4 Fifth post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	Not estimable
11.5 Seventh post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	2.01 [-4.55, 8.55]
12 ALT (alanine transaminase) (IU/litre)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
12.1 First post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	31.01 [-111.76, 173.76]
12.2 Second post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	24.01 [-118.76, 166.76]
12.3 Third post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	15.01 [-59.45, 89.45]
12.4 Fifth post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	11.01 [-59.36, 81.36]
12.5 Seventh post-operative day	1	92	Mean Difference (IV, Fixed, 95% CI)	-4.01 [-55.54, 47.54]

Comparison 5. 20 minutes intermittent PTC versus 10 minutes intermittent PTC

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Bilirubin (micromole/litre)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
1.1 Second post-operative day	1	9	Mean Difference (IV, Fixed, 95% CI)	34.04 [-15.46, 84.06]
2 ALT (alanine transaminase) (IU/litre)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
2.1 Second post-operative day	1	9	Mean Difference (IV, Fixed, 95% CI)	486.10 [-464.52, 1438.32]

Comparison 6. Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Mortality	2	127	Risk Ratio (M-H, Fixed, 95% CI)	3.08 [0.13, 73.24]
2 Liver failure	1	73	Risk Ratio (M-H, Fixed, 95% CI)	0.21 [0.01, 4.14]
3 Peri-operative morbidity	2		Risk Ratio (M-H, Fixed, 95% CI)	Subtotals only
3.1 Abdominal collections	1	73	Risk Ratio (M-H, Fixed, 95% CI)	1.37 [0.33, 5.70]
3.2 Wound infection	1	73	Risk Ratio (M-H, Fixed, 95% CI)	0.69 [0.12, 3.86]
3.3 Pulmonary complications	2	127	Risk Ratio (M-H, Fixed, 95% CI)	1.01 [0.44, 2.29]
3.4 Bile leak	2	127	Risk Ratio (M-H, Fixed, 95% CI)	1.42 [0.48, 4.25]
4 Number needing transfusion	1	73	Risk Ratio (M-H, Fixed, 95% CI)	0.84 [0.40, 1.78]
5 Number of units transfused	2	127	Mean Difference (IV, Fixed, 95% CI)	-0.69 [-1.55, 0.17]
6 Hospital stay (in days)	2	127	Mean Difference (IV, Random, 95% CI)	-0.10 [-2.79, 2.60]
7 ITU stay (in days)	2	127	Mean Difference (IV, Fixed, 95% CI)	1.26 [-0.66, 3.18]
8 Operating time	2	127	Mean Difference (IV, Random, 95% CI)	-13.82 [-51.17, 23.54]
9 Blood loss (ml)	2		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
9.1 Transection	1	73	Mean Difference (IV, Fixed, 95% CI)	-104.01 [-228.46, 20.46]
9.2 Operative	2	127	Mean Difference (IV, Fixed, 95% CI)	-164.73 [-271.83, -57.64]
10 Bilirubin (micromole/litre)	2		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
10.1 First post-operative day	2	127	Mean Difference (IV, Fixed, 95% CI)	1.02 [-3.35, 5.38]
10.2 Third post-operative day	1	54	Mean Difference (IV, Fixed, 95% CI)	0.06 [-3.83, 4.83]
10.3 Sixth post-operative day	1	54	Mean Difference (IV, Fixed, 95% CI)	3.80 [-0.53, 8.13]
11 Prothrombin activity (percentage of normal)	2		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
11.1 First post-operative day	2	127	Mean Difference (IV, Fixed, 95% CI)	-1.05 [-4.18, 2.09]
11.2 Third post-operative day	1	54	Mean Difference (IV, Fixed, 95% CI)	-0.10 [-3.38, 3.18]
11.3 Sixth post-operative day	1	54	Mean Difference (IV, Fixed, 95% CI)	2.30 [-0.92, 5.52]
12 AST (IU/L)	2		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
12.1 First post-operative day	2	127	Mean Difference (IV, Fixed, 95% CI)	50.55 [-45.27, 146.38]

12.2 Third post-operative day	1	54	Mean Difference (IV, Fixed, 95% CI)	66.01 [-17.42, 149.42]
12.3 Sixth post-operative day	1	54	Mean Difference (IV, Fixed, 95% CI)	-1.01 [-5.94, 3.94]
13 ALT (IU/L)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
13.1 First post-operative day	1	73	Mean Difference (IV, Fixed, 95% CI)	-108.01 [-277.07, 61.07]

Analysis 1.1. Comparison 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC), Outcome 1 Mortality.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 1 Mortality

Study or subgroup	HVE n/N	PTC n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Belghiti 1996	0/28	1/24		51.4 %	0.29 [0.01, 6.74]
Chen 2006	0/60	1/58		48.6 %	0.32 [0.01, 7.76]
Total (95% CI)	**88**	**82**		**100.0 %**	**0.30 [0.03, 2.86]**

Total events: 0 (HVE), 2 (PTC)

Heterogeneity: $Chi^2 = 0.00$, df = 1 (P = 0.96); $I^2 = 0.0\%$

Test for overall effect: Z = 1.04 (P = 0.30)

Analysis 1.2. Comparison 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC), Outcome 2 Liver failure.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 2 Liver failure

Study or subgroup	HVE n/N	PTC n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Belghiti 1996	0/28	0/24		0.0 %	0.0 [0.0, 0.0]
Chen 2006	2/60	2/58		100.0 %	0.97 [0.14, 6.64]
Total (95% CI)	**88**	**82**		**100.0 %**	**0.97 [0.14, 6.64]**
Total events: 2 (HVE), 2 (PTC)					
Heterogeneity: Chi^2 = 0.0, df = 0 (P = 1.00); I^2 =0.0%					
Test for overall effect: Z = 0.03 (P = 0.97)					

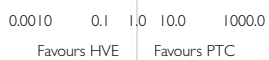
Analysis 1.3. Comparison 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC), Outcome 3 Peri-operative morbidity.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 3 Peri-operative morbidity

Study or subgroup	HVE n/N	PTC n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 Re-operation					
Belghiti 1996	1/28	0/24		100.0 %	2.59 [0.11, 60.69]
Subtotal (95% CI)	**28**	**24**		**100.0 %**	**2.59 [0.11, 60.69]**
Total events: 1 (HVE), 0 (PTC)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.59 (P = 0.56)					
2 Abdominal collections					
Belghiti 1996	9/28	4/24		89.4 %	1.93 [0.68, 5.48]
Chen 2006	1/60	0/58		10.6 %	2.90 [0.12, 69.81]
Subtotal (95% CI)	**88**	**82**		**100.0 %**	**2.03 [0.75, 5.49]**



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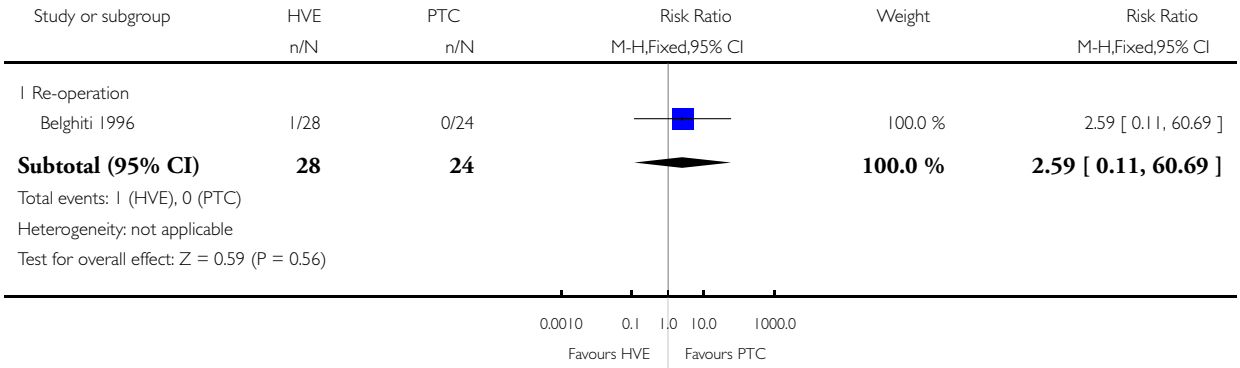
Study or subgroup	HVE n/N	PTC n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Total events: 10 (HVE), 4 (PTC)					
Heterogeneity: Chi² = 0.06, df = 1 (P = 0.81); I² =0.0%					
Test for overall effect: Z = 1.40 (P = 0.16)					
3 Wound infection					
Chen 2006	1/60	1/58		100.0 %	0.97 [0.06, 15.09]
Subtotal (95% CI)	**60**	**58**		**100.0 %**	**0.97 [0.06, 15.09]**
Total events: 1 (HVE), 1 (PTC)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.02 (P = 0.98)					
4 Ascites					
Chen 2006	4/60	6/58		100.0 %	0.64 [0.19, 2.17]
Subtotal (95% CI)	**60**	**58**		**100.0 %**	**0.64 [0.19, 2.17]**
Total events: 4 (HVE), 6 (PTC)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.71 (P = 0.48)					
5 Haematoma					
Belghiti 1996	2/28	1/24		100.0 %	1.71 [0.17, 17.76]
Subtotal (95% CI)	**28**	**24**		**100.0 %**	**1.71 [0.17, 17.76]**
Total events: 2 (HVE), 1 (PTC)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.45 (P = 0.65)					
6 Pulmonary complications					
Belghiti 1996	8/28	4/24		34.6 %	1.71 [0.59, 4.99]
Chen 2006	11/60	8/58		65.4 %	1.33 [0.58, 3.07]
Subtotal (95% CI)	**88**	**82**		**100.0 %**	**1.46 [0.76, 2.82]**
Total events: 19 (HVE), 12 (PTC)					
Heterogeneity: Chi² = 0.13, df = 1 (P = 0.71); I² =0.0%					
Test for overall effect: Z = 1.13 (P = 0.26)					
7 Air embolism					
Belghiti 1996	0/24	2/20		100.0 %	0.17 [0.01, 3.31]
Subtotal (95% CI)	**24**	**20**		**100.0 %**	**0.17 [0.01, 3.31]**
Total events: 0 (HVE), 2 (PTC)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.17 (P = 0.24)					

Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

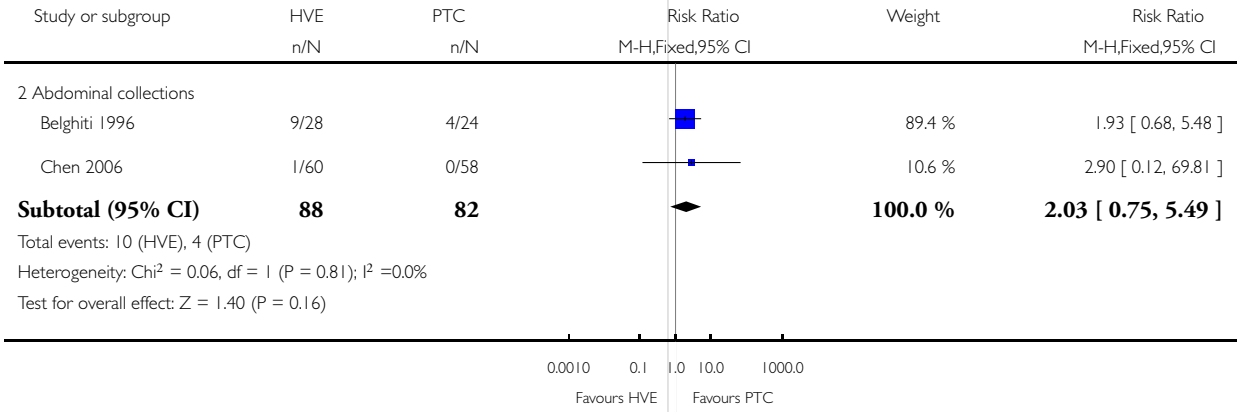
Outcome: 3 Peri-operative morbidity



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

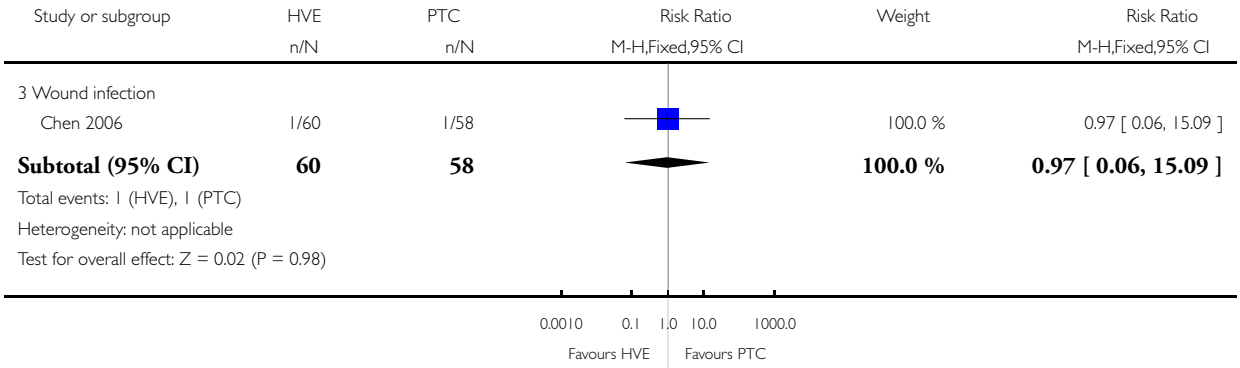
Outcome: 3 Peri-operative morbidity



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

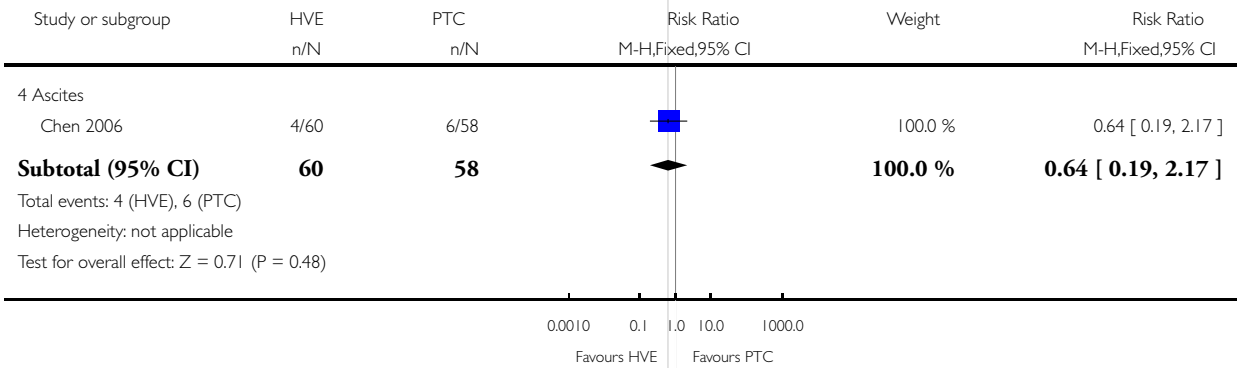
Outcome: 3 Peri-operative morbidity



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

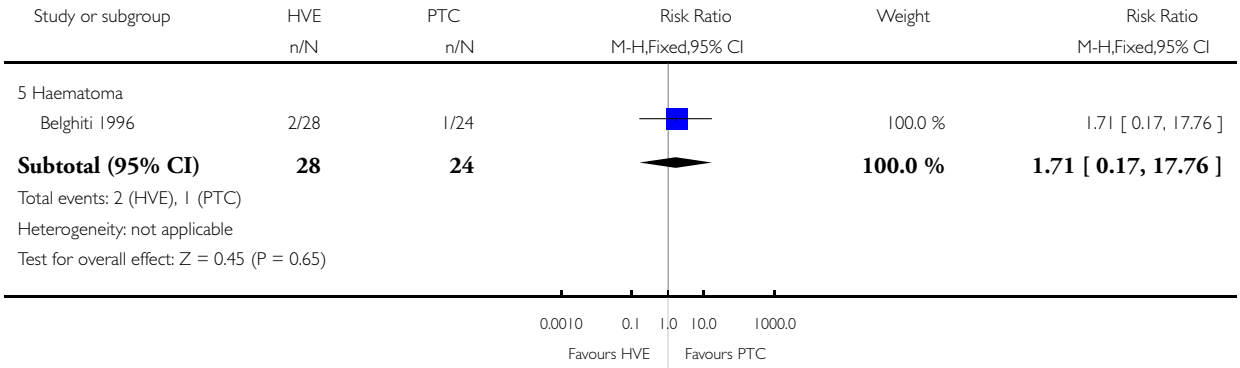
Outcome: 3 Peri-operative morbidity



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

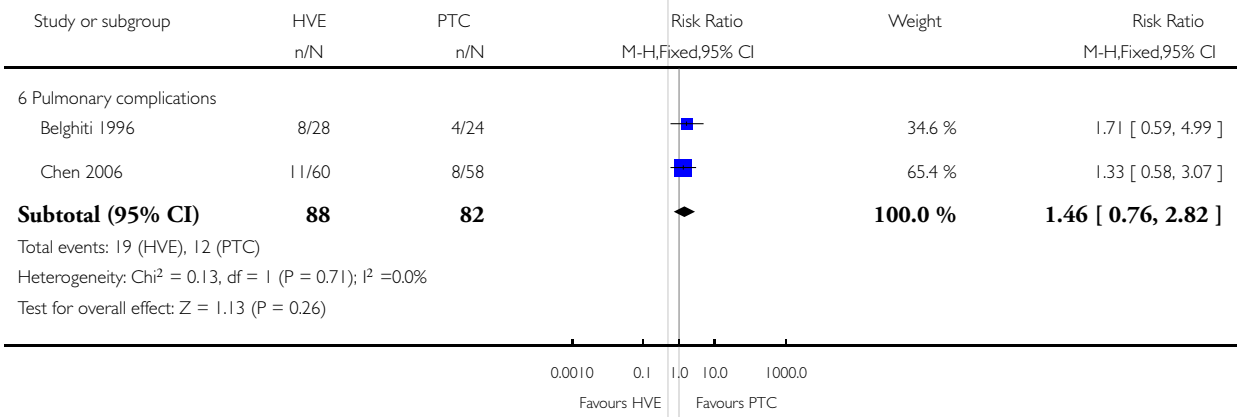
Outcome: 3 Peri-operative morbidity



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 3 Peri-operative morbidity



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 3 Peri-operative morbidity

Study or subgroup	HVE n/N	PTC n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
7 Air embolism					
Belghiti 1996	0/24	2/20		100.0 %	0.17 [0.01, 3.31]
Subtotal (95% CI)	**24**	**20**		**100.0 %**	**0.17 [0.01, 3.31]**
Total events: 0 (HVE), 2 (PTC)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.17 (P = 0.24)					

Analysis 1.4. Comparison 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC), Outcome 4 Number needing transfusion.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 4 Number needing transfusion

Study or subgroup	HVE n/N	PTC n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
Belghiti 1996	16/24	10/20		51.1 %	1.33 [0.79, 2.25]
Chen 2006	8/60	27/58		48.9 %	0.29 [0.14, 0.58]
Total (95% CI)	**84**	**78**		**100.0 %**	**0.63 [0.13, 3.14]**
Total events: 24 (HVE), 37 (PTC)					
Heterogeneity: Tau^2 = 1.25; Chi^2 = 13.58, df = 1 (P = 0.00023); I^2 =93%					
Test for overall effect: Z = 0.57 (P = 0.57)					

Analysis 1.5. Comparison 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC), Outcome 5 Number of units transfused.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 5 Number of units transfused

Study or subgroup	HVE N	Mean(SD)	PTC N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Belghiti 1996	24	2.5 (3.4)	20	2.9 (3.9)		100.0 %	-0.40 [-2.58, 1.78]
Total (95% CI)	**24**		**20**			**100.0 %**	**-0.40 [-2.58, 1.78]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.36 (P = 0.72)

Analysis 1.6. Comparison 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC), Outcome 6 Hospital stay (days).

Review: Methods of vascular occlusion for elective liver resections

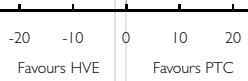
Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 6 Hospital stay (days)

Study or subgroup	HVE N	Mean(SD)	PTC N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Belghiti 1996	28	21 (11)	24	16 (7)		100.0 %	5.00 [0.06, 9.94]
Total (95% CI)	**28**		**24**			**100.0 %**	**5.00 [0.06, 9.94]**

Heterogeneity: not applicable

Test for overall effect: Z = 1.98 (P = 0.047)



Analysis 1.7. Comparison 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC), Outcome 7 Operating time (minutes).

Review: Methods of vascular occlusion for elective liver resections

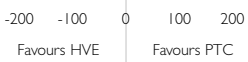
Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 7 Operating time (minutes)

Study or subgroup	HVE N	Mean(SD)	PTC N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Belghiti 1996	24	366 (106)	20	301 (103)		34.4 %	65.00 [3.06, 126.94]
Chen 2006	60	133 (11.8)	58	124.5 (10.7)		65.6 %	8.50 [4.44, 12.56]
Total (95% CI)	**84**		**78**			**100.0 %**	**27.95 [-24.66, 80.57]**

Heterogeneity: Tau² = 1094.67; Chi² = 3.18, df = 1 (P = 0.07); I² =69%

Test for overall effect: Z = 1.04 (P = 0.30)



Analysis 1.8. Comparison 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC), Outcome 8 Haemodynamic changes.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 8 Haemodynamic changes

Study or subgroup	HVE N	Mean(SD)	PTC N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 Mean Arterial Pressure (MAP) mmHg							
Belghiti 1996	24	93 (17)	20	102 (16)		24.8 %	-9.00 [-18.77, 0.77]
Chen 2006	60	81.9 (17)	58	83.3 (14)		75.2 %	-1.40 [-7.01, 4.21]
Subtotal (95% CI)	**84**		**78**			**100.0 %**	**-3.29 [-8.15, 1.58]**

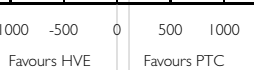
Heterogeneity: Chi² = 1.75, df = 1 (P = 0.19); I² =43%

Test for overall effect: Z = 1.32 (P = 0.19)

2 Cardiac Index (L/ min/ sq. m)							
Belghiti 1996	24	2.5 (0.5)	20	3.8 (1)		100.0 %	-1.30 [-1.78, -0.82]
Subtotal (95% CI)	**24**		**20**			**100.0 %**	**-1.30 [-1.78, -0.82]**

Heterogeneity: not applicable

Test for overall effect: Z = 5.29 (P < 0.00001)



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Study or subgroup	HVE N	HVE Mean(SD)	PTC N	PTC Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
3 Systemic Vascular Resistance (SVR) dyne.s.cm^-5							
Belghiti 1996	24	1699 (555)	20	947 (247)		100.0 %	752.00 [504.98, 999.02]
Subtotal (95% CI)	**24**		**20**			**100.0 %**	**752.00 [504.98, 999.02]**
Heterogeneity: not applicable							
Test for overall effect: Z = 5.97 (P < 0.00001)							
Test for subgroup differences: Chi² = 36.36, df = 2 (P = 0.00), I² =94%							

Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

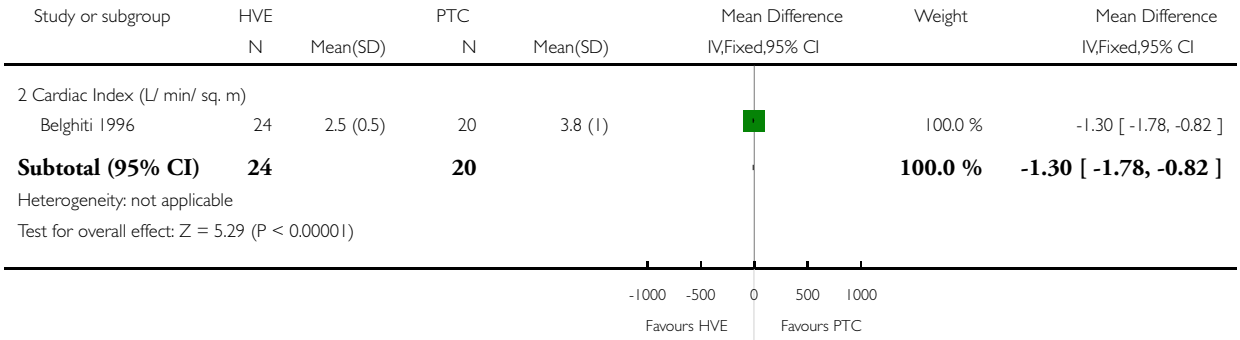
Outcome: 8 Haemodynamic changes

Study or subgroup	HVE N	HVE Mean(SD)	PTC N	PTC Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 Mean Arterial Pressure (MAP) mmHg							
Belghiti 1996	24	93 (17)	20	102 (16)		24.8 %	-9.00 [-18.77, 0.77]
Chen 2006	60	81.9 (17)	58	83.3 (14)		75.2 %	-1.40 [-7.01, 4.21]
Subtotal (95% CI)	**84**		**78**			**100.0 %**	**-3.29 [-8.15, 1.58]**
Heterogeneity: Chi² = 1.75, df = 1 (P = 0.19); I² =43%							
Test for overall effect: Z = 1.32 (P = 0.19)							

Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

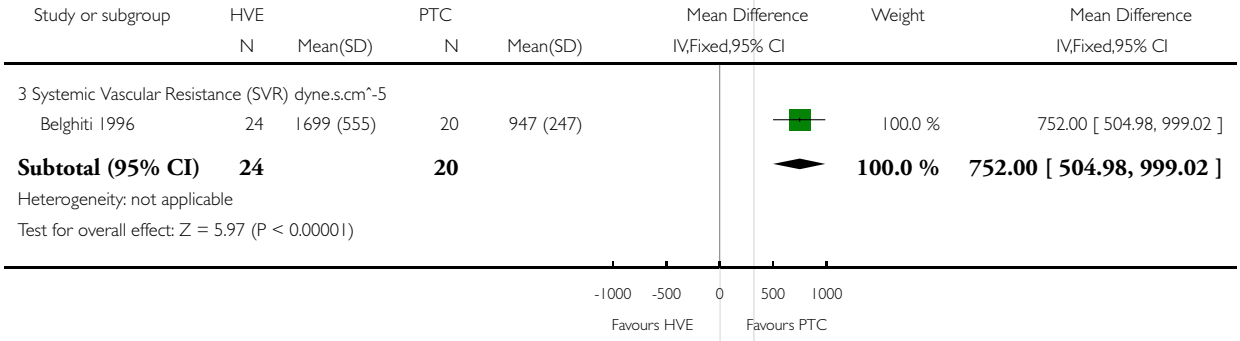
Outcome: 8 Haemodynamic changes



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 8 Haemodynamic changes

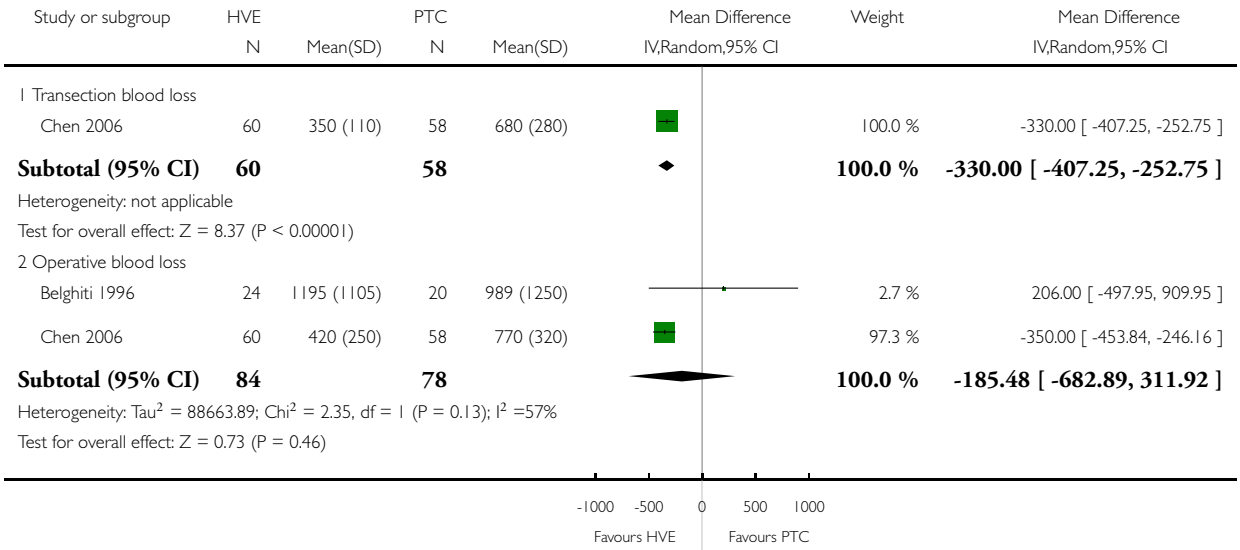


Analysis 1.9. Comparison 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC), Outcome 9 Blood loss (ml).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

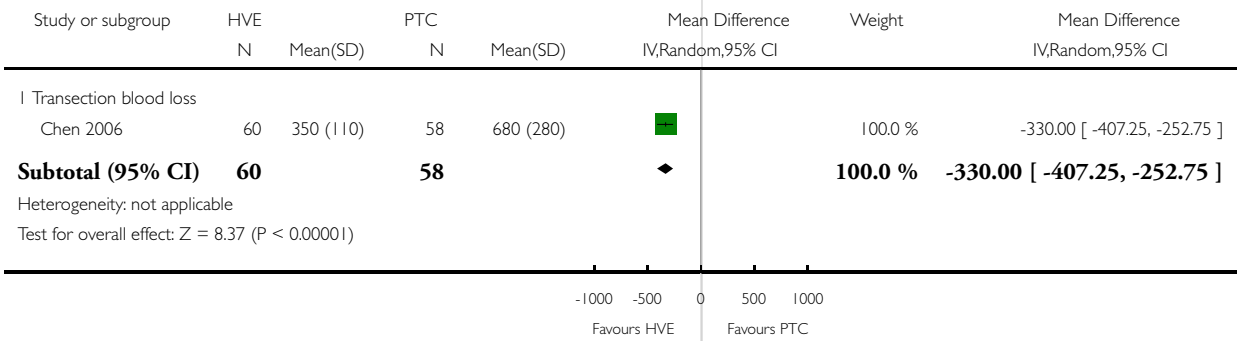
Outcome: 9 Blood loss (ml)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

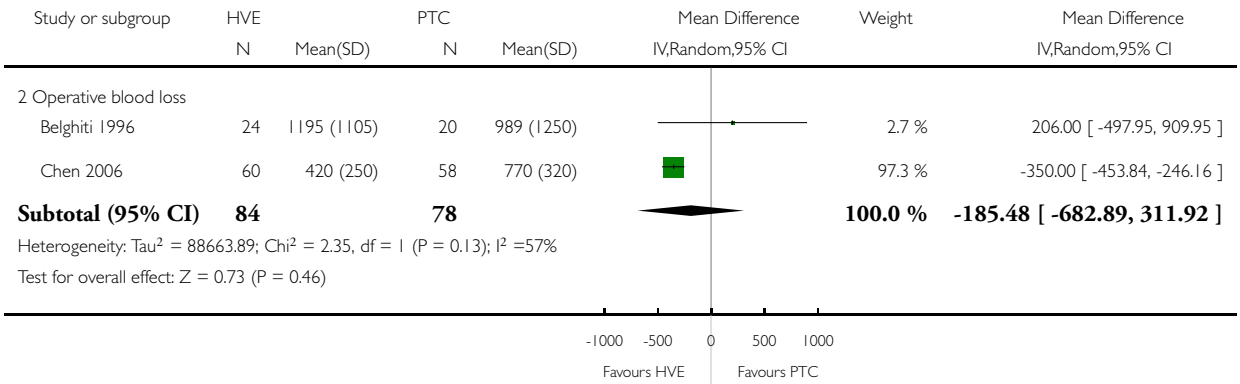
Outcome: 9 Blood loss (ml)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 9 Blood loss (ml)

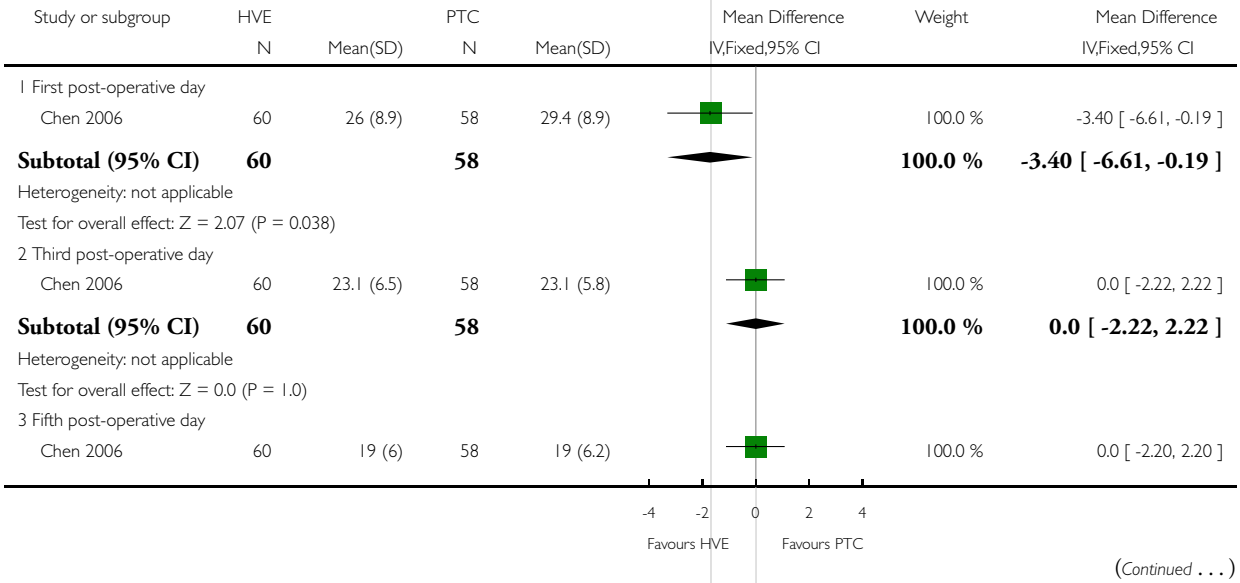


Analysis 1.10. Comparison 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC), Outcome 10 Bilirubin (micromole/litre).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 10 Bilirubin (micromole/litre)



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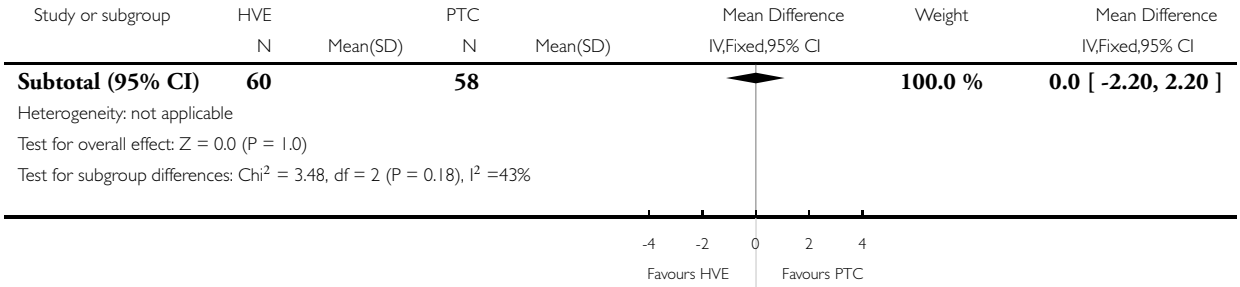
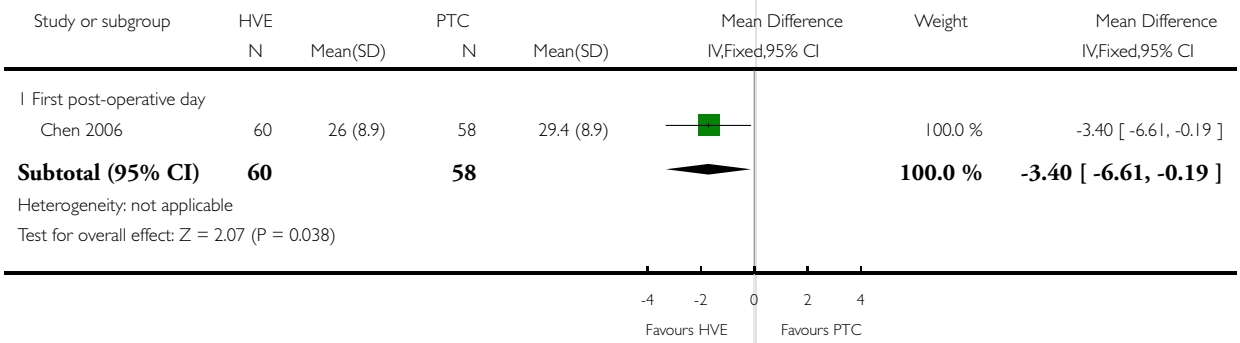


Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

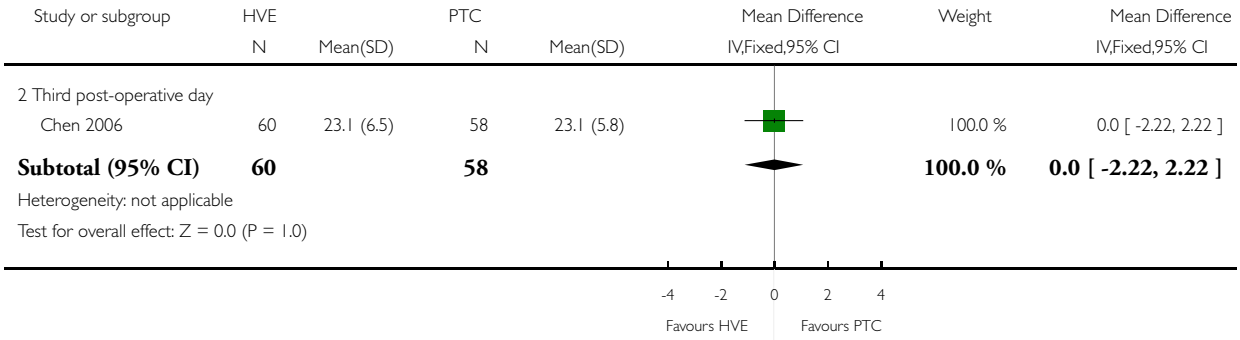
Outcome: 10 Bilirubin (micromole/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

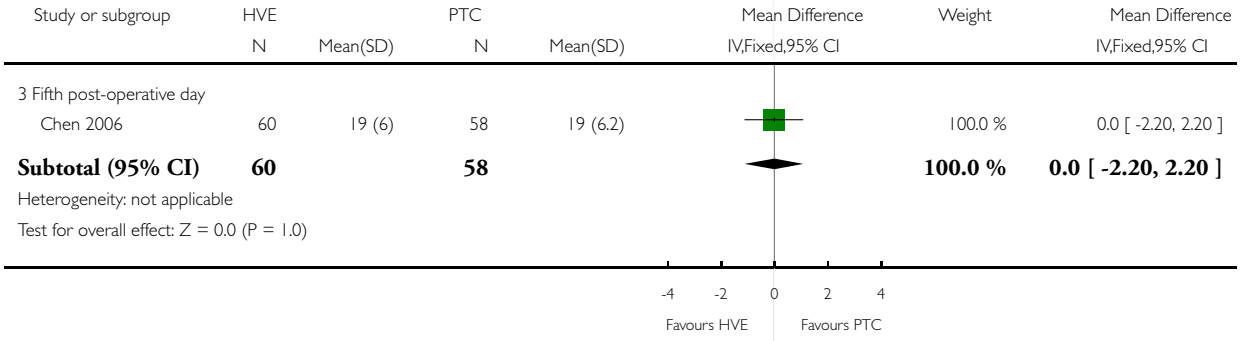
Outcome: 10 Bilirubin (micromole/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 10 Bilirubin (micromole/litre)

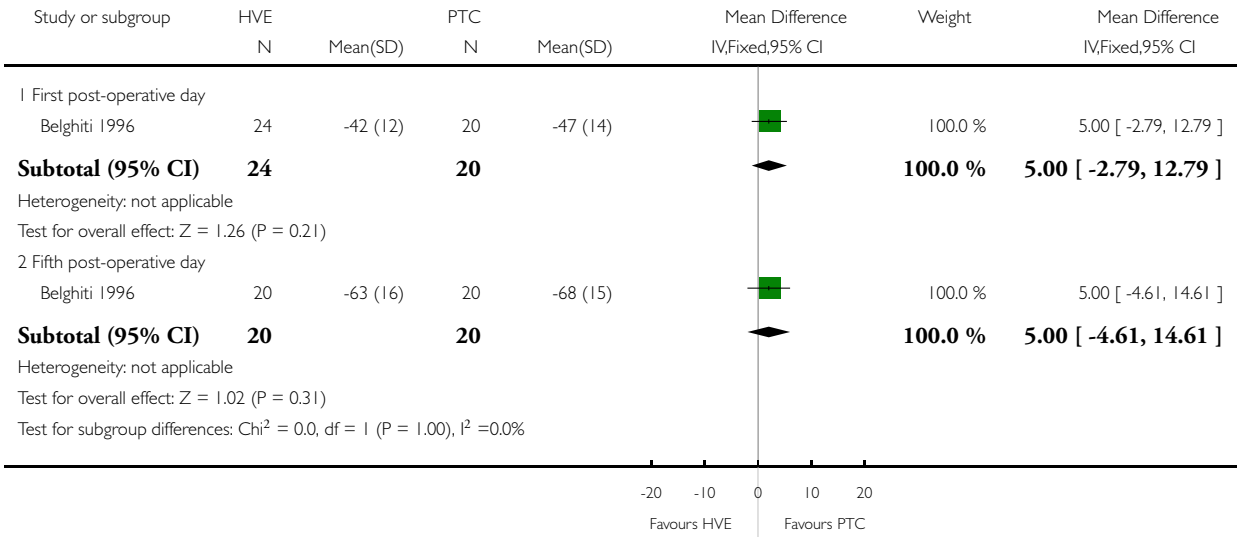


Analysis 1.11. Comparison 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC), Outcome 11 Prothrombin activity (percentage of normal).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

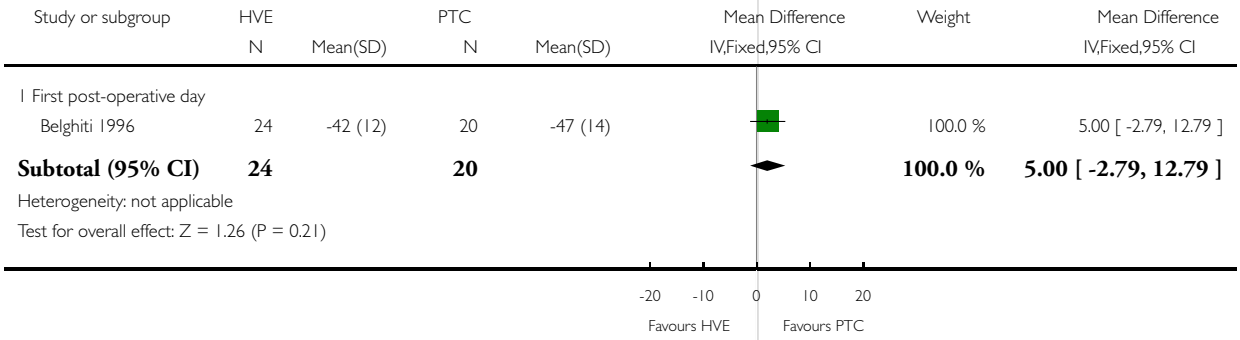
Outcome: 11 Prothrombin activity (percentage of normal)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

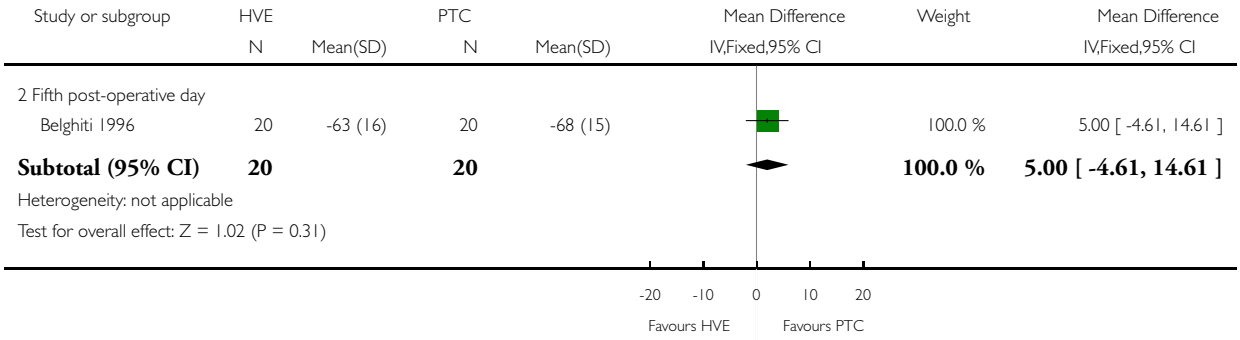
Outcome: 11 Prothrombin activity (percentage of normal)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 11 Prothrombin activity (percentage of normal)

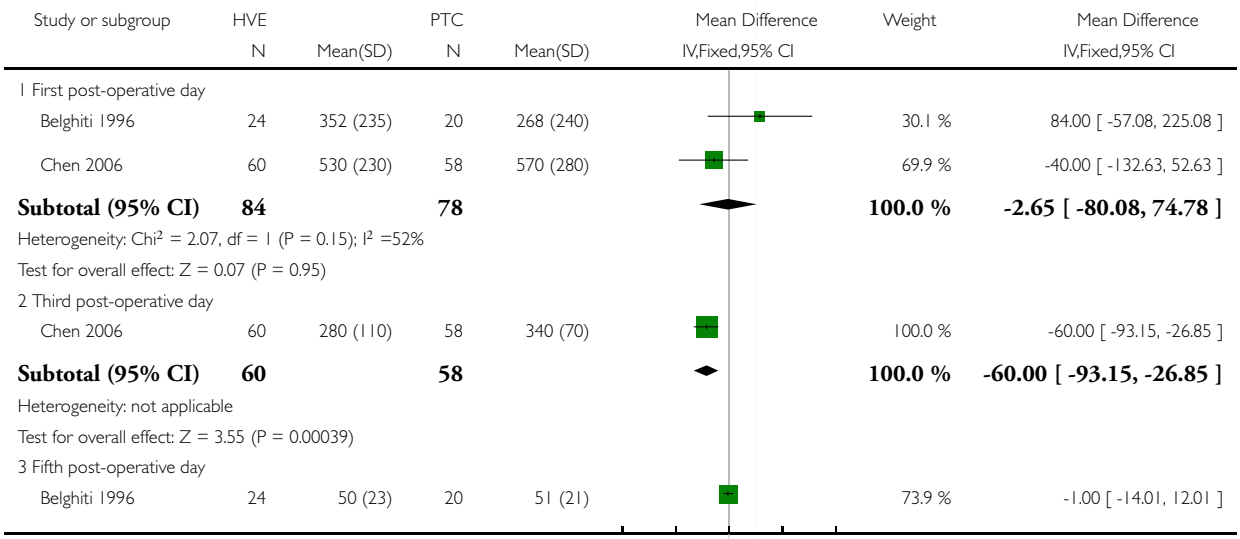


Analysis 1.12. Comparison 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC), Outcome 12 AST (aspartate transaminase) (IU/litre).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 12 AST (aspartate transaminase) (IU/litre)



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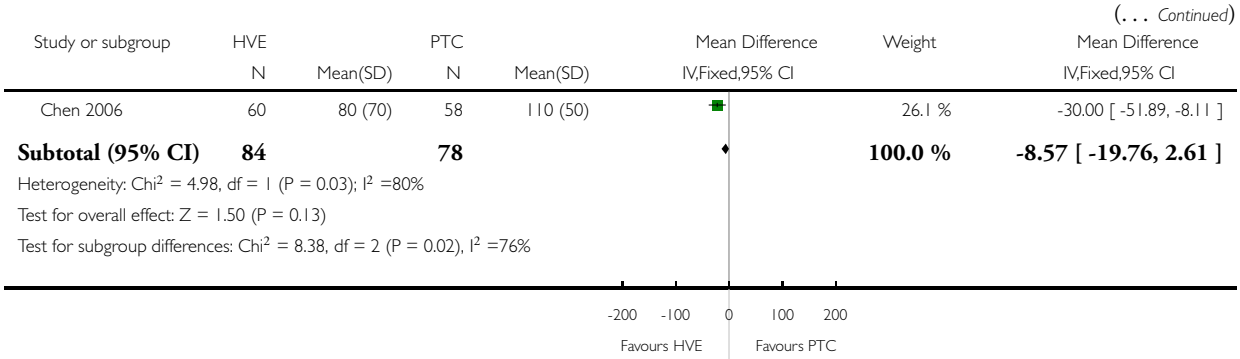
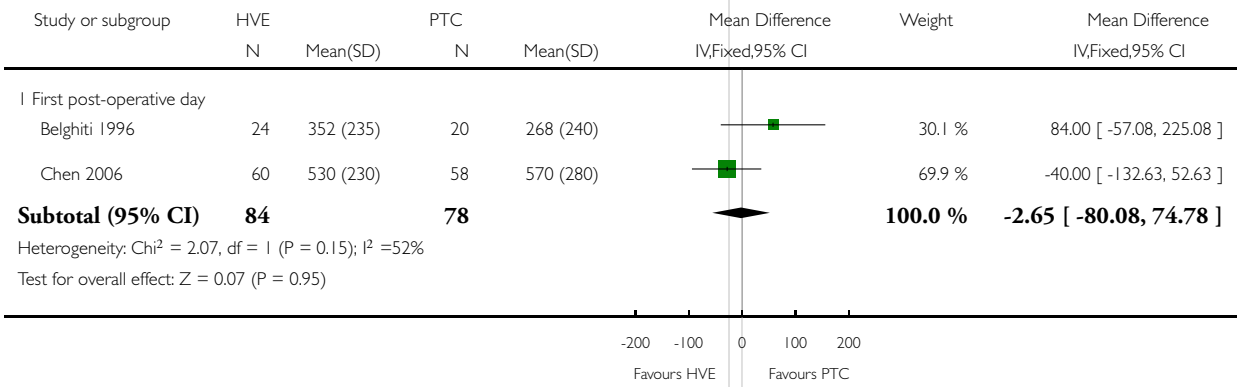


Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

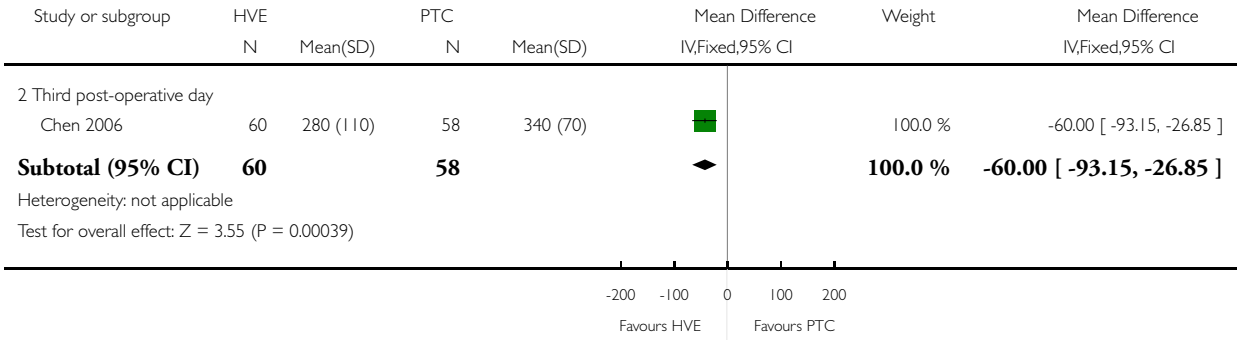
Outcome: 12 AST (aspartate transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

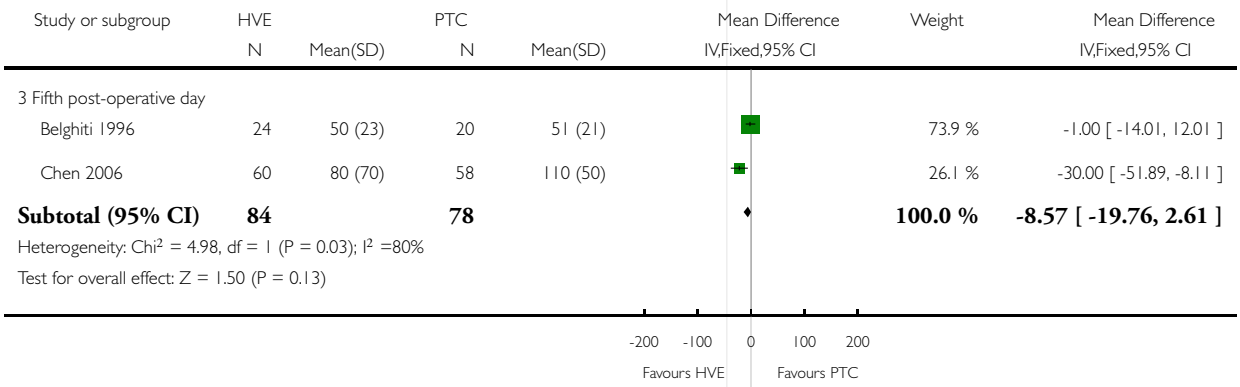
Outcome: 12 AST (aspartate transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 12 AST (aspartate transaminase) (IU/litre)

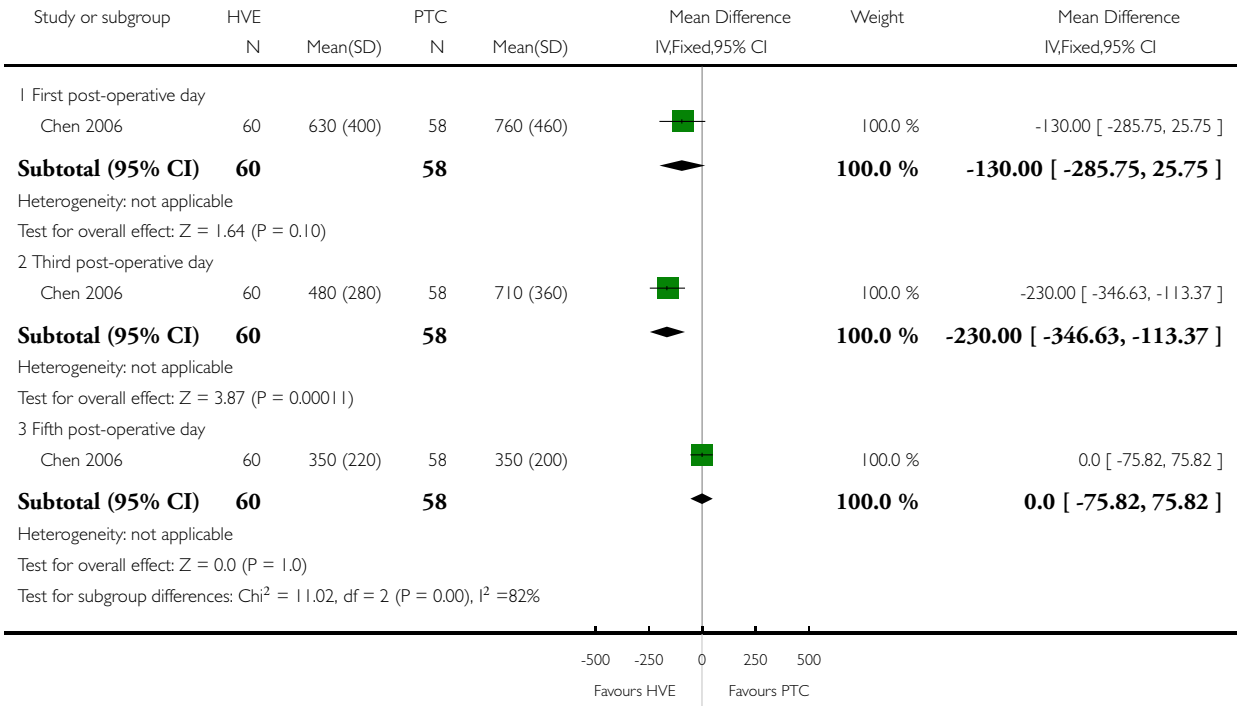


Analysis 1.13. Comparison 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC), Outcome 13 ALT (alanine transaminase) (IU/litre).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

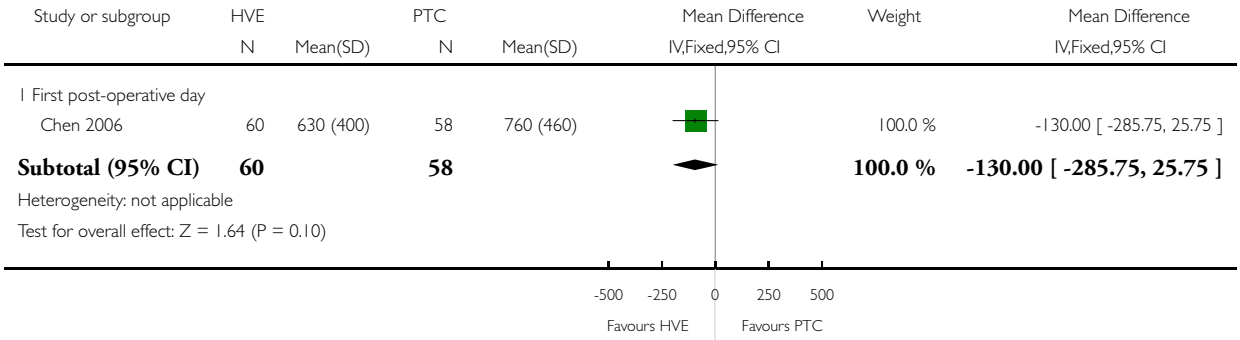
Outcome: 13 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

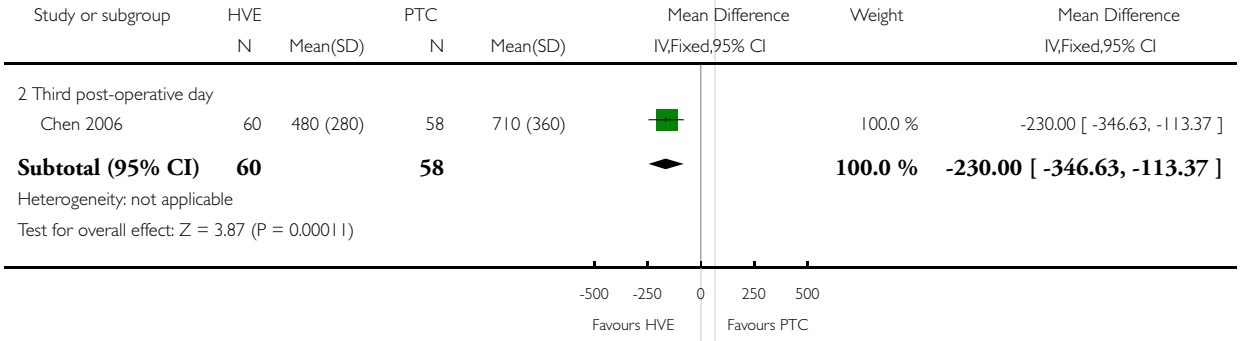
Outcome: 13 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

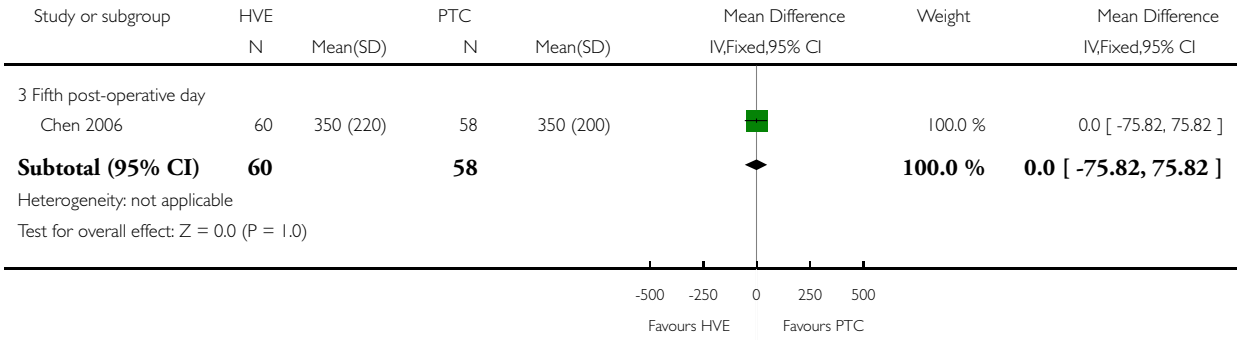
Outcome: 13 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 1 Hepatic vascular exclusion (HVE) versus portal triad clamping (PTC)

Outcome: 13 ALT (alanine transaminase) (IU/litre)

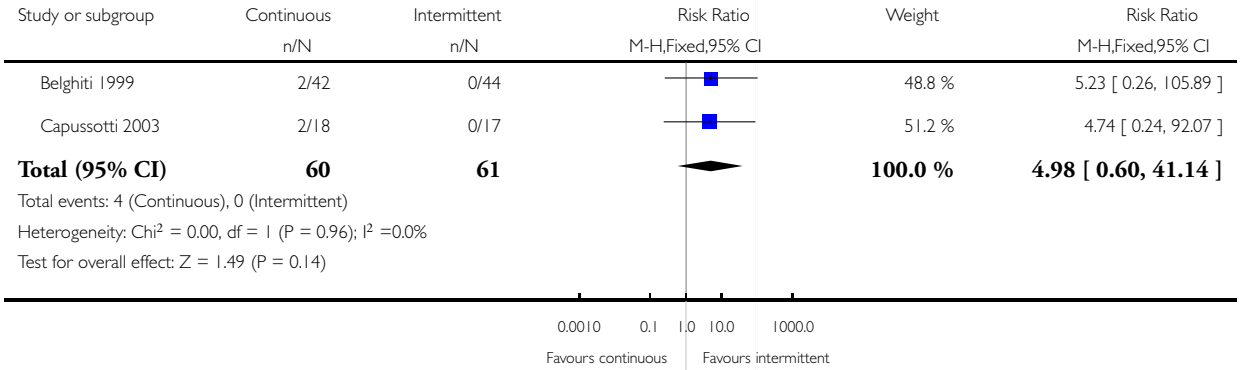


Analysis 2.1. Comparison 2 Portal triad clamping: 'continuous' versus 'intermittent', Outcome 1 Mortality.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 1 Mortality

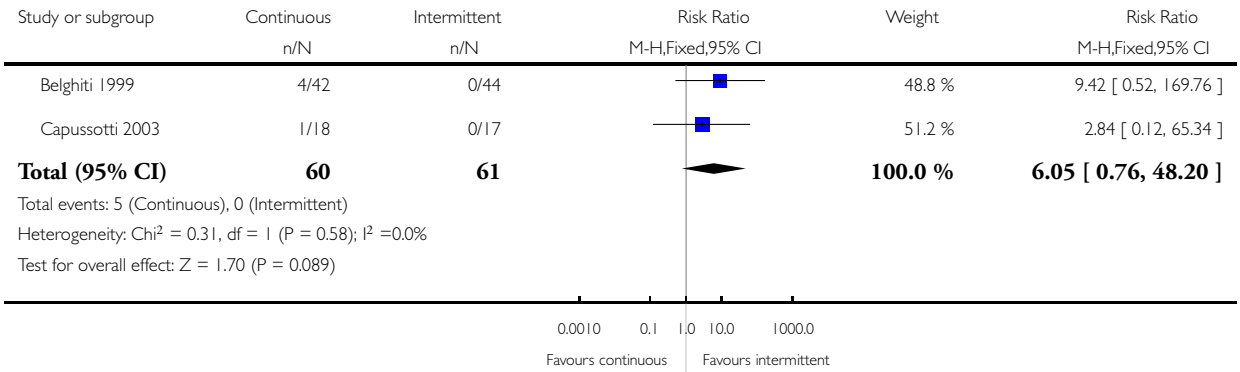


Analysis 2.2. Comparison 2 Portal triad clamping: 'continuous' versus 'intermittent', Outcome 2 Liver failure.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 2 Liver failure

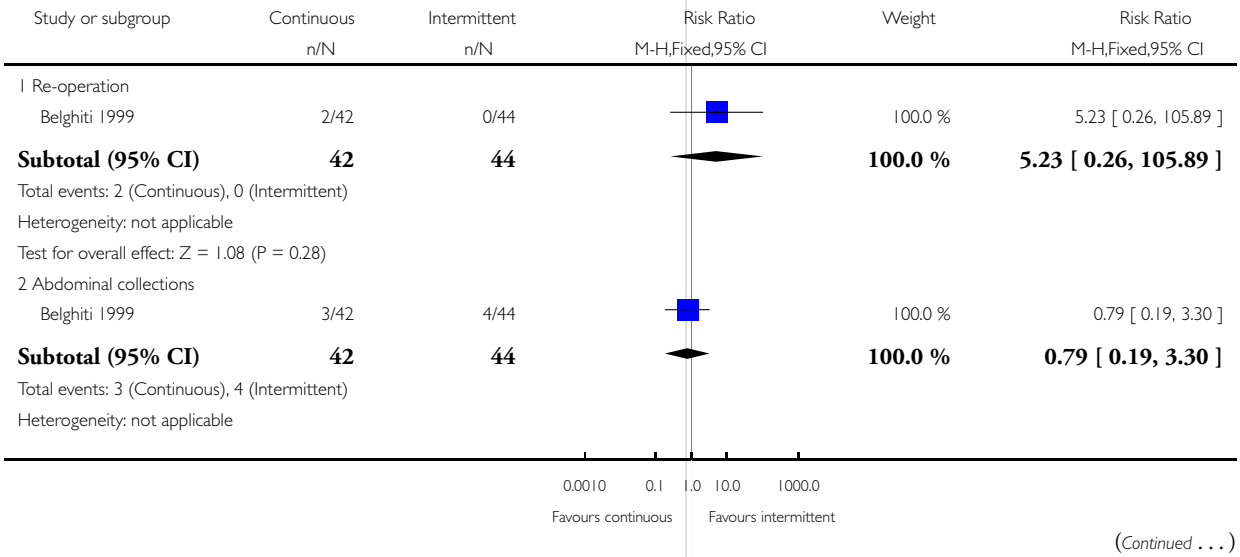


Analysis 2.3. Comparison 2 Portal triad clamping: 'continuous' versus 'intermittent', Outcome 3 Peri-operative morbidity.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 3 Peri-operative morbidity



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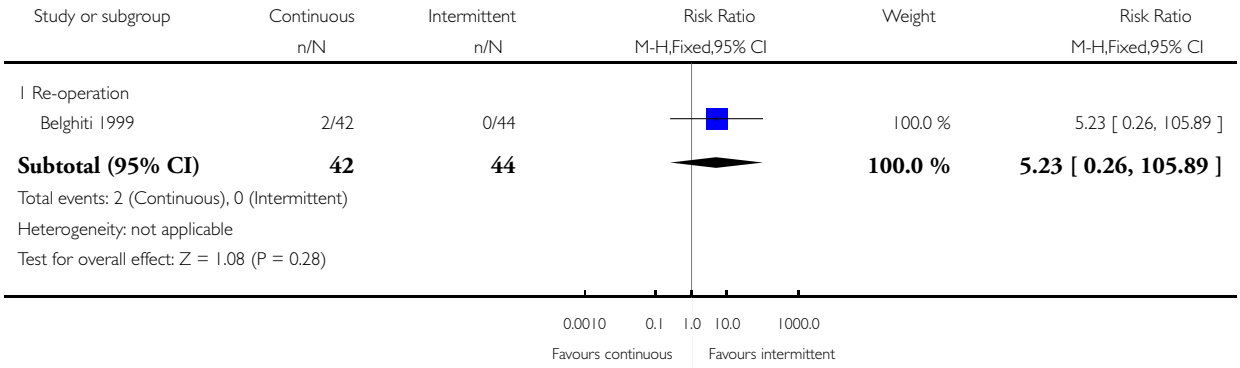
Study or subgroup	Continuous n/N	Intermittent n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Test for overall effect: Z = 0.33 (P = 0.74)					
3 Haematoma					
Belghiti 1999	1/42	1/44		100.0 %	1.05 [0.07, 16.21]
Subtotal (95% CI)	**42**	**44**		**100.0 %**	**1.05 [0.07, 16.21]**
Total events: 1 (Continuous), 1 (Intermittent)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.03 (P = 0.97)					
4 Pulmonary complications					
Belghiti 1999	5/42	5/44		100.0 %	1.05 [0.33, 3.36]
Subtotal (95% CI)	**42**	**44**		**100.0 %**	**1.05 [0.33, 3.36]**
Total events: 5 (Continuous), 5 (Intermittent)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.08 (P = 0.94)					
5 Biliary fistula					
Belghiti 1999	1/42	1/44		100.0 %	1.05 [0.07, 16.21]
Subtotal (95% CI)	**42**	**44**		**100.0 %**	**1.05 [0.07, 16.21]**
Total events: 1 (Continuous), 1 (Intermittent)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.03 (P = 0.97)					
6 Pancreatitis					
Belghiti 1999	0/42	1/44		100.0 %	0.35 [0.01, 8.33]
Subtotal (95% CI)	**42**	**44**		**100.0 %**	**0.35 [0.01, 8.33]**
Total events: 0 (Continuous), 1 (Intermittent)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.65 (P = 0.52)					

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

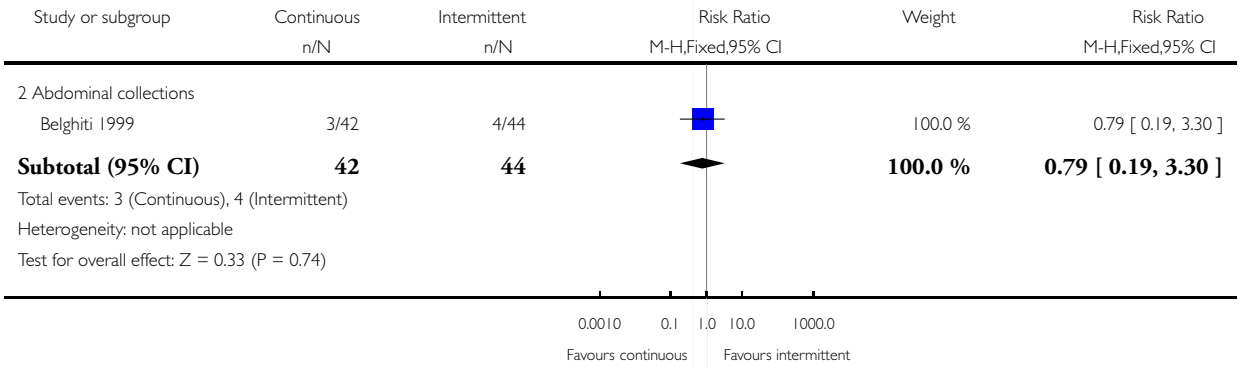
Outcome: 3 Peri-operative morbidity



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

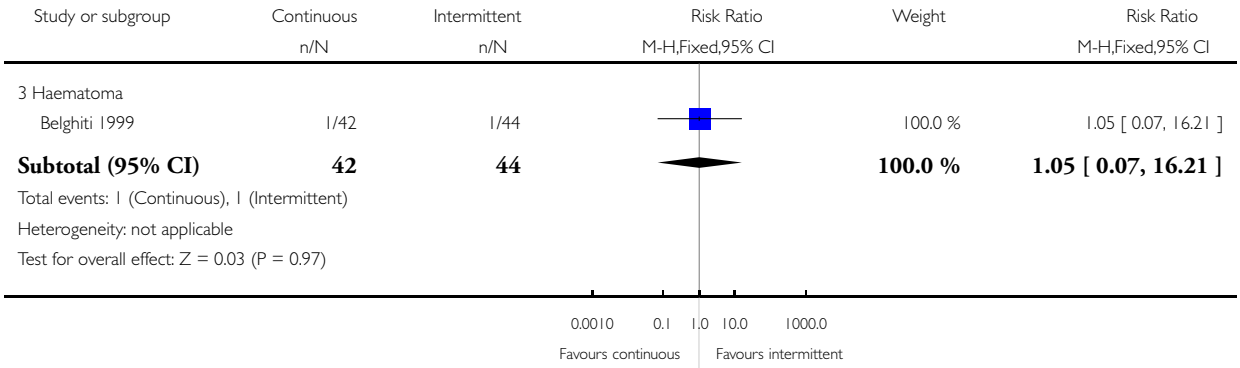
Outcome: 3 Peri-operative morbidity



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

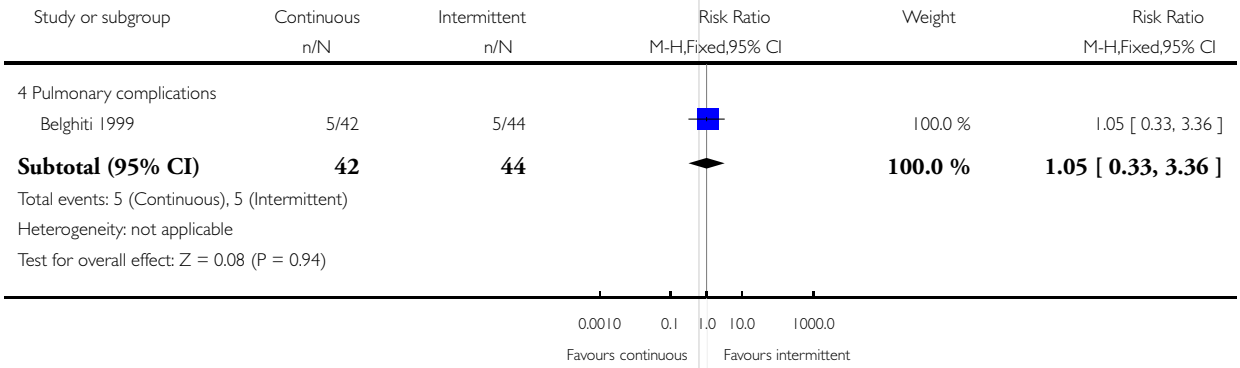
Outcome: 3 Peri-operative morbidity



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

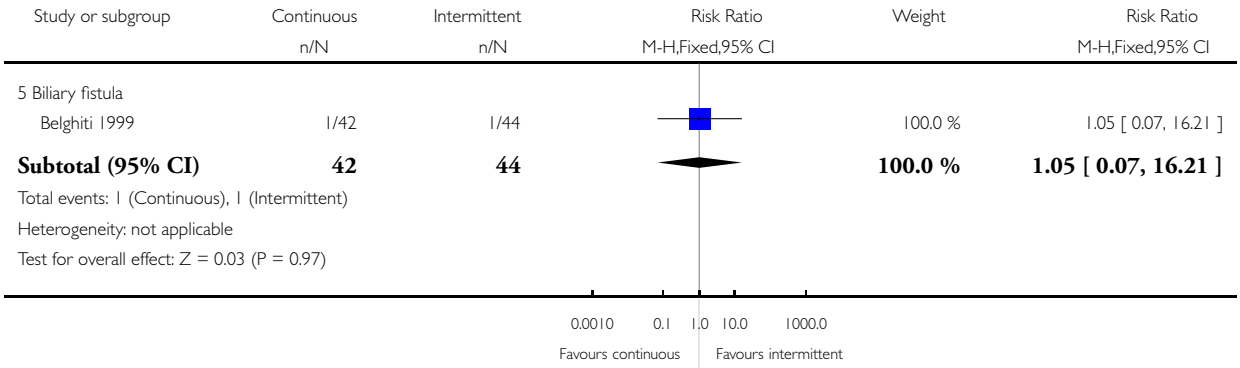
Outcome: 3 Peri-operative morbidity



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

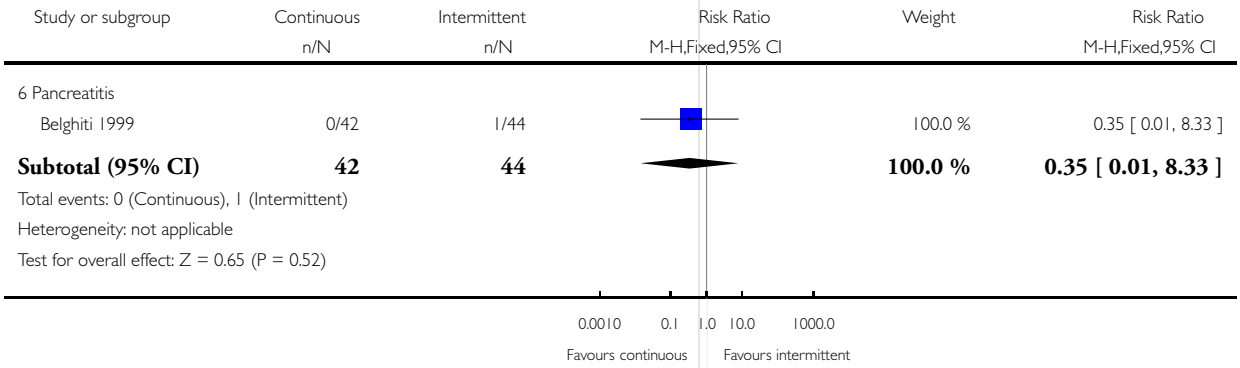
Outcome: 3 Peri-operative morbidity



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 3 Peri-operative morbidity

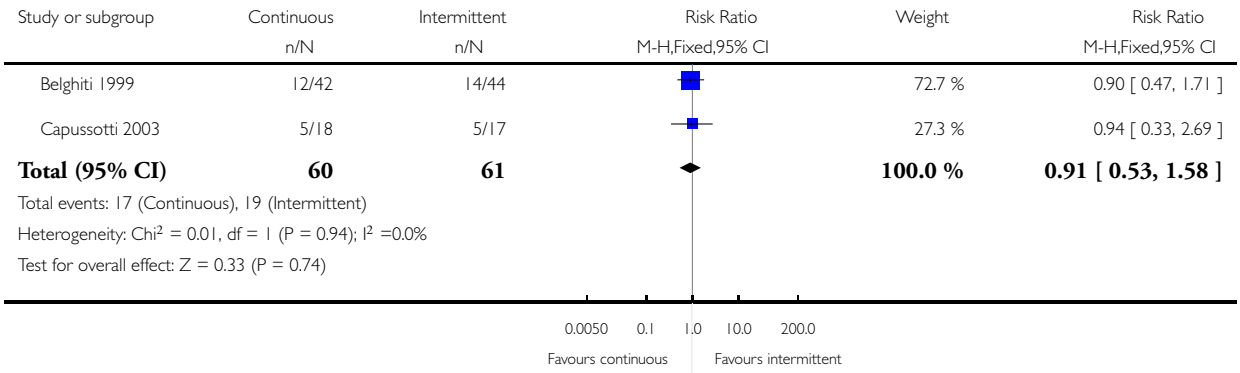


Analysis 2.4. Comparison 2 Portal triad clamping: 'continuous' versus 'intermittent', Outcome 4 Number needing transfusion.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 4 Number needing transfusion

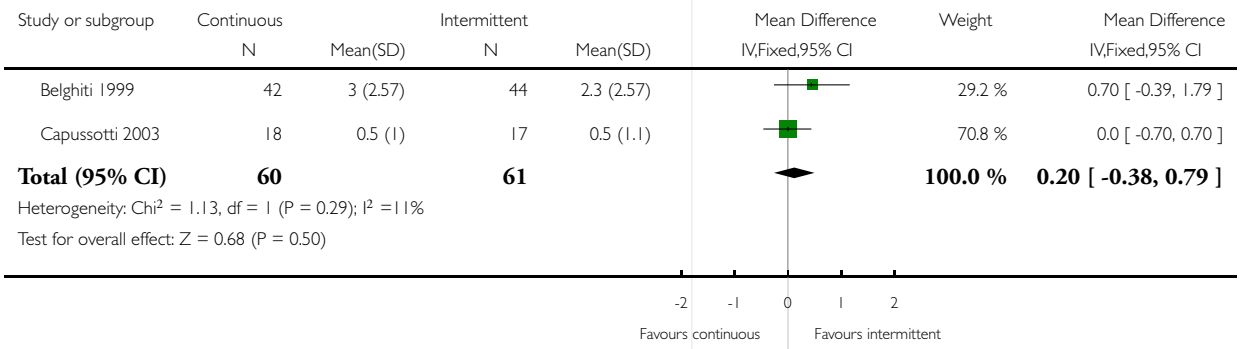


Analysis 2.5. Comparison 2 Portal triad clamping: 'continuous' versus 'intermittent', Outcome 5 Number of units transfused.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 5 Number of units transfused

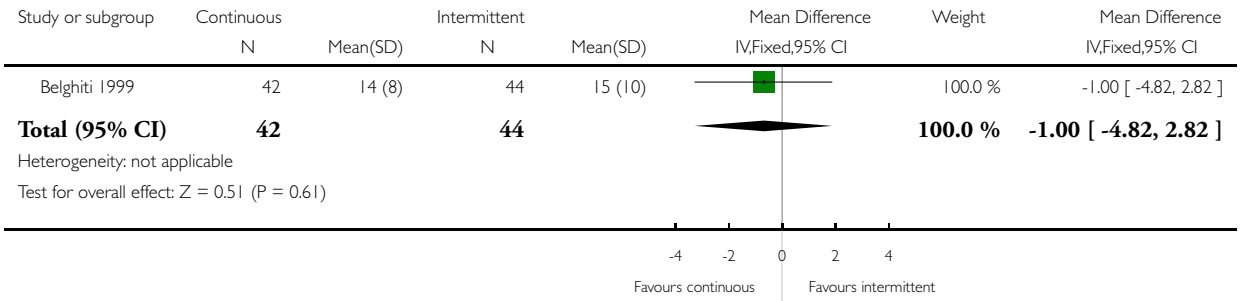


Analysis 2.6. Comparison 2 Portal triad clamping: 'continuous' versus 'intermittent', Outcome 6 Hospital stay (in days).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 6 Hospital stay (in days)

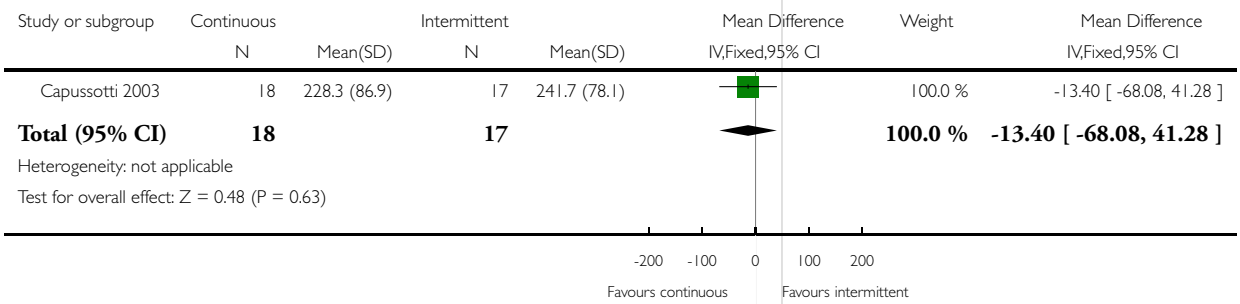


Analysis 2.7. Comparison 2 Portal triad clamping: 'continuous' versus 'intermittent', Outcome 7 Operating time (in minutes).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 7 Operating time (in minutes)

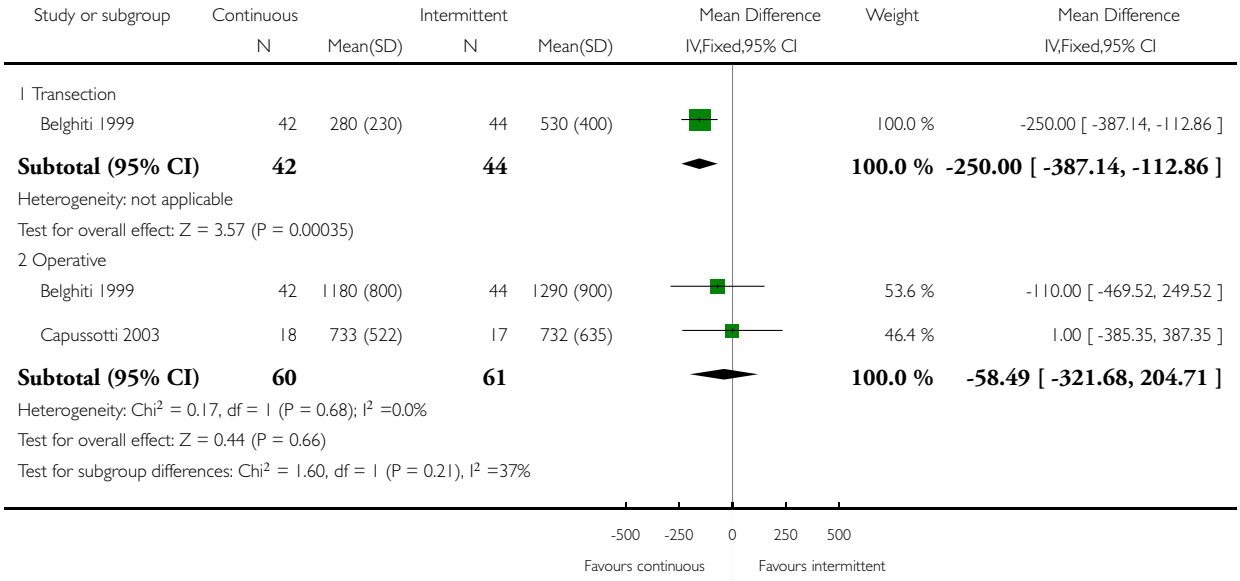


Analysis 2.8. Comparison 2 Portal triad clamping: 'continuous' versus 'intermittent', Outcome 8 Blood loss.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

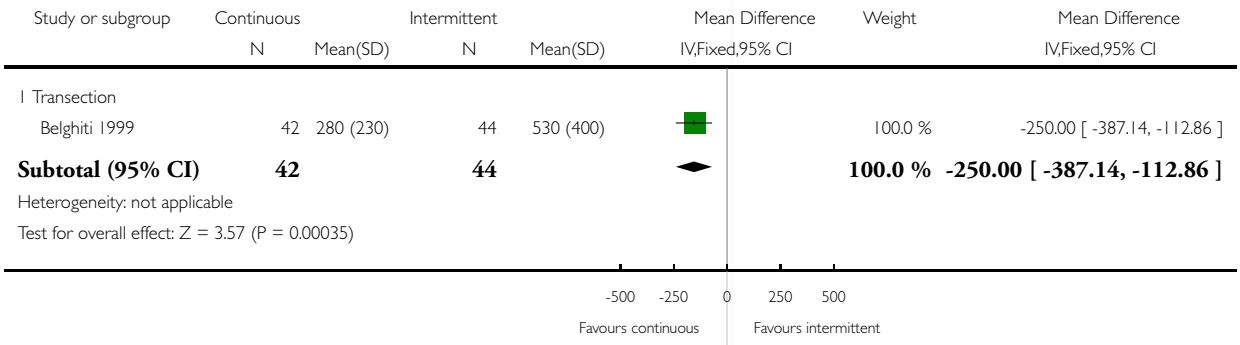
Outcome: 8 Blood loss



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

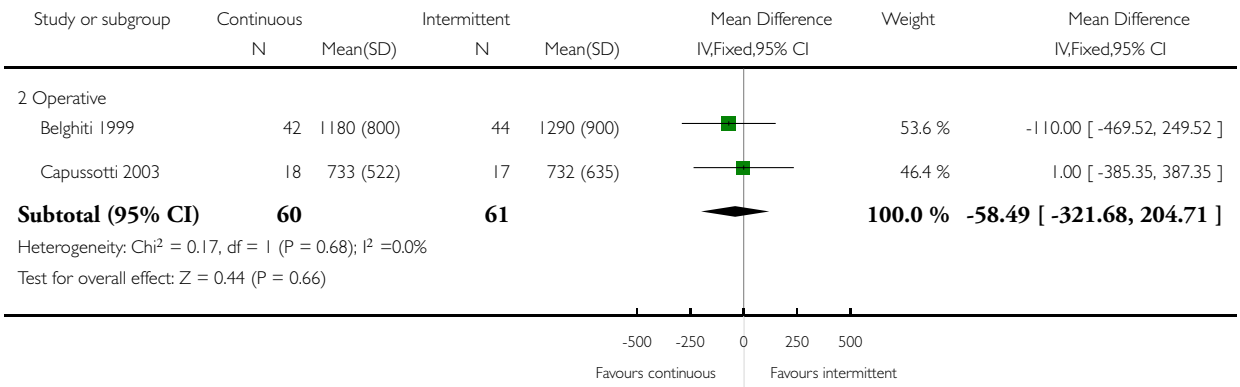
Outcome: 8 Blood loss



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 8 Blood loss

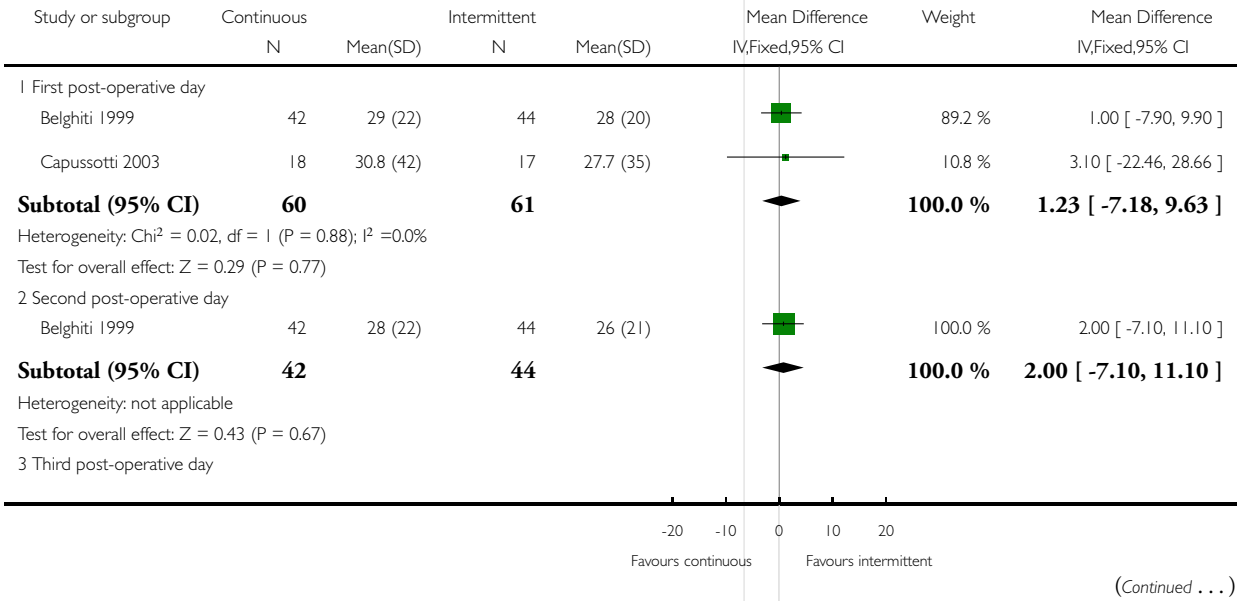


Analysis 2.9. Comparison 2 Portal triad clamping: 'continuous' versus 'intermittent', Outcome 9 Bilirubin (micromole/litre).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 9 Bilirubin (micromole/litre)



(*Continued* . . .)

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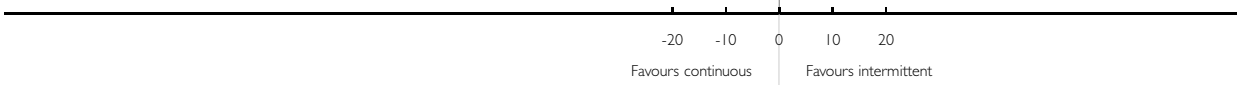
Study or subgroup	Continuous N	Mean(SD)	Intermittent N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Capussotti 2003	18	35.9 (42)	17	27.4 (35)		100.0 %	8.50 [-17.06, 34.06]
Subtotal (95% CI)	**18**		**17**			**100.0 %**	**8.50 [-17.06, 34.06]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.65 (P = 0.51)							
4 Fifth post-operative day							
Belghiti 1999	42	35 (42)	44	25 (22)		100.0 %	10.00 [-4.27, 24.27]
Subtotal (95% CI)	**42**		**44**			**100.0 %**	**10.00 [-4.27, 24.27]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.37 (P = 0.17)							
5 Seventh post-operative day							
Belghiti 1999	42	32 (38)	44	26 (35)		70.1 %	6.00 [-9.46, 21.46]
Capussotti 2003	24	37.5 (42)	17	27.4 (35)		29.9 %	10.10 [-13.55, 33.75]
Subtotal (95% CI)	**66**		**61**			**100.0 %**	**7.23 [-5.71, 20.17]**
Heterogeneity: Chi² = 0.08, df = 1 (P = 0.78); I² =0.0%							
Test for overall effect: Z = 1.09 (P = 0.27)							
Test for subgroup differences: Chi² = 1.64, df = 4 (P = 0.80), I² =0.0%							



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

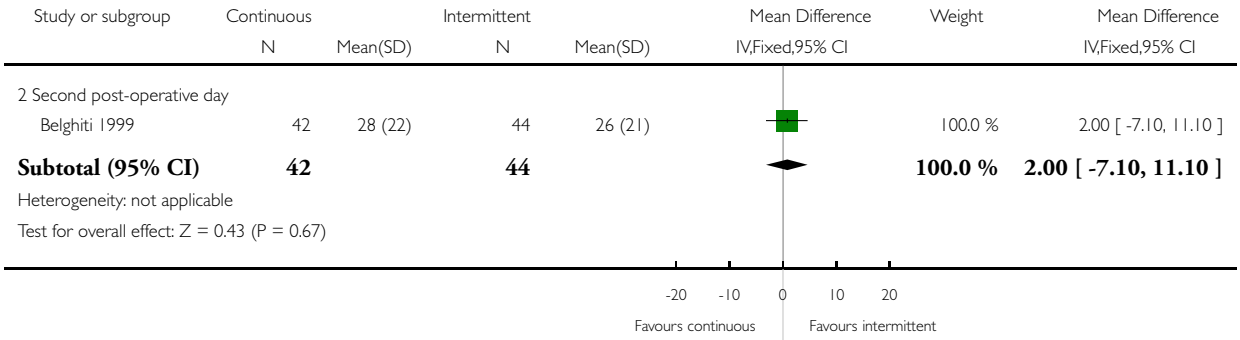
Outcome: 9 Bilirubin (micromole/litre)

Study or subgroup	Continuous N	Mean(SD)	Intermittent N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 First post-operative day							
Belghiti 1999	42	29 (22)	44	28 (20)		89.2 %	1.00 [-7.90, 9.90]
Capussotti 2003	18	30.8 (42)	17	27.7 (35)		10.8 %	3.10 [-22.46, 28.66]
Subtotal (95% CI)	**60**		**61**			**100.0 %**	**1.23 [-7.18, 9.63]**
Heterogeneity: Chi² = 0.02, df = 1 (P = 0.88); I² =0.0%							
Test for overall effect: Z = 0.29 (P = 0.77)							

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

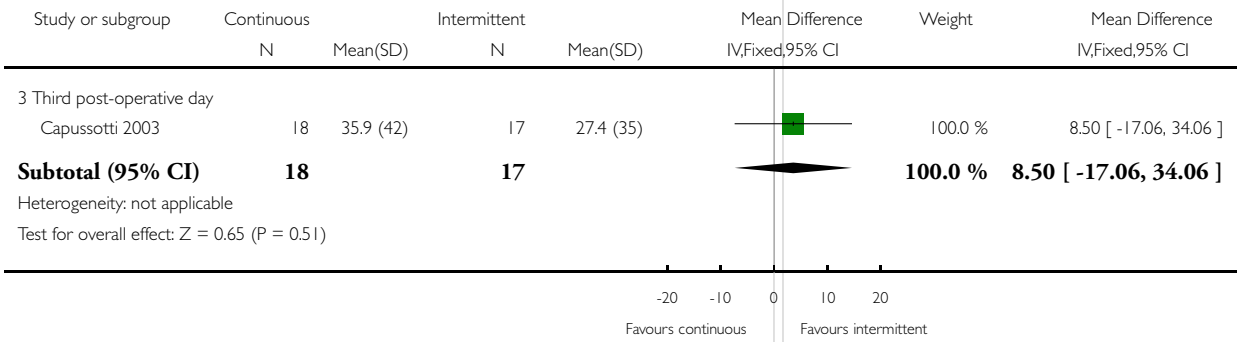
Outcome: 9 Bilirubin (micromole/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

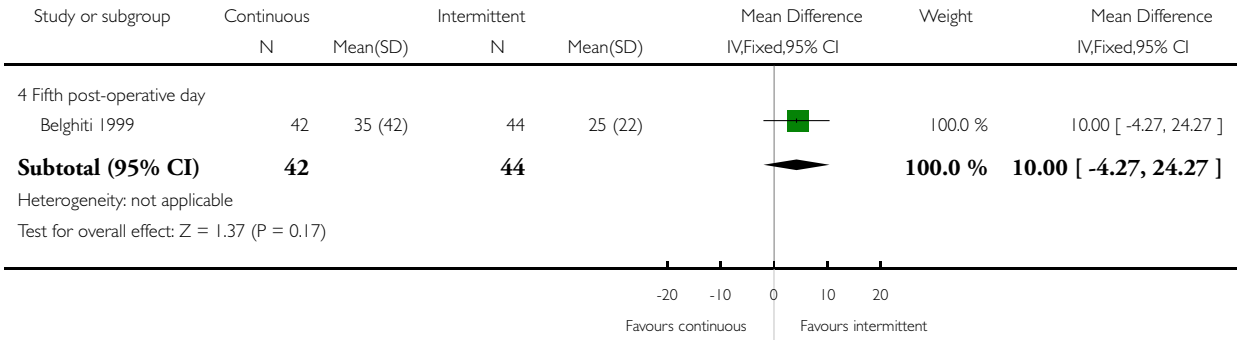
Outcome: 9 Bilirubin (micromole/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

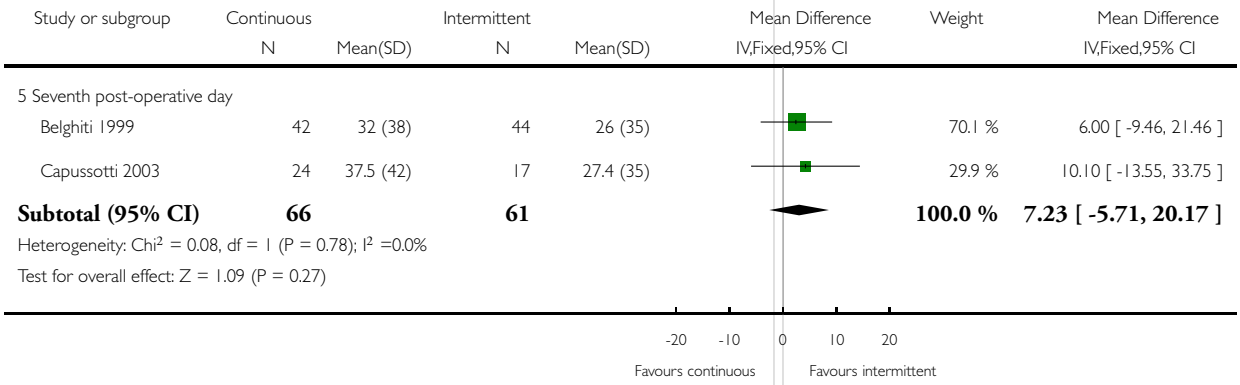
Outcome: 9 Bilirubin (micromole/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 9 Bilirubin (micromole/litre)

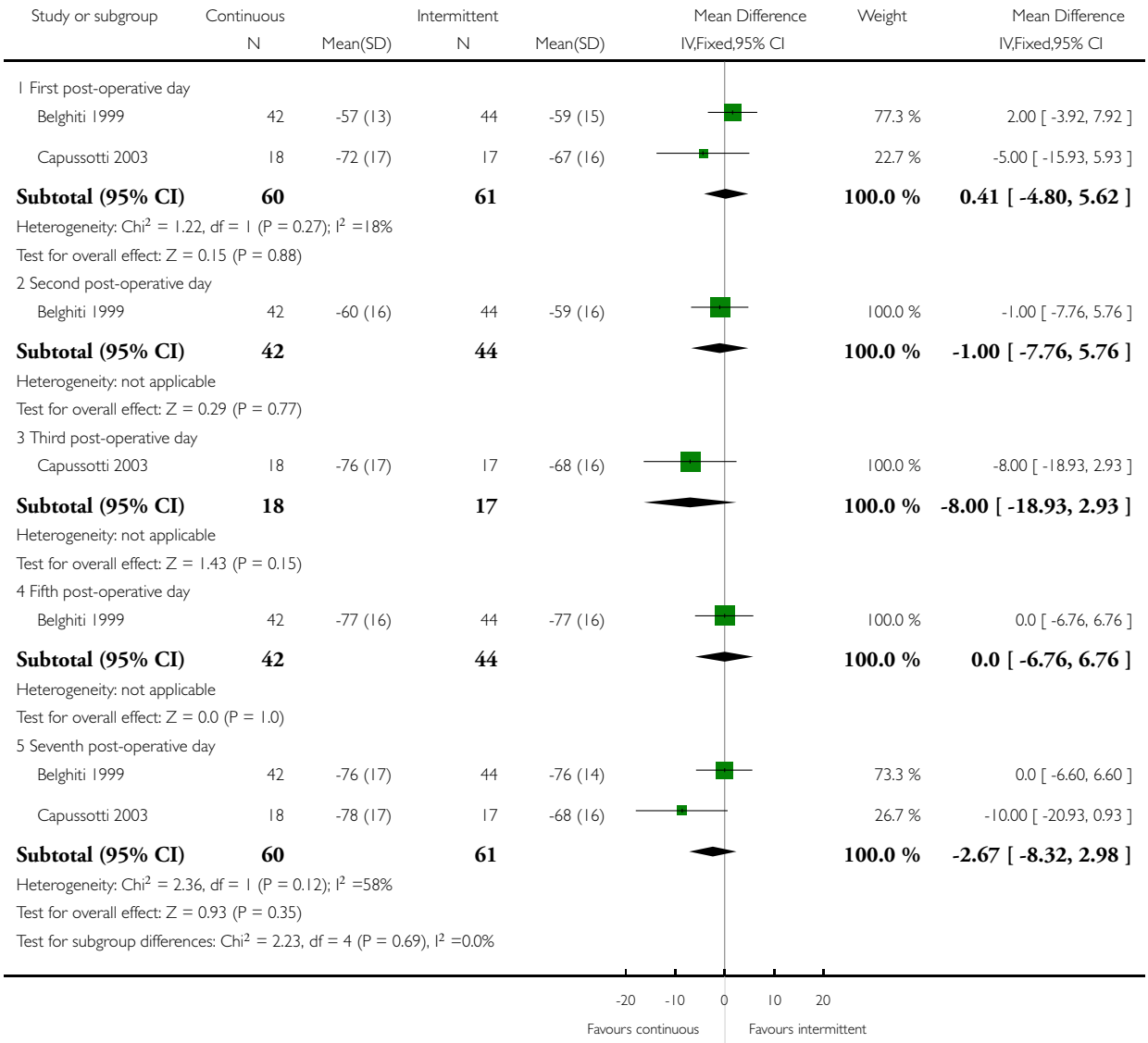


Analysis 2.10. Comparison 2 Portal triad clamping: 'continuous' versus 'intermittent', Outcome 10 Prothrombin activity (percentage of normal).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 10 Prothrombin activity (percentage of normal)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 10 Prothrombin activity (percentage of normal)

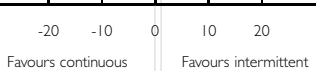
Study or subgroup	Continuous N	Mean(SD)	Intermittent N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 First post-operative day							
Belghiti 1999	42	-57 (13)	44	-59 (15)		77.3 %	2.00 [-3.92, 7.92]
Capussotti 2003	18	-72 (17)	17	-67 (16)		22.7 %	-5.00 [-15.93, 5.93]
Subtotal (95% CI)	**60**		**61**			**100.0 %**	**0.41 [-4.80, 5.62]**
Heterogeneity: Chi^2 = 1.22, df = 1 (P = 0.27); I^2 =18%							
Test for overall effect: Z = 0.15 (P = 0.88)							

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 10 Prothrombin activity (percentage of normal)

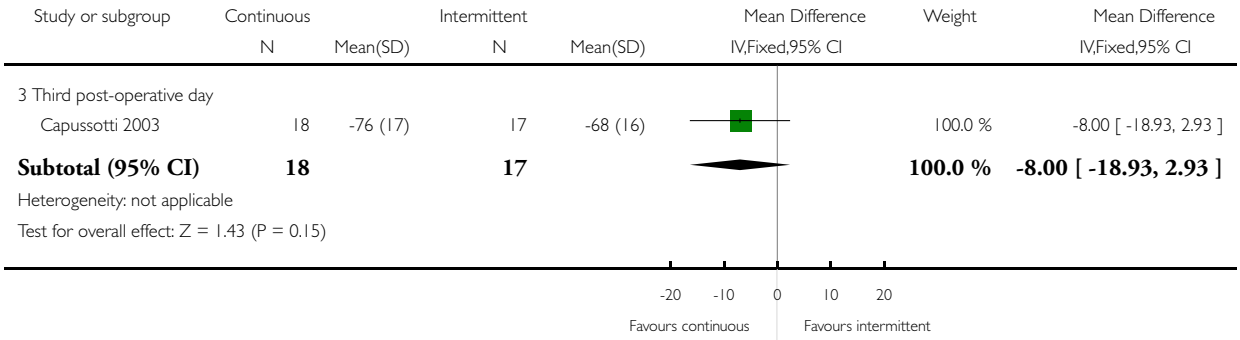
Study or subgroup	Continuous N	Mean(SD)	Intermittent N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
2 Second post-operative day							
Belghiti 1999	42	-60 (16)	44	-59 (16)		100.0 %	-1.00 [-7.76, 5.76]
Subtotal (95% CI)	**42**		**44**			**100.0 %**	**-1.00 [-7.76, 5.76]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.29 (P = 0.77)							



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

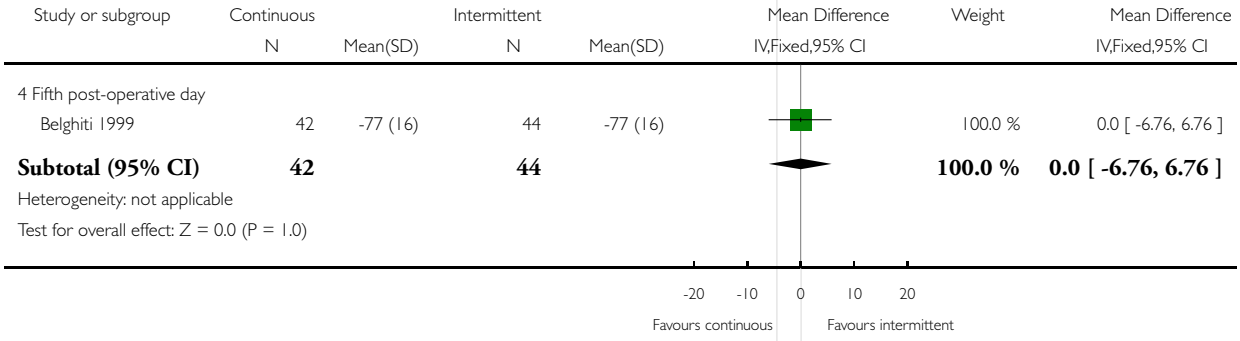
Outcome: 10 Prothrombin activity (percentage of normal)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 10 Prothrombin activity (percentage of normal)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 10 Prothrombin activity (percentage of normal)

Study or subgroup	Continuous N	Mean(SD)	Intermittent N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
5 Seventh post-operative day							
Belghiti 1999	42	-76 (17)	44	-76 (14)		73.3 %	0.0 [-6.60, 6.60]
Capussotti 2003	18	-78 (17)	17	-68 (16)		26.7 %	-10.00 [-20.93, 0.93]
Subtotal (95% CI)	**60**		**61**			**100.0 %**	**-2.67 [-8.32, 2.98]**

Heterogeneity: Chi² = 2.36, df = 1 (P = 0.12); I² =58%

Test for overall effect: Z = 0.93 (P = 0.35)

Analysis 2.11. Comparison 2 Portal triad clamping: 'continuous' versus 'intermittent', Outcome 11 AST (aspartate transaminase) (IU/litre).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 11 AST (aspartate transaminase) (IU/litre)

Study or subgroup	Continuous N	Mean(SD)	Intermittent N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 First post-operative day							
Belghiti 1999	42	294 (221)	44	264 (191)		86.4 %	30.00 [-57.48, 117.48]
Capussotti 2003	18	240 (436)	17	340 (191)		13.6 %	-100.00 [-320.94, 120.94]
Subtotal (95% CI)	**60**		**61**			**100.0 %**	**12.38 [-68.95, 93.72]**

Heterogeneity: Chi² = 1.15, df = 1 (P = 0.28); I² =13%

Test for overall effect: Z = 0.30 (P = 0.77)

2 Second post-operative day							
Belghiti 1999	42	301 (436)	44	167 (133)		100.0 %	134.00 [-3.59, 271.59]
Subtotal (95% CI)	**42**		**44**			**100.0 %**	**134.00 [-3.59, 271.59]**

Heterogeneity: not applicable

Test for overall effect: Z = 1.91 (P = 0.056)

(*Continued* . . .)

(. . . *Continued*)

Study or subgroup	Continuous N	Mean(SD)	Intermittent N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
3 Third post-operative day							
Capussotti 2003	18	110 (436)	17	150 (191)		100.0 %	-40.00 [-260.94, 180.94]
Subtotal (95% CI)	**18**		**17**			**100.0 %**	**-40.00 [-260.94, 180.94]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.35 (P = 0.72)							
4 Fifth post-operative day							
Belghiti 1999	42	70 (59)	44	62 (35)		100.0 %	8.00 [-12.62, 28.62]
Subtotal (95% CI)	**42**		**44**			**100.0 %**	**8.00 [-12.62, 28.62]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.76 (P = 0.45)							
5 Seventh post-operative day							
Belghiti 1999	42	47 (23)	44	44 (24)		99.8 %	3.00 [-6.93, 12.93]
Capussotti 2003	18	80 (436)	17	70 (191)		0.2 %	10.00 [-210.94, 230.94]
Subtotal (95% CI)	**60**		**61**			**100.0 %**	**3.01 [-6.91, 12.94]**
Heterogeneity: Chi^2 = 0.00, df = 1 (P = 0.95); I^2 =0.0%							
Test for overall effect: Z = 0.60 (P = 0.55)							
Test for subgroup differences: Chi^2 = 3.79, df = 4 (P = 0.43), I^2 =0.0%							

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

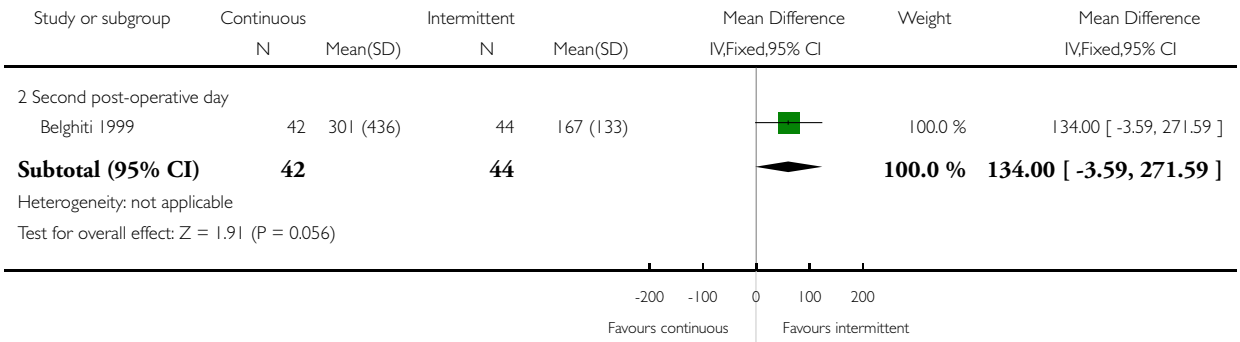
Outcome: 11 AST (aspartate transaminase) (IU/litre)

Study or subgroup	Continuous N	Mean(SD)	Intermittent N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 First post-operative day							
Belghiti 1999	42	294 (221)	44	264 (191)		86.4 %	30.00 [-57.48, 117.48]
Capussotti 2003	18	240 (436)	17	340 (191)		13.6 %	-100.00 [-320.94, 120.94]
Subtotal (95% CI)	**60**		**61**			**100.0 %**	**12.38 [-68.95, 93.72]**
Heterogeneity: Chi^2 = 1.15, df = 1 (P = 0.28); I^2 =13%							
Test for overall effect: Z = 0.30 (P = 0.77)							

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

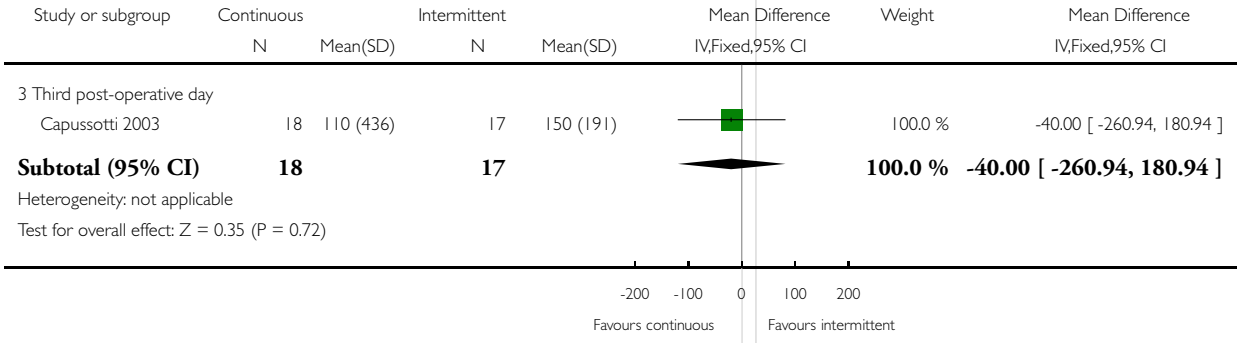
Outcome: 11 AST (aspartate transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 11 AST (aspartate transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 11 AST (aspartate transaminase) (IU/litre)

Study or subgroup	Continuous N	Mean(SD)	Intermittent N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
4 Fifth post-operative day							
Belghiti 1999	42	70 (59)	44	62 (35)		100.0 %	8.00 [-12.62, 28.62]
Subtotal (95% CI)	**42**		**44**			**100.0 %**	**8.00 [-12.62, 28.62]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.76 (P = 0.45)

Review: Methods of vascular occlusion for elective liver resections

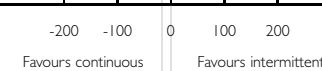
Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 11 AST (aspartate transaminase) (IU/litre)

Study or subgroup	Continuous N	Mean(SD)	Intermittent N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
5 Seventh post-operative day							
Belghiti 1999	42	47 (23)	44	44 (24)		99.8 %	3.00 [-6.93, 12.93]
Capussotti 2003	18	80 (436)	17	70 (191)		0.2 %	10.00 [-210.94, 230.94]
Subtotal (95% CI)	**60**		**61**			**100.0 %**	**3.01 [-6.91, 12.94]**

Heterogeneity: Chi^2 = 0.00, df = 1 (P = 0.95); I^2 =0.0%

Test for overall effect: Z = 0.60 (P = 0.55)

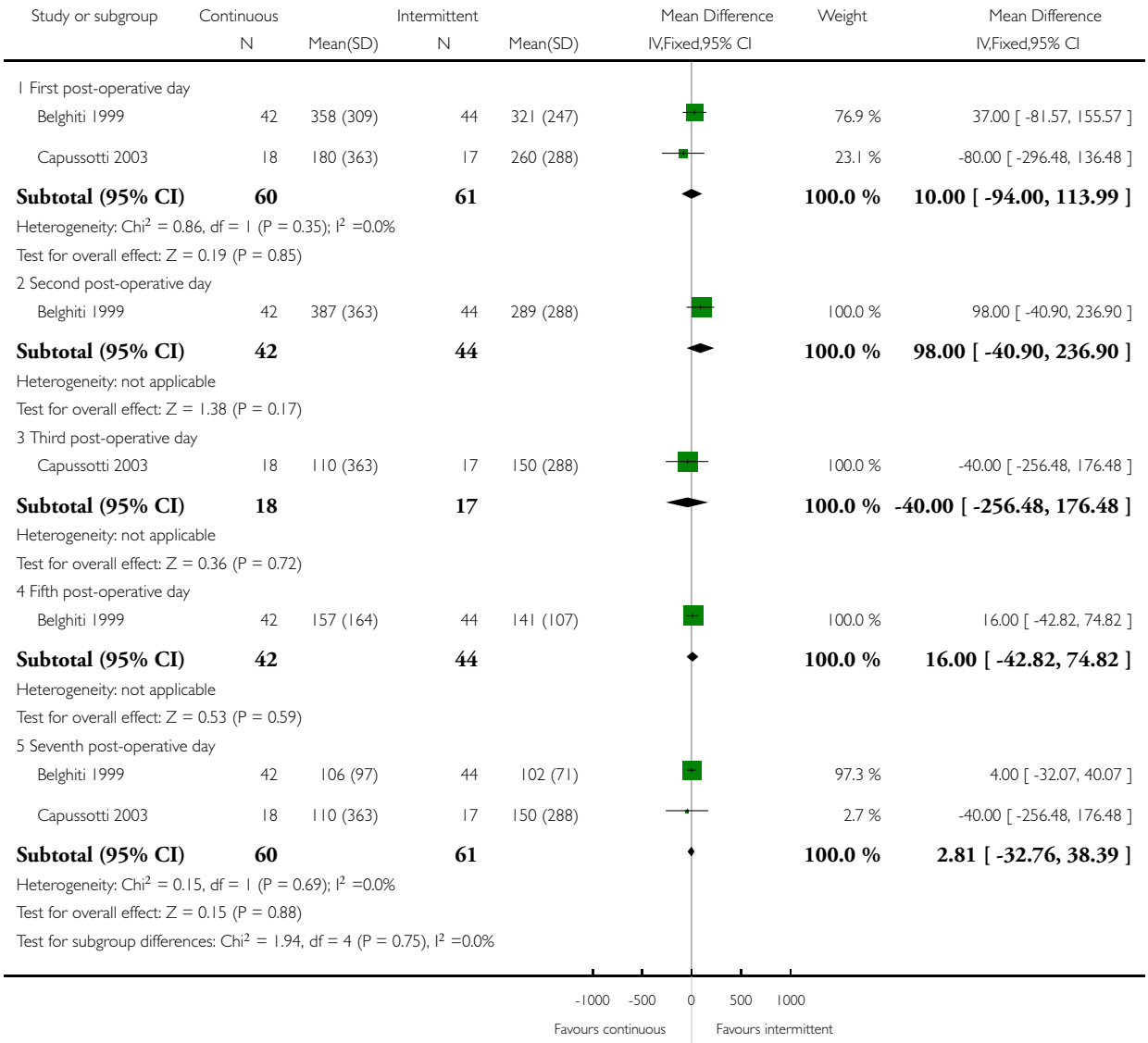


Analysis 2.12. Comparison 2 Portal triad clamping: 'continuous' versus 'intermittent', Outcome 12 ALT (alanine transaminase) (IU/litre).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

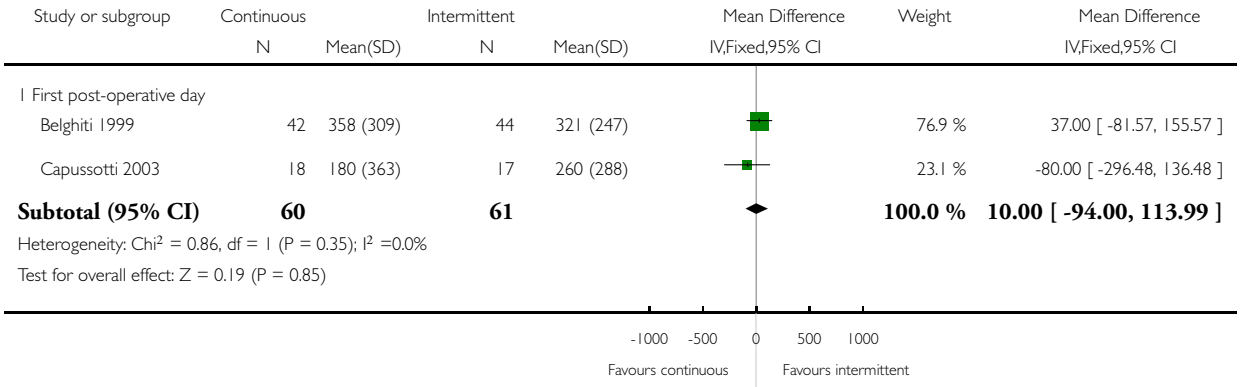
Outcome: 12 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

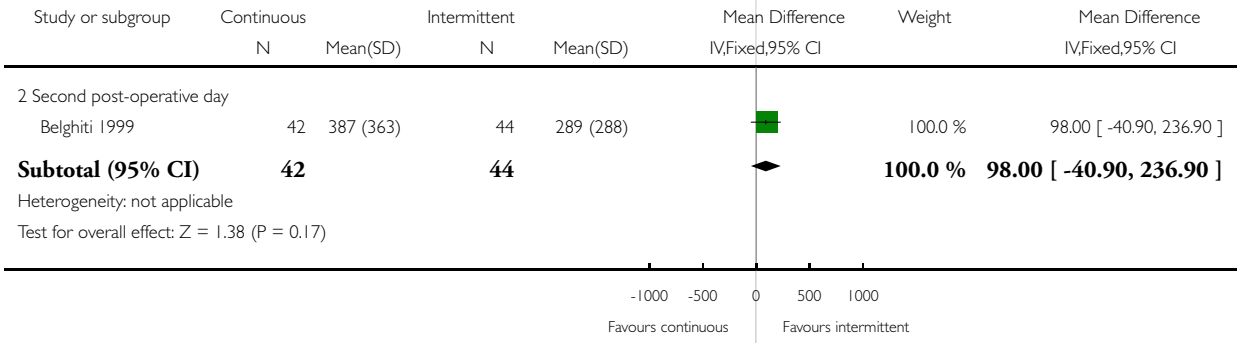
Outcome: 12 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

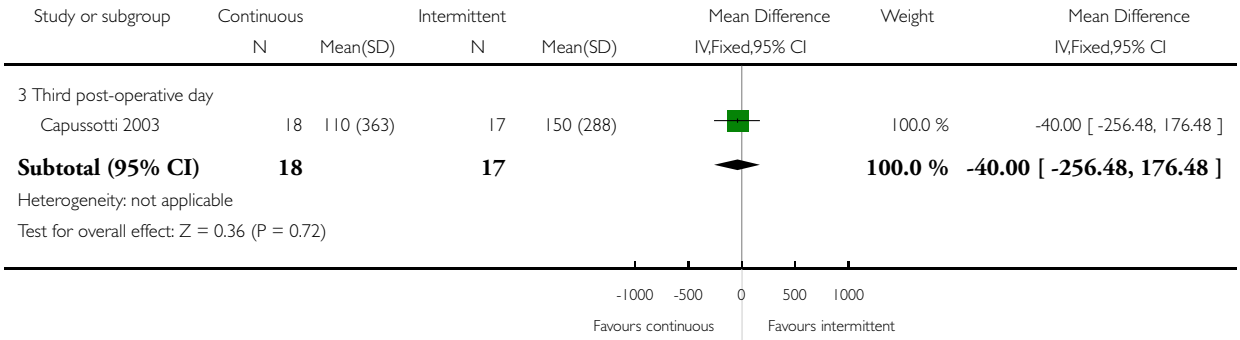
Outcome: 12 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

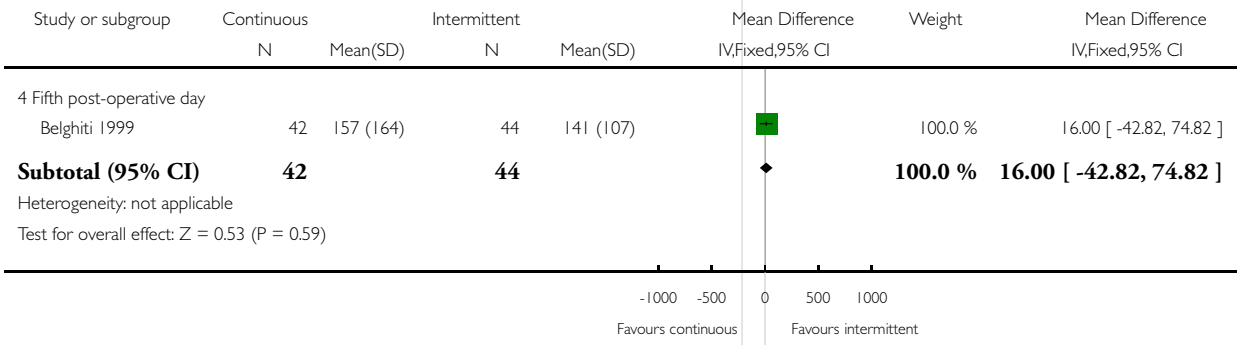
Outcome: 12 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

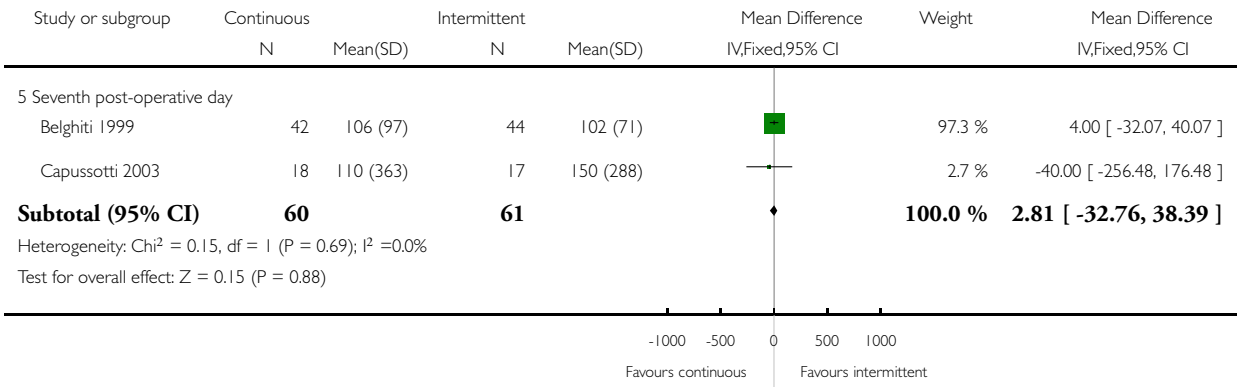
Outcome: 12 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 2 Portal triad clamping: 'continuous' versus 'intermittent'

Outcome: 12 ALT (alanine transaminase) (IU/litre)

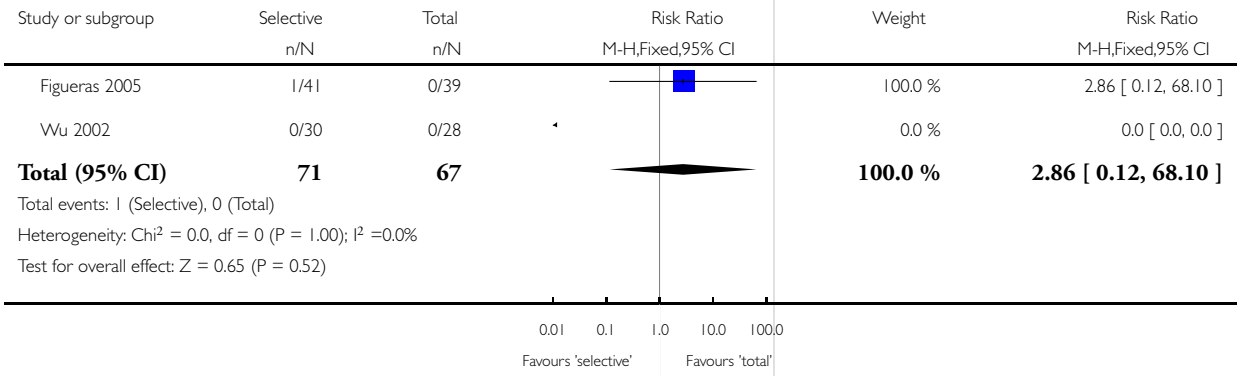


Analysis 3.1. Comparison 3 Inflow occlusion: 'selective' versus 'total', Outcome 1 Mortality.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 1 Mortality



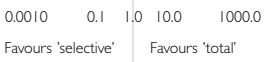
Analysis 3.2. Comparison 3 Inflow occlusion: 'selective' versus 'total', Outcome 2 Liver failure.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 2 Liver failure

Study or subgroup	Selective n/N	Total n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Figueras 2005	4/41	0/39		100.0 %	8.57 [0.48, 154.15]
Total (95% CI)	**41**	**39**		**100.0 %**	**8.57 [0.48, 154.15]**
Total events: 4 (Selective), 0 (Total)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.46 (P = 0.15)					



Analysis 3.3. Comparison 3 Inflow occlusion: 'selective' versus 'total', Outcome 3 Peri-operative morbidity.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 3 Peri-operative morbidity

Study or subgroup	Selective n/N	Total n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 Re-operation					
Figueras 2005	0/41	0/39		0.0 %	0.0 [0.0, 0.0]
Subtotal (95% CI)	**41**	**39**		**0.0 %**	**0.0 [0.0, 0.0]**
Total events: 0 (Selective), 0 (Total)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.0 (P < 0.00001)					
2 Abdominal collections					
Figueras 2005	1/41	0/39		14.2 %	2.86 [0.12, 68.10]
Wu 2002	5/30	3/28		85.8 %	1.56 [0.41, 5.91]
Subtotal (95% CI)	**71**	**67**		**100.0 %**	**1.74 [0.51, 5.94]**
Total events: 6 (Selective), 3 (Total)					
Heterogeneity: Chi^2 = 0.12, df = 1 (P = 0.73); I^2 =0.0%					
Test for overall effect: Z = 0.88 (P = 0.38)					
3 Wound infection					

(*Continued . . .*)

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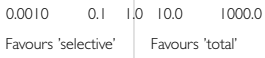
Study or subgroup	Selective n/N	Total n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Wu 2002	2/30	0/28		100.0 %	4.68 [0.23, 93.37]
Subtotal (95% CI)	**30**	**28**		**100.0 %**	**4.68 [0.23, 93.37]**
Total events: 2 (Selective), 0 (Total)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.01 (P = 0.31)					
4 Pulmonary complications					
Figueras 2005	1/41	3/39		74.8 %	0.32 [0.03, 2.92]
Wu 2002	2/30	1/28		25.2 %	1.87 [0.18, 19.47]
Subtotal (95% CI)	**71**	**67**		**100.0 %**	**0.71 [0.16, 3.07]**
Total events: 3 (Selective), 4 (Total)					
Heterogeneity: Chi^2 = 1.16, df = 1 (P = 0.28); I^2 =14%					
Test for overall effect: Z = 0.46 (P = 0.64)					
5 Cardiac failure					
Figueras 2005	2/41	0/39		100.0 %	4.76 [0.24, 96.16]
Subtotal (95% CI)	**41**	**39**		**100.0 %**	**4.76 [0.24, 96.16]**
Total events: 2 (Selective), 0 (Total)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.02 (P = 0.31)					
6 Portal vein thrombosis					
Figueras 2005	2/41	0/39		100.0 %	4.76 [0.24, 96.16]
Subtotal (95% CI)	**41**	**39**		**100.0 %**	**4.76 [0.24, 96.16]**
Total events: 2 (Selective), 0 (Total)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.02 (P = 0.31)					
7 Bile leak					
Figueras 2005	0/41	1/39		27.1 %	0.32 [0.01, 7.57]
Wu 2002	5/30	4/28		72.9 %	1.17 [0.35, 3.91]
Subtotal (95% CI)	**71**	**67**		**100.0 %**	**0.94 [0.31, 2.83]**
Total events: 5 (Selective), 5 (Total)					
Heterogeneity: Chi^2 = 0.57, df = 1 (P = 0.45); I^2 =0.0%					
Test for overall effect: Z = 0.12 (P = 0.91)					
8 Ascites					
Figueras 2005	4/41	3/39		74.8 %	1.27 [0.30, 5.31]
Wu 2002	2/30	1/28		25.2 %	1.87 [0.18, 19.47]
Subtotal (95% CI)	**71**	**67**		**100.0 %**	**1.42 [0.42, 4.80]**
Total events: 6 (Selective), 4 (Total)					
Heterogeneity: Chi^2 = 0.08, df = 1 (P = 0.78); I^2 =0.0%					
Test for overall effect: Z = 0.56 (P = 0.57)					

Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 3 Peri-operative morbidity

Study or subgroup	Selective n/N	Total n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 Re-operation					
Figueras 2005	0/41	0/39		0.0 %	0.0 [0.0, 0.0]
Subtotal (95% CI)	**41**	**39**		**0.0 %**	**0.0 [0.0, 0.0]**
Total events: 0 (Selective), 0 (Total)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.0 (P < 0.00001)					

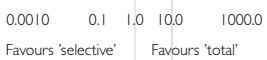


Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 3 Peri-operative morbidity

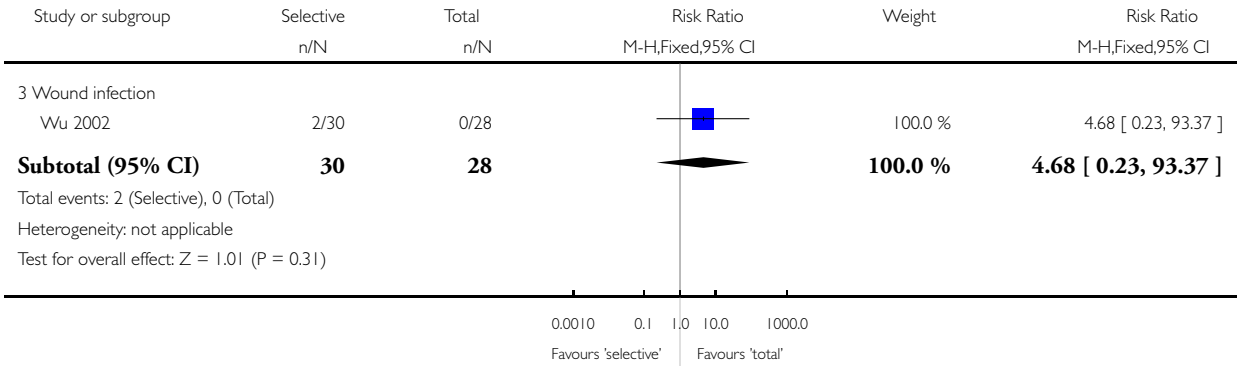
Study or subgroup	Selective n/N	Total n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
2 Abdominal collections					
Figueras 2005	1/41	0/39		14.2 %	2.86 [0.12, 68.10]
Wu 2002	5/30	3/28		85.8 %	1.56 [0.41, 5.91]
Subtotal (95% CI)	**71**	**67**		**100.0 %**	**1.74 [0.51, 5.94]**
Total events: 6 (Selective), 3 (Total)					
Heterogeneity: Chi^2 = 0.12, df = 1 (P = 0.73); I^2 =0.0%					
Test for overall effect: Z = 0.88 (P = 0.38)					



Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

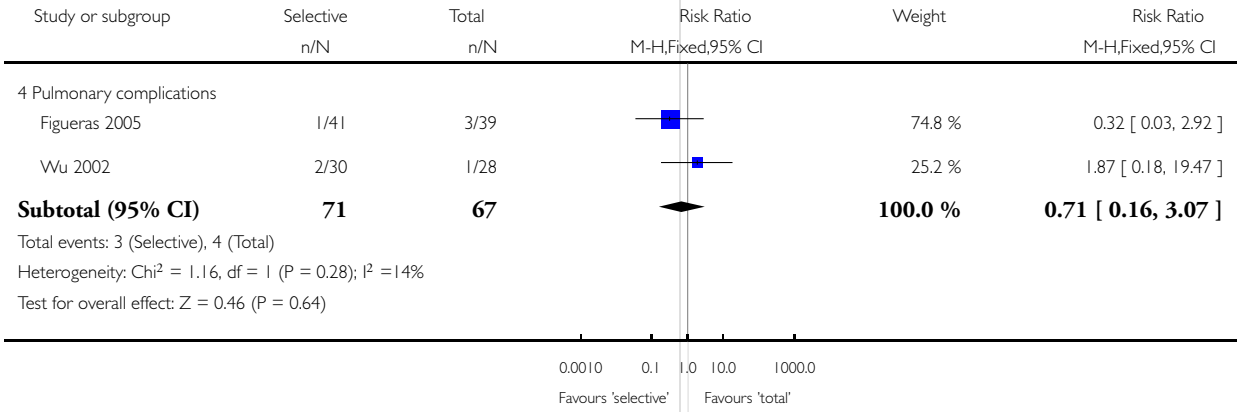
Outcome: 3 Peri-operative morbidity



Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 3 Peri-operative morbidity

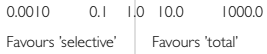


Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 3 Peri-operative morbidity

Study or subgroup	Selective n/N	Total n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
5 Cardiac failure					
Figueras 2005	2/41	0/39		100.0 %	4.76 [0.24, 96.16]
Subtotal (95% CI)	**41**	**39**		**100.0 %**	**4.76 [0.24, 96.16]**
Total events: 2 (Selective), 0 (Total)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.02 (P = 0.31)					

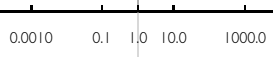


Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 3 Peri-operative morbidity

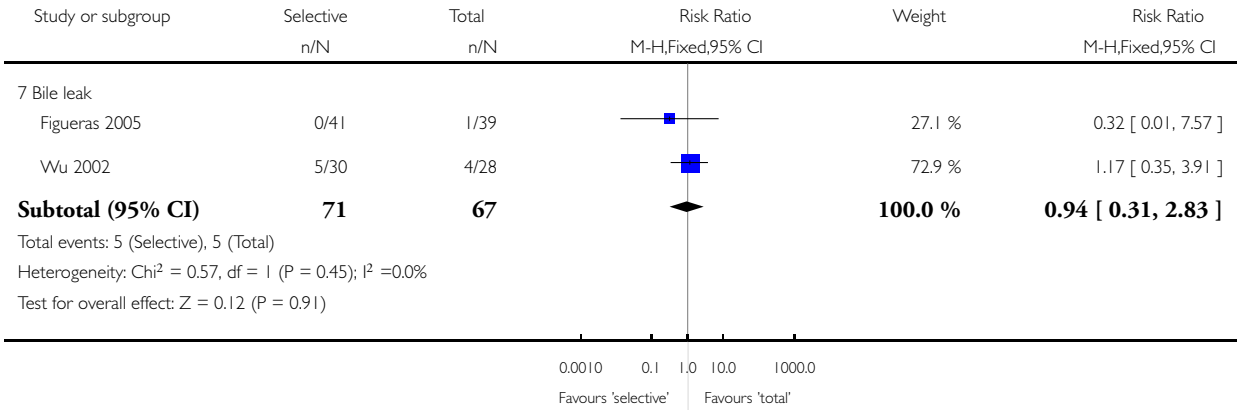
Study or subgroup	Selective n/N	Total n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
6 Portal vein thrombosis					
Figueras 2005	2/41	0/39		100.0 %	4.76 [0.24, 96.16]
Subtotal (95% CI)	**41**	**39**		**100.0 %**	**4.76 [0.24, 96.16]**
Total events: 2 (Selective), 0 (Total)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.02 (P = 0.31)					



Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

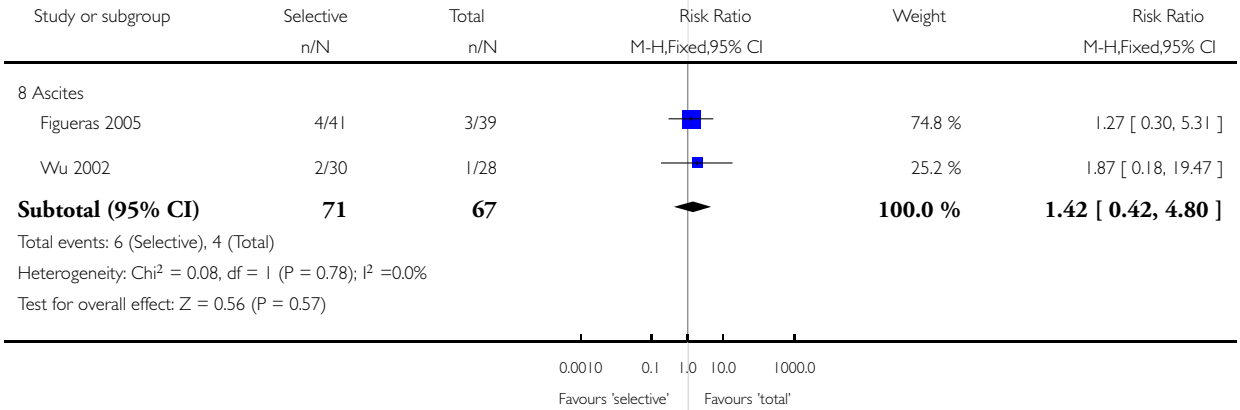
Outcome: 3 Peri-operative morbidity



Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 3 Peri-operative morbidity



Analysis 3.4. Comparison 3 Inflow occlusion: 'selective' versus 'total', Outcome 4 Number needing transfusion.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 4 Number needing transfusion

Study or subgroup	Selective n/N	Total n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
Figueras 2005	6/41	4/39		45.5 %	1.43 [0.44, 4.67]
Wu 2002	5/30	12/28		54.5 %	0.39 [0.16, 0.96]
Total (95% CI)	**71**	**67**		**100.0 %**	**0.70 [0.20, 2.50]**

Total events: 11 (Selective), 16 (Total)

Heterogeneity: $Tau^2 = 0.56$; $Chi^2 = 2.91$, df = 1 (P = 0.09); $I^2 = 66\%$

Test for overall effect: Z = 0.54 (P = 0.59)

Analysis 3.5. Comparison 3 Inflow occlusion: 'selective' versus 'total', Outcome 5 Number of units transfused.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 5 Number of units transfused

Study or subgroup	Selective N	Mean(SD)	Total N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Figueras 2005	41	0.34 (0.9)	39	0.36 (1)		100.0 %	-0.02 [-0.44, 0.40]
Total (95% CI)	**41**		**39**			**100.0 %**	**-0.02 [-0.44, 0.40]**

Heterogeneity: not applicable

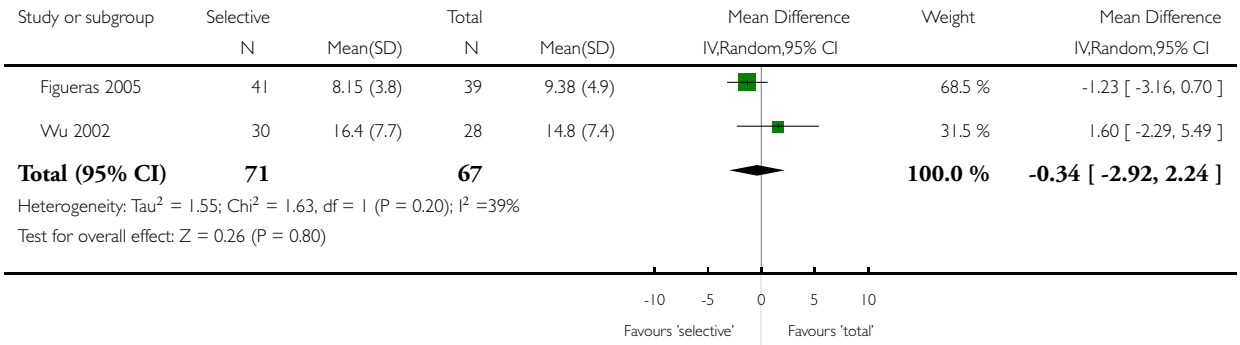
Test for overall effect: Z = 0.09 (P = 0.93)

Analysis 3.6. Comparison 3 Inflow occlusion: 'selective' versus 'total', Outcome 6 Hospital stay (in days).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 6 Hospital stay (in days)

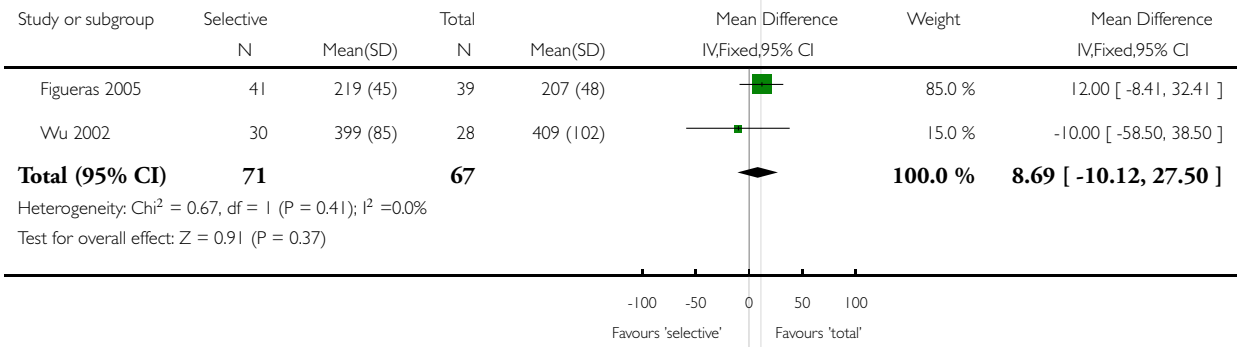


Analysis 3.7. Comparison 3 Inflow occlusion: 'selective' versus 'total', Outcome 7 Operating time (min).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 7 Operating time (min)



Analysis 3.8. Comparison 3 Inflow occlusion: 'selective' versus 'total', Outcome 8 Hemodynamics change (10 min after release of clamping).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 8 Hemodynamics change (10 min after release of clamping)

Study or subgroup	Selective N	Mean(SD)	Total N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 Mean Arterial Pressure mmHg							
Figueras 2005	41	87.5 (16)	39	90.2 (12)		100.0 %	-2.70 [-8.88, 3.48]
Subtotal (95% CI)	**41**		**39**			**100.0 %**	**-2.70 [-8.88, 3.48]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.86 (P = 0.39)

Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 8 Hemodynamics change (10 min after release of clamping)

Study or subgroup	Selective N	Mean(SD)	Total N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 Mean Arterial Pressure mmHg							
Figueras 2005	41	87.5 (16)	39	90.2 (12)		100.0 %	-2.70 [-8.88, 3.48]
Subtotal (95% CI)	**41**		**39**			**100.0 %**	**-2.70 [-8.88, 3.48]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.86 (P = 0.39)

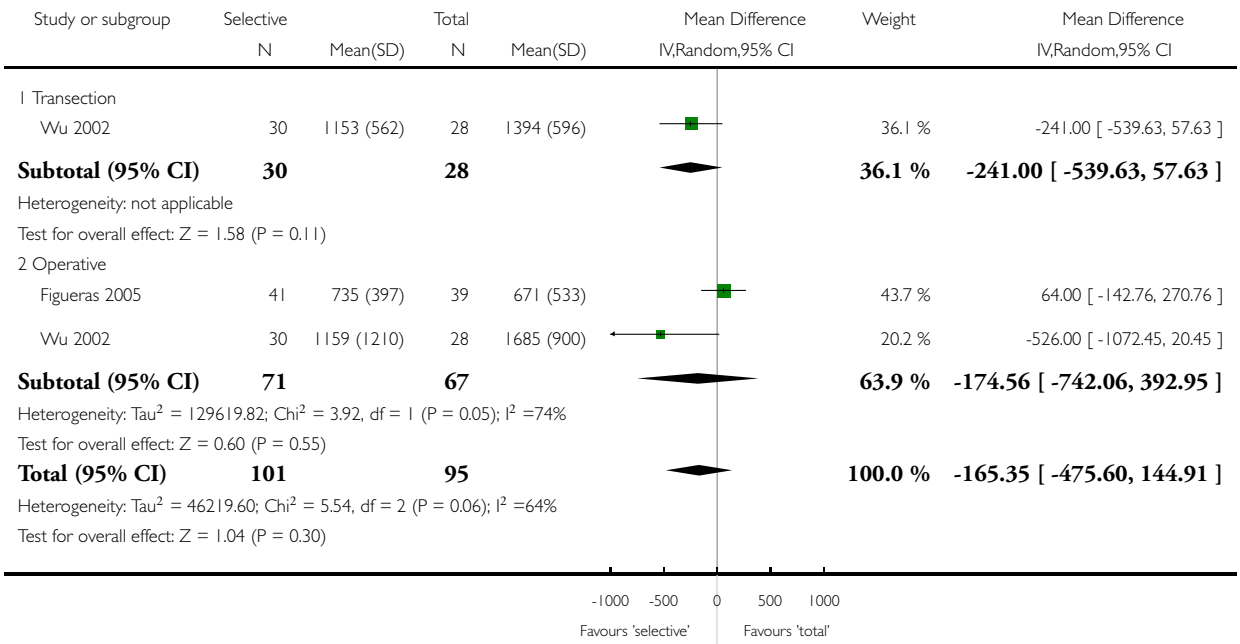
-10
-5
0
5
10
Favours 'selective'
Favours 'total'

Analysis 3.9. Comparison 3 Inflow occlusion: 'selective' versus 'total', Outcome 9 Blood loss (ml).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

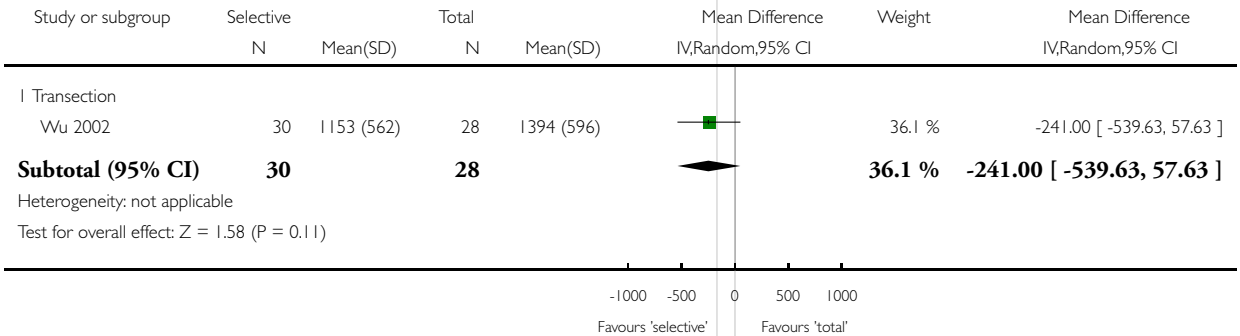
Outcome: 9 Blood loss (ml)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

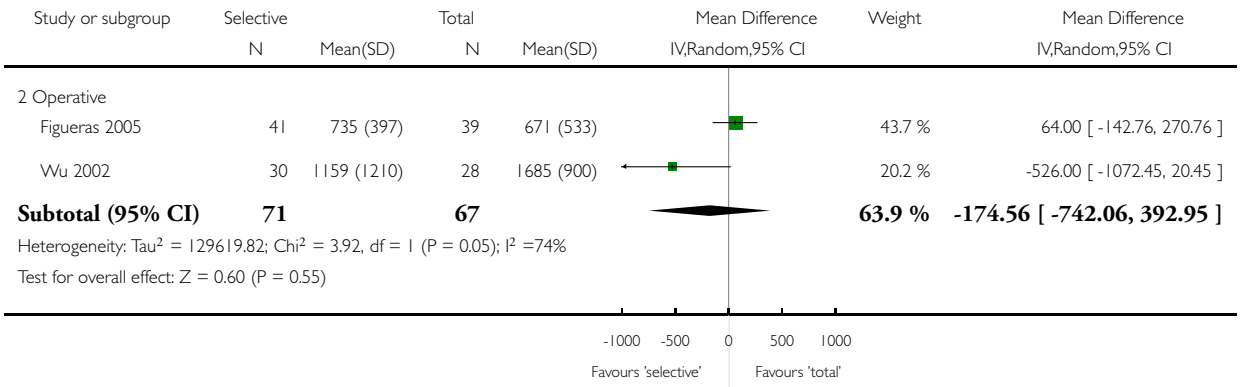
Outcome: 9 Blood loss (ml)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 9 Blood loss (ml)

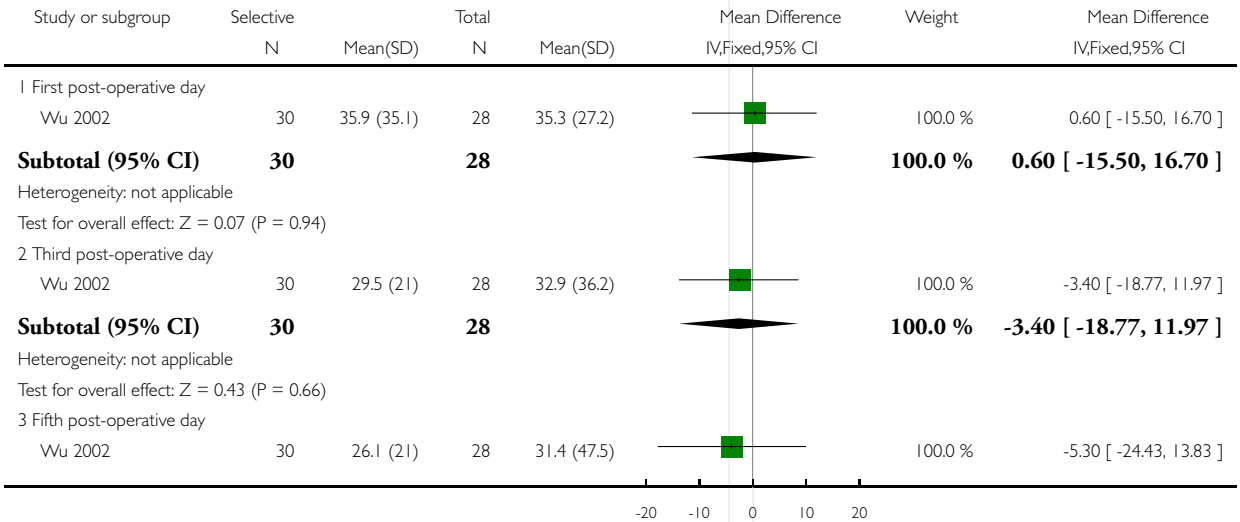


Analysis 3.10. Comparison 3 Inflow occlusion: 'selective' versus 'total', Outcome 10 Bilirubin (micromole/litre).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 10 Bilirubin (micromole/litre)



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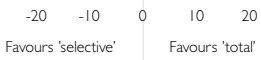
Study or subgroup	Selective N	Mean(SD)	Total N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Subtotal (95% CI)	**30**		**28**			**100.0 %**	**-5.30 [-24.43, 13.83]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.54 (P = 0.59)							
4 Seventh post-operative day							
Wu 2002	30	21.8 (24.6)	28	26 (50.9)		100.0 %	-4.20 [-25.01, 16.61]
Subtotal (95% CI)	**30**		**28**			**100.0 %**	**-4.20 [-25.01, 16.61]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.40 (P = 0.69)							
Test for subgroup differences: Chi^2 = 0.26, df = 3 (P = 0.97), I^2 =0.0%							

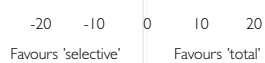


Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 10 Bilirubin (micromole/litre)

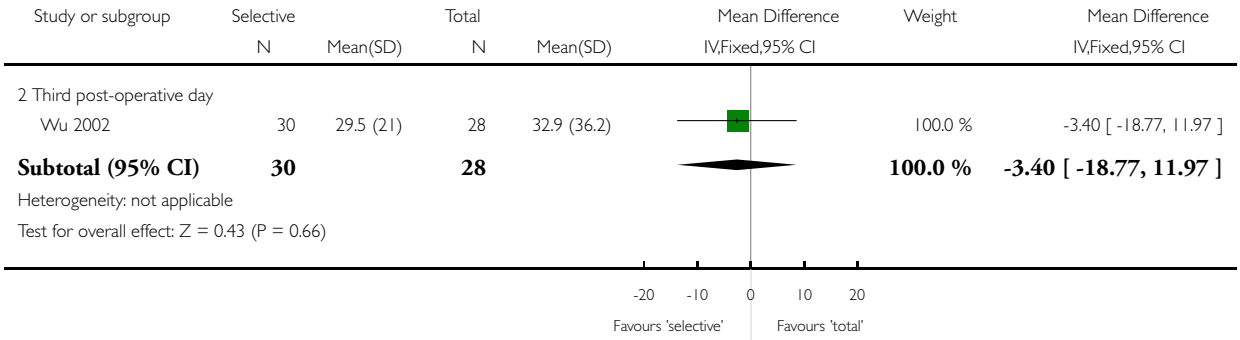
Study or subgroup	Selective N	Mean(SD)	Total N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 First post-operative day							
Wu 2002	30	35.9 (35.1)	28	35.3 (27.2)		100.0 %	0.60 [-15.50, 16.70]
Subtotal (95% CI)	**30**		**28**			**100.0 %**	**0.60 [-15.50, 16.70]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.07 (P = 0.94)							



Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

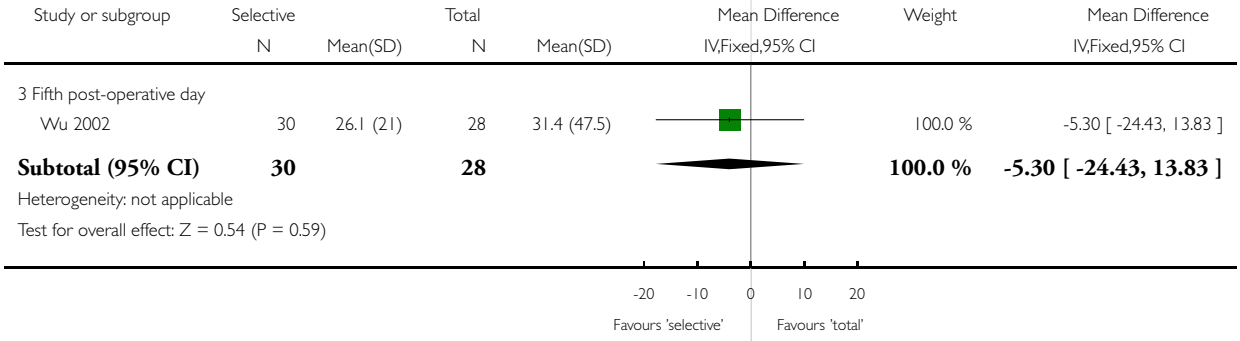
Outcome: 10 Bilirubin (micromole/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

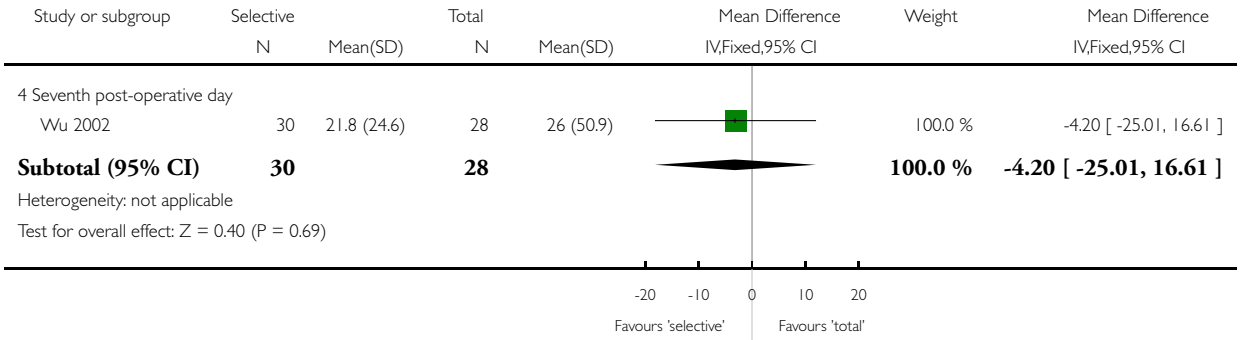
Outcome: 10 Bilirubin (micromole/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 10 Bilirubin (micromole/litre)

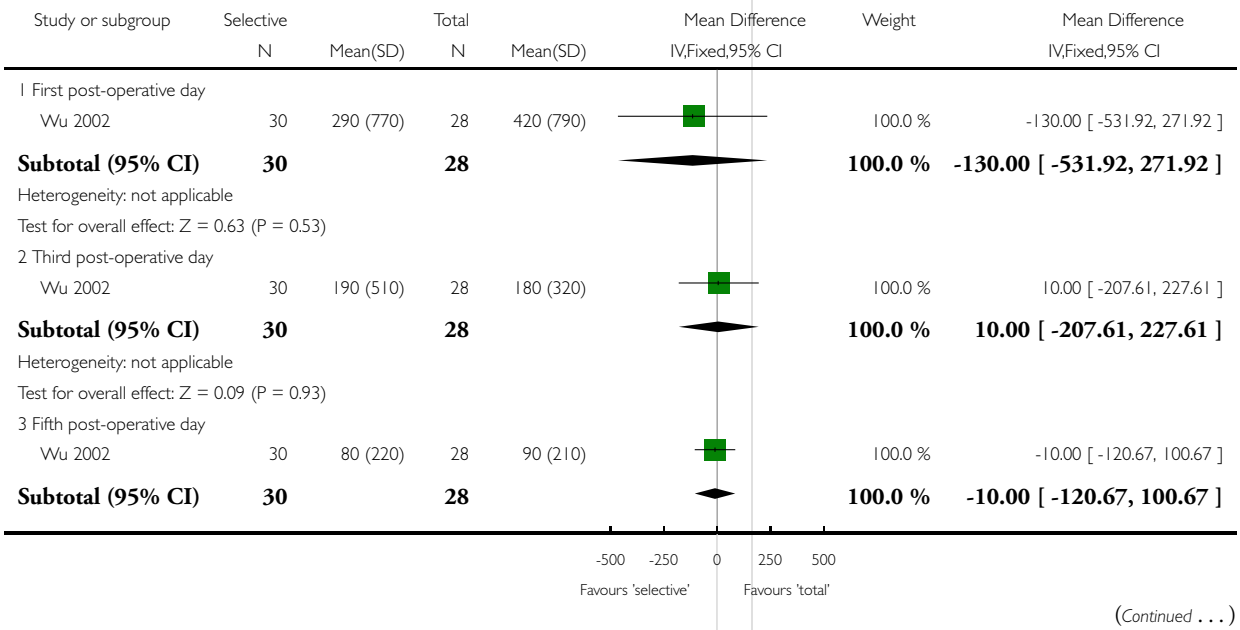


Analysis 3.11. Comparison 3 Inflow occlusion: 'selective' versus 'total', Outcome 11 AST (aspartate transaminase) (IU/litre).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 11 AST (aspartate transaminase) (IU/litre)



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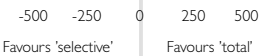
Study or subgroup	Selective N	Mean(SD)	Total N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Heterogeneity: not applicable							
Test for overall effect: Z = 0.18 (P = 0.86)							
4 Seventh post-operative day							
Wu 2002	30	30 (20)	28	50 (40)		100.0 %	-20.00 [-36.45, -3.55]
Subtotal (95% CI)	**30**		**28**			**100.0 %**	**-20.00 [-36.45, -3.55]**
Heterogeneity: not applicable							
Test for overall effect: Z = 2.38 (P = 0.017)							
Test for subgroup differences: Chi^2 = 0.39, df = 3 (P = 0.94), I^2 =0.0%							

Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 11 AST (aspartate transaminase) (IU/litre)

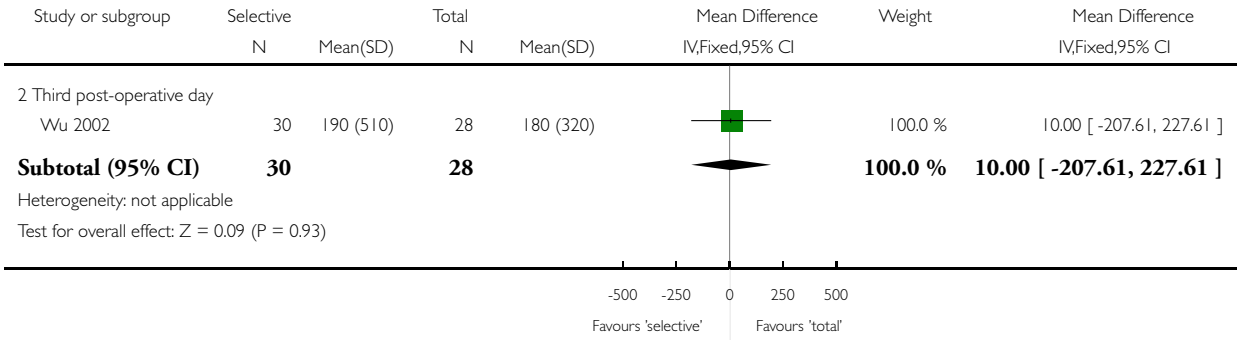
Study or subgroup	Selective N	Mean(SD)	Total N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 First post-operative day							
Wu 2002	30	290 (770)	28	420 (790)		100.0 %	-130.00 [-531.92, 271.92]
Subtotal (95% CI)	**30**		**28**			**100.0 %**	**-130.00 [-531.92, 271.92]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.63 (P = 0.53)							



Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

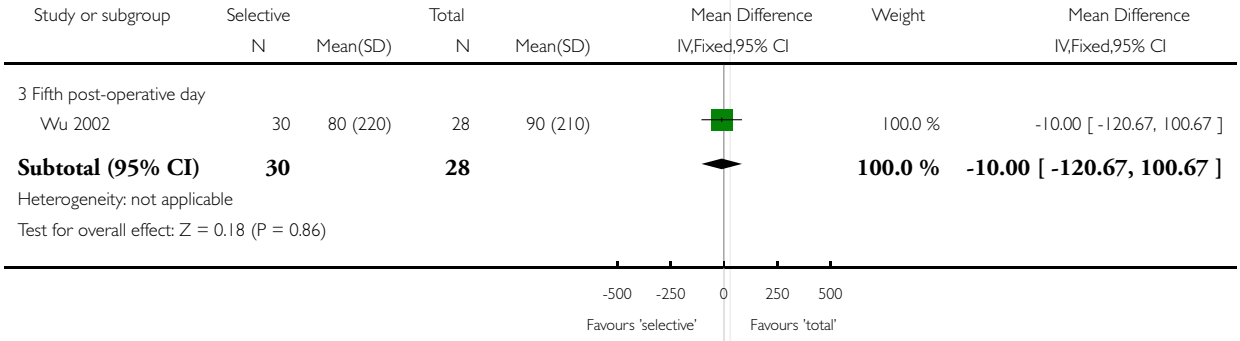
Outcome: 11 AST (aspartate transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

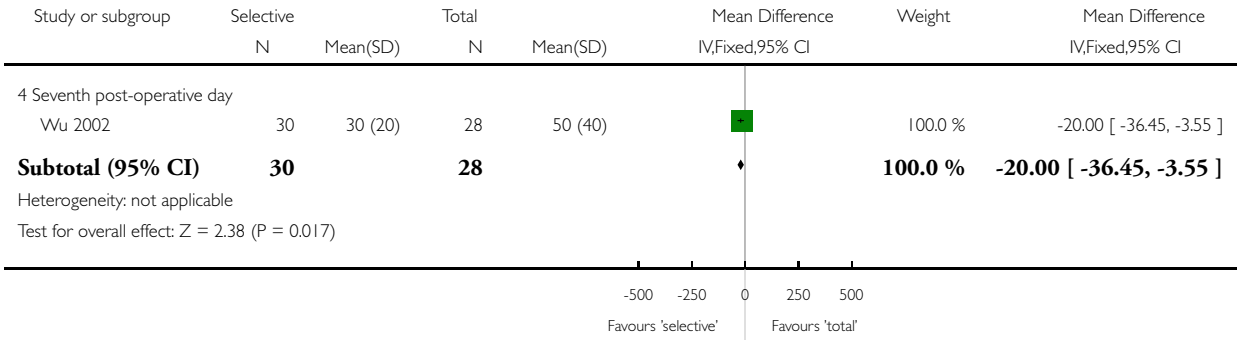
Outcome: 11 AST (aspartate transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 11 AST (aspartate transaminase) (IU/litre)

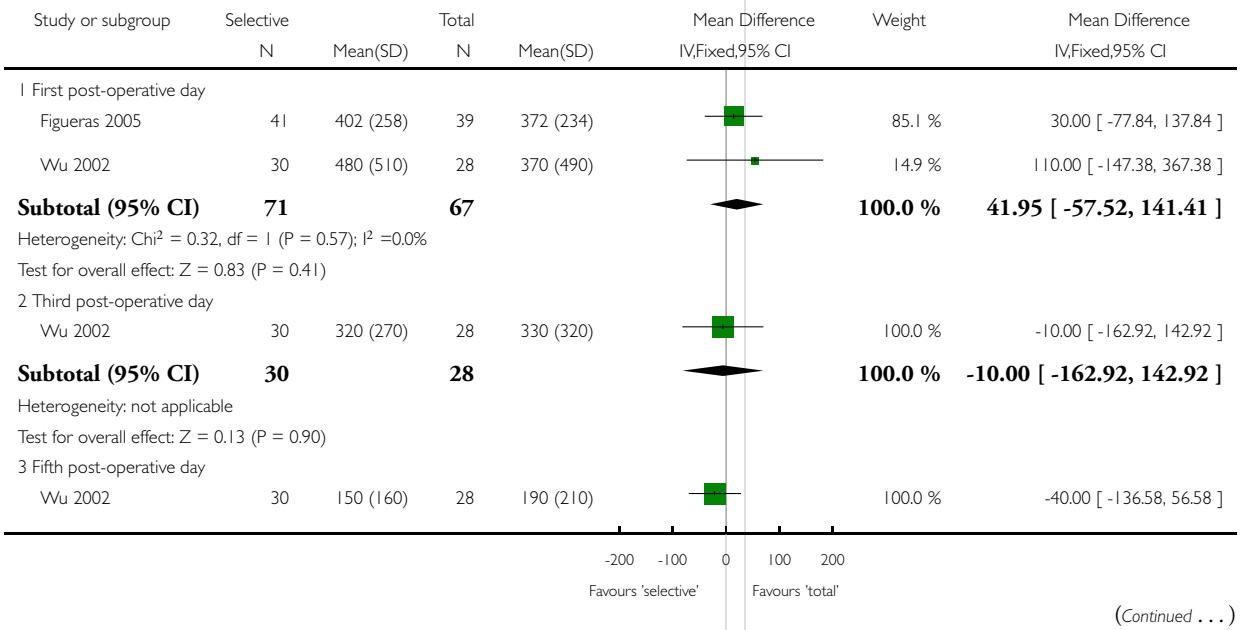


Analysis 3.12. Comparison 3 Inflow occlusion: 'selective' versus 'total', Outcome 12 ALT (alanine transaminase) (IU/litre).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 12 ALT (alanine transaminase) (IU/litre)



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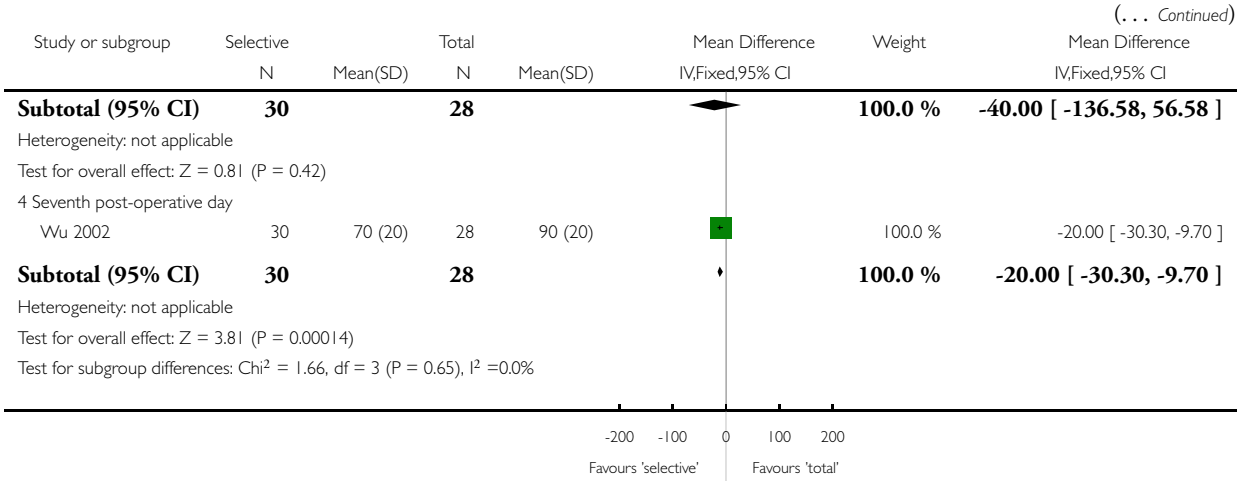
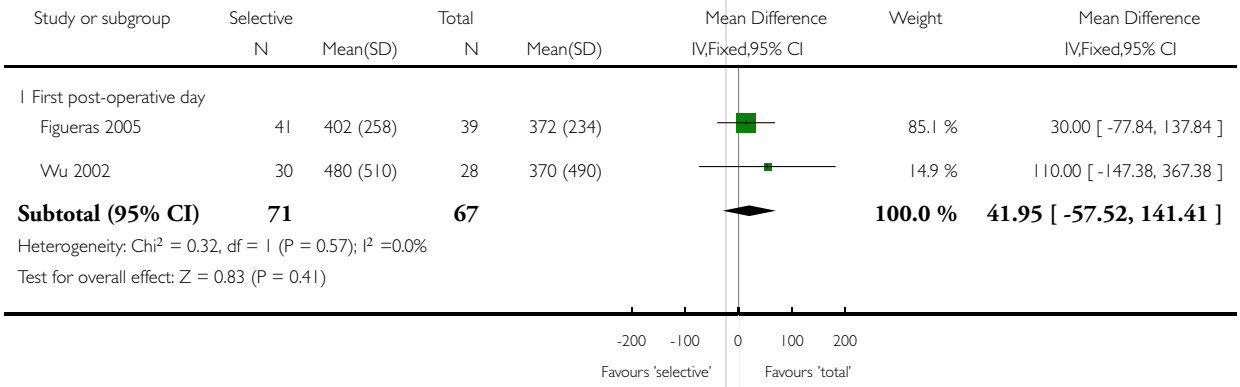


Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

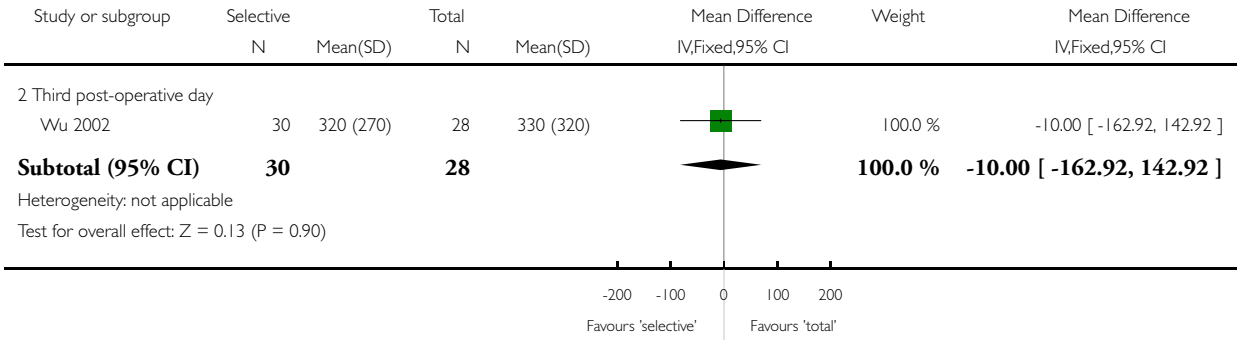
Outcome: 12 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

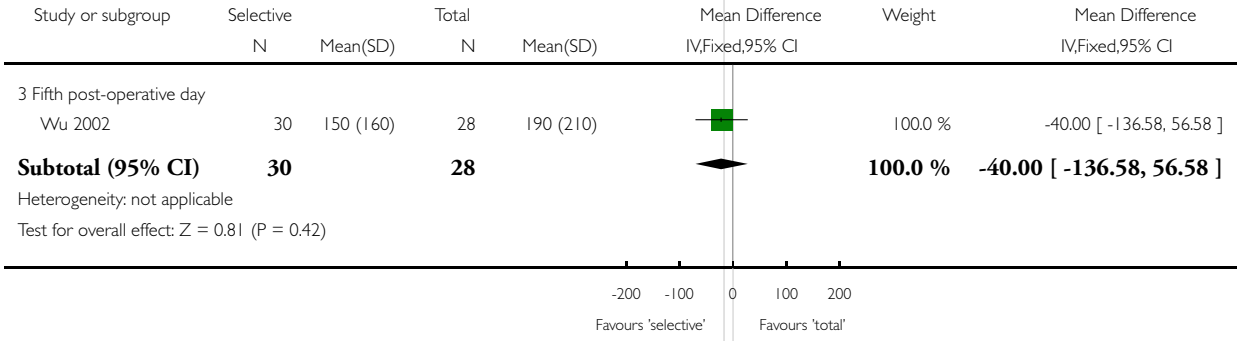
Outcome: 12 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

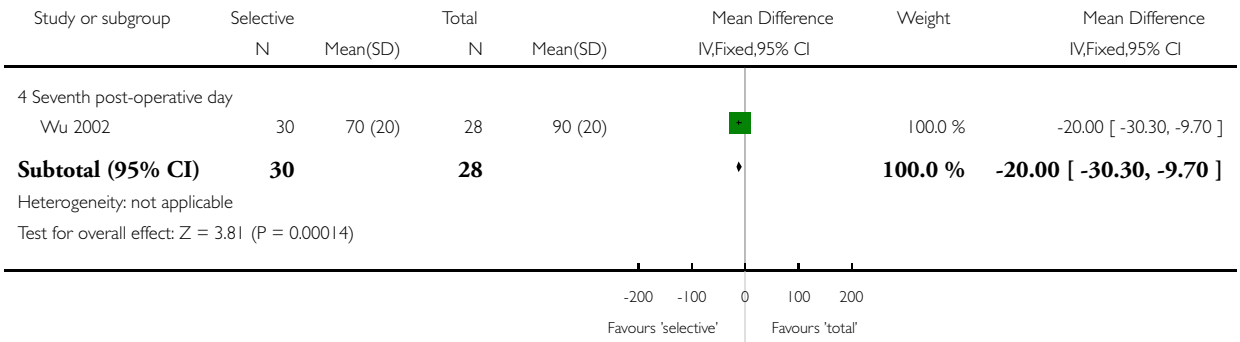
Outcome: 12 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 3 Inflow occlusion: 'selective' versus 'total'

Outcome: 12 ALT (alanine transaminase) (IU/litre)

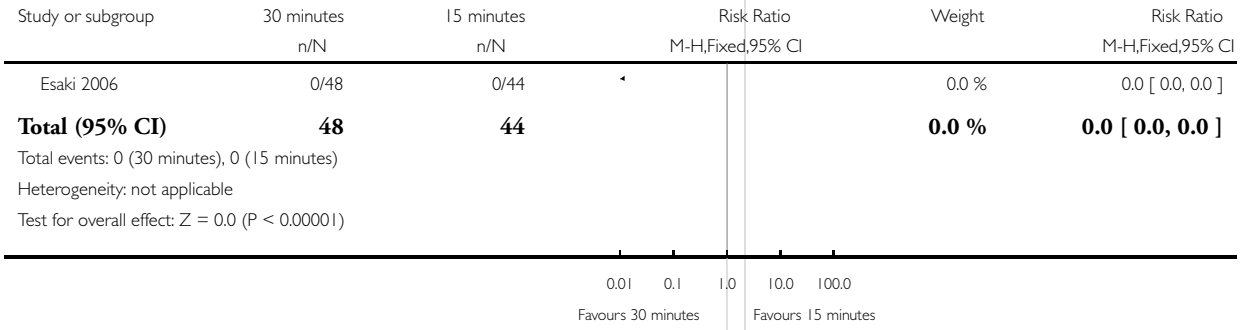


Analysis 4.1. Comparison 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC, Outcome 1 Mortality.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 1 Mortality



Analysis 4.2. Comparison 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC, Outcome 2 Peri-operative morbidity.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 2 Peri-operative morbidity

Study or subgroup	30 minutes n/N	15 minutes n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 Wound infection					
Esaki 2006	3/48	1/44		100.0 %	2.75 [0.30, 25.47]
Subtotal (95% CI)	**48**	**44**		**100.0 %**	**2.75 [0.30, 25.47]**
Total events: 3 (30 minutes), 1 (15 minutes)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.89 (P = 0.37)					
2 Pulmonary complications					
Esaki 2006	2/48	2/44		100.0 %	0.92 [0.13, 6.23]
Subtotal (95% CI)	**48**	**44**		**100.0 %**	**0.92 [0.13, 6.23]**
Total events: 2 (30 minutes), 2 (15 minutes)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.09 (P = 0.93)					
3 Bile leak					
Esaki 2006	4/48	7/44		100.0 %	0.52 [0.16, 1.67]
Subtotal (95% CI)	**48**	**44**		**100.0 %**	**0.52 [0.16, 1.67]**
Total events: 4 (30 minutes), 7 (15 minutes)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.09 (P = 0.27)					
4 Cholangitis					
Esaki 2006	2/48	0/44		100.0 %	4.59 [0.23, 93.09]
Subtotal (95% CI)	**48**	**44**		**100.0 %**	**4.59 [0.23, 93.09]**
Total events: 2 (30 minutes), 0 (15 minutes)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.99 (P = 0.32)					
5 Pancreatic fistula					
Esaki 2006	0/48	1/44		100.0 %	0.31 [0.01, 7.32]
Subtotal (95% CI)	**48**	**44**		**100.0 %**	**0.31 [0.01, 7.32]**
Total events: 0 (30 minutes), 1 (15 minutes)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.73 (P = 0.46)					
6 Bowel obstruction					
Esaki 2006	1/48	0/44		100.0 %	2.76 [0.12, 65.92]
Subtotal (95% CI)	**48**	**44**		**100.0 %**	**2.76 [0.12, 65.92]**

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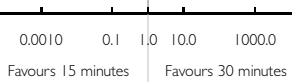
Study or subgroup	30 minutes n/N	15 minutes n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Total events: 1 (30 minutes), 0 (15 minutes)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.63 (P = 0.53)					

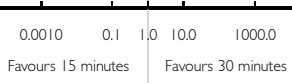


Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 2 Peri-operative morbidity

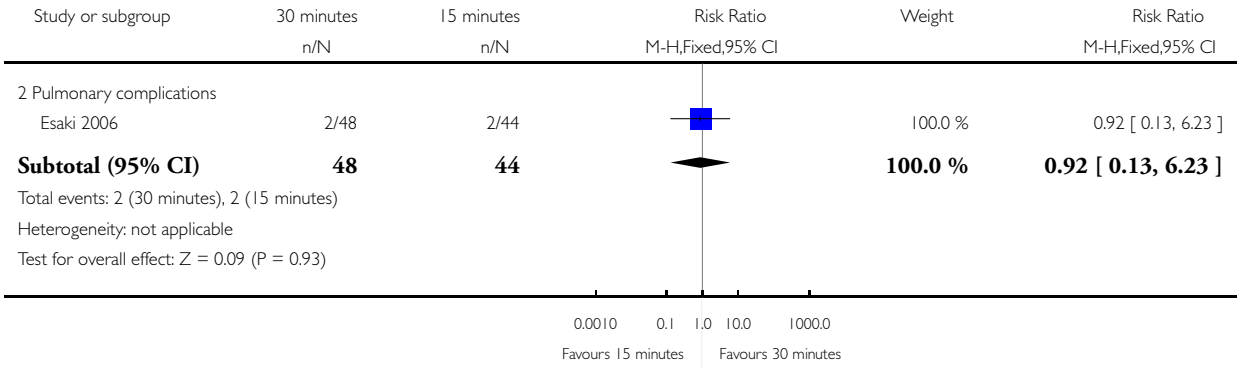
Study or subgroup	30 minutes n/N	15 minutes n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 Wound infection					
Esaki 2006	3/48	1/44		100.0 %	2.75 [0.30, 25.47]
Subtotal (95% CI)	**48**	**44**		**100.0 %**	**2.75 [0.30, 25.47]**
Total events: 3 (30 minutes), 1 (15 minutes)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.89 (P = 0.37)					



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

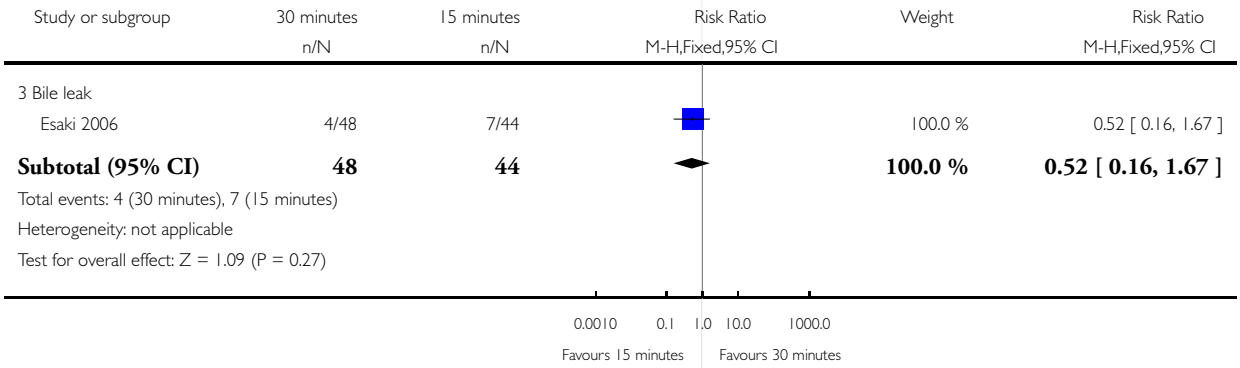
Outcome: 2 Peri-operative morbidity



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 2 Peri-operative morbidity



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 2 Peri-operative morbidity

Study or subgroup	30 minutes n/N	15 minutes n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
4 Cholangitis					
Esaki 2006	2/48	0/44		100.0 %	4.59 [0.23, 93.09]
Subtotal (95% CI)	**48**	**44**		**100.0 %**	**4.59 [0.23, 93.09]**
Total events: 2 (30 minutes), 0 (15 minutes)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.99 (P = 0.32)					

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 2 Peri-operative morbidity

Study or subgroup	30 minutes n/N	15 minutes n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
5 Pancreatic fistula					
Esaki 2006	0/48	1/44		100.0 %	0.31 [0.01, 7.32]
Subtotal (95% CI)	**48**	**44**		**100.0 %**	**0.31 [0.01, 7.32]**
Total events: 0 (30 minutes), 1 (15 minutes)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.73 (P = 0.46)					

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 2 Peri-operative morbidity

Study or subgroup	30 minutes n/N	15 minutes n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
6 Bowel obstruction					
Esaki 2006	1/48	0/44		100.0 %	2.76 [0.12, 65.92]
Subtotal (95% CI)	**48**	**44**		**100.0 %**	**2.76 [0.12, 65.92]**
Total events: 1 (30 minutes), 0 (15 minutes)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.63 (P = 0.53)					

Analysis 4.3. Comparison 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC, Outcome 3 Number needing transfusion.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 3 Number needing transfusion

Study or subgroup	30 minutes n/N	15 minutes n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Esaki 2006	4/48	4/44		100.0 %	0.92 [0.24, 3.45]
Total (95% CI)	**48**	**44**		**100.0 %**	**0.92 [0.24, 3.45]**
Total events: 4 (30 minutes), 4 (15 minutes)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.13 (P = 0.90)					

Analysis 4.4. Comparison 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC, Outcome 4 Number of units transfused.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 4 Number of units transfused

Study or subgroup	30 minutes N	Mean(SD)	15 minutes N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Esaki 2006	48	4 (8)	44	4 (8)		100.0 %	0.0 [-3.27, 3.27]
Total (95% CI)	**48**		**44**			**100.0 %**	**0.0 [-3.27, 3.27]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.0 (P = 1.0)

Analysis 4.5. Comparison 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC, Outcome 5 Number of units of FFP transfused.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 5 Number of units of FFP transfused

Study or subgroup	30 minutes N	Mean(SD)	15 minutes N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Esaki 2006	48	3 (8.5)	44	2 (8.5)		100.0 %	1.00 [-2.48, 4.48]
Total (95% CI)	**48**		**44**			**100.0 %**	**1.00 [-2.48, 4.48]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.56 (P = 0.57)

Analysis 4.6. Comparison 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC, Outcome 6 Hospital stay.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 6 Hospital stay

Study or subgroup	30 minutes N	Mean(SD)	15 minutes N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Esaki 2006	48	12 (6)	44	12 (6)		100.0 %	0.0 [-2.45, 2.45]
Total (95% CI)	**48**		**44**			**100.0 %**	**0.0 [-2.45, 2.45]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.0 (P = 1.0)

Analysis 4.7. Comparison 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC, Outcome 7 Operating time.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 7 Operating time

Study or subgroup	30 minutes N	Mean(SD)	15 minutes N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Esaki 2006	48	255 (122)	44	307 (122)		100.0 %	-52.00 [-101.91, -2.09]
Total (95% CI)	**48**		**44**			**100.0 %**	**-52.00 [-101.91, -2.09]**

Heterogeneity: not applicable

Test for overall effect: Z = 2.04 (P = 0.041)

Analysis 4.8. Comparison 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC, Outcome 8 Blood loss (ml).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 8 Blood loss (ml)

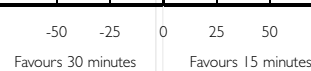
Study or subgroup	30 minutes N	Mean(SD)	15 minutes N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 Transection (per sq cm)							
Esaki 2006	48	4.9 (3.8)	44	6.2 (3.8)		100.0 %	-1.30 [-2.85, 0.25]
Subtotal (95% CI)	**48**		**44**			**100.0 %**	**-1.30 [-2.85, 0.25]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.64 (P = 0.10)							
2 Operative							
Esaki 2006	48	391 (99)	44	352 (99)		100.0 %	39.00 [-1.50, 79.50]
Subtotal (95% CI)	**48**		**44**			**100.0 %**	**39.00 [-1.50, 79.50]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.89 (P = 0.059)							
Test for subgroup differences: Chi^2 = 3.80, df = 1 (P = 0.05), I^2 =74%							

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 8 Blood loss (ml)

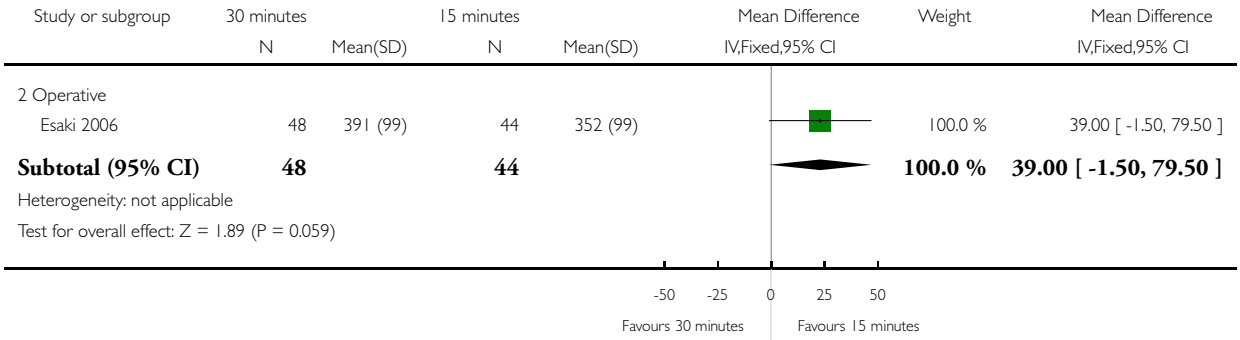
Study or subgroup	30 minutes N	Mean(SD)	15 minutes N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 Transection (per sq cm)							
Esaki 2006	48	4.9 (3.8)	44	6.2 (3.8)		100.0 %	-1.30 [-2.85, 0.25]
Subtotal (95% CI)	**48**		**44**			**100.0 %**	**-1.30 [-2.85, 0.25]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.64 (P = 0.10)							



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 8 Blood loss (ml)

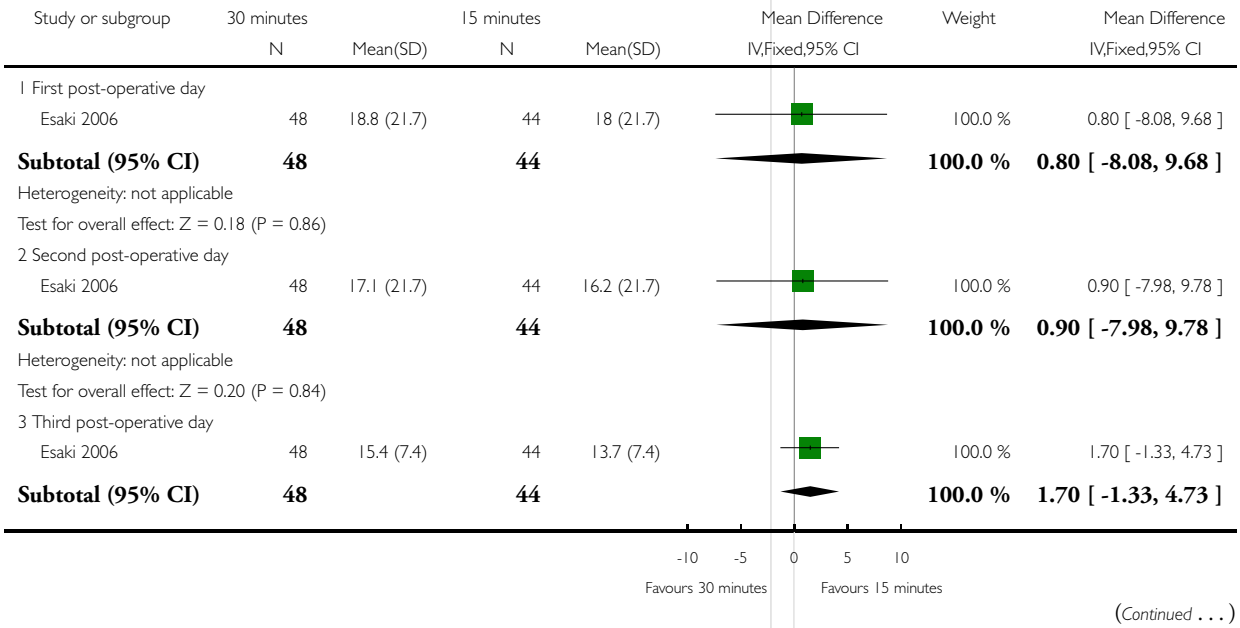


Analysis 4.9. Comparison 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC, Outcome 9 Bilirubin (micromole/litre).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 9 Bilirubin (micromole/litre)



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Study or subgroup	30 minutes N	Mean(SD)	15 minutes N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Heterogeneity: not applicable							
Test for overall effect: Z = 1.10 (P = 0.27)							
4 Fifth post-operative day							
Esaki 2006	48	13.7 (8.2)	44	12 (8.2)		100.0 %	1.70 [-1.65, 5.05]
Subtotal (95% CI)	**48**		**44**			**100.0 %**	**1.70 [-1.65, 5.05]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.99 (P = 0.32)							
5 Seventh post-operative day							
Esaki 2006	48	13.7 (5.7)	44	11.9 (5.7)		100.0 %	1.80 [-0.53, 4.13]
Subtotal (95% CI)	**48**		**44**			**100.0 %**	**1.80 [-0.53, 4.13]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.51 (P = 0.13)							
Test for subgroup differences: Chi^2 = 0.08, df = 4 (P = 1.00), I^2 =0.0%							

-10 -5 0 5 10

Favours 30 minutes Favours 15 minutes

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 9 Bilirubin (micromole/litre)

Study or subgroup	30 minutes N	Mean(SD)	15 minutes N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 First post-operative day							
Esaki 2006	48	18.8 (21.7)	44	18 (21.7)		100.0 %	0.80 [-8.08, 9.68]
Subtotal (95% CI)	**48**		**44**			**100.0 %**	**0.80 [-8.08, 9.68]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.18 (P = 0.86)							

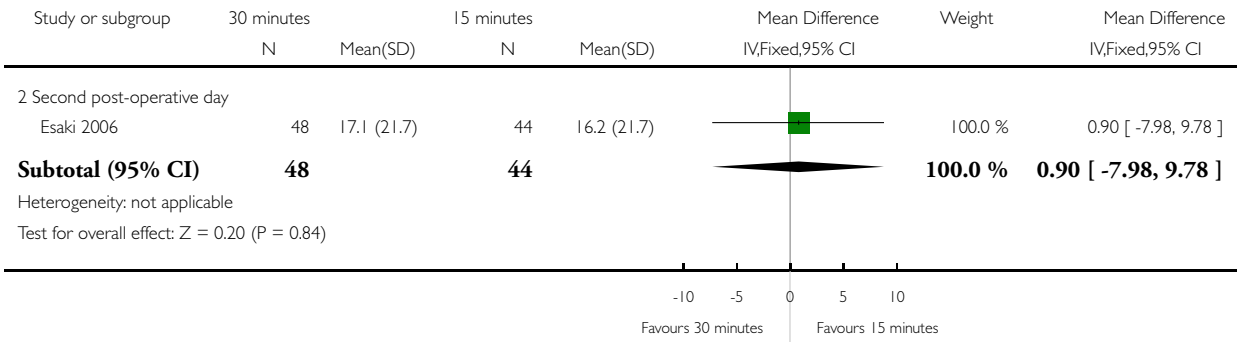
-10 -5 0 5 10

Favours 30 minutes Favours 15 minutes

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

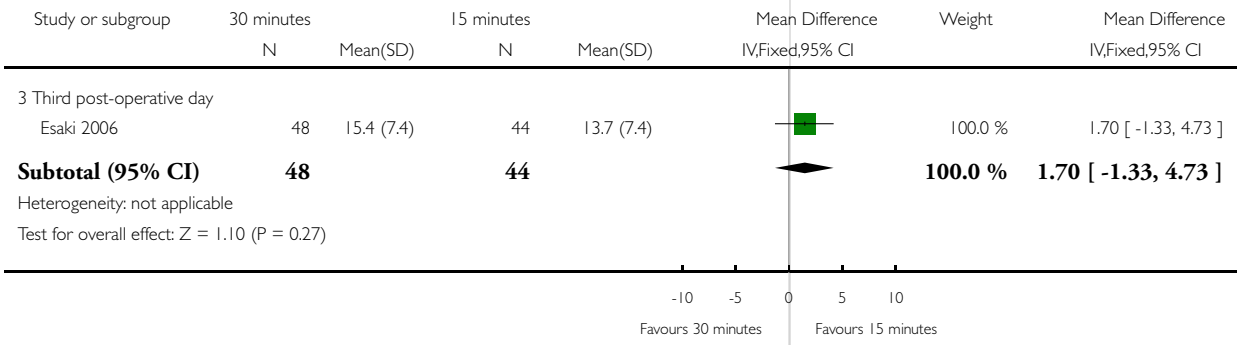
Outcome: 9 Bilirubin (micromole/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

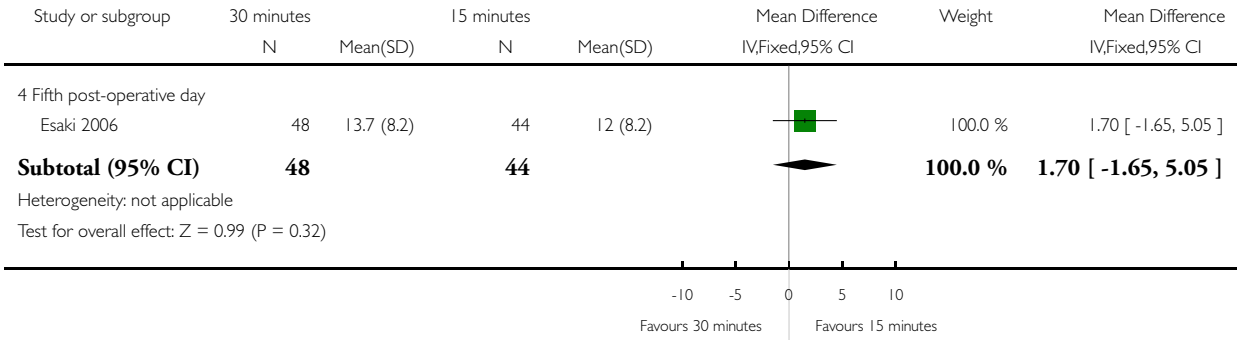
Outcome: 9 Bilirubin (micromole/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

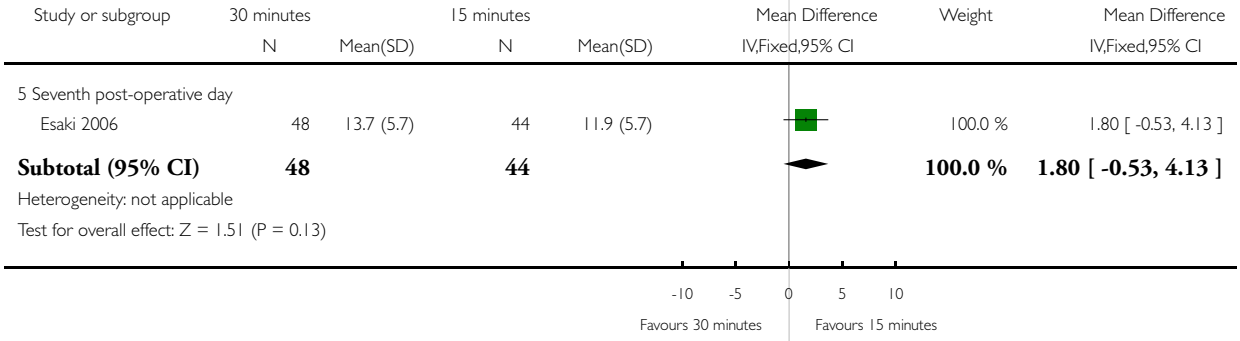
Outcome: 9 Bilirubin (micromole/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 9 Bilirubin (micromole/litre)

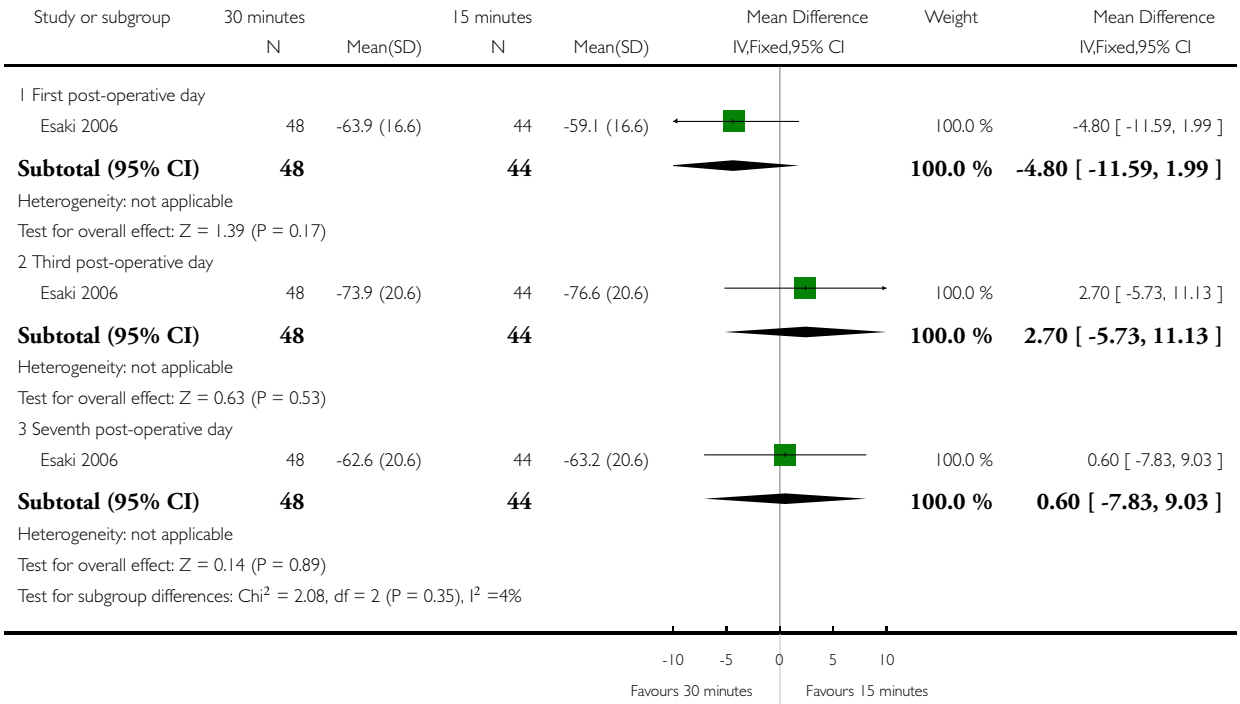


Analysis 4.10. Comparison 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC, Outcome 10 Prothrombin activity (percentage of normal).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

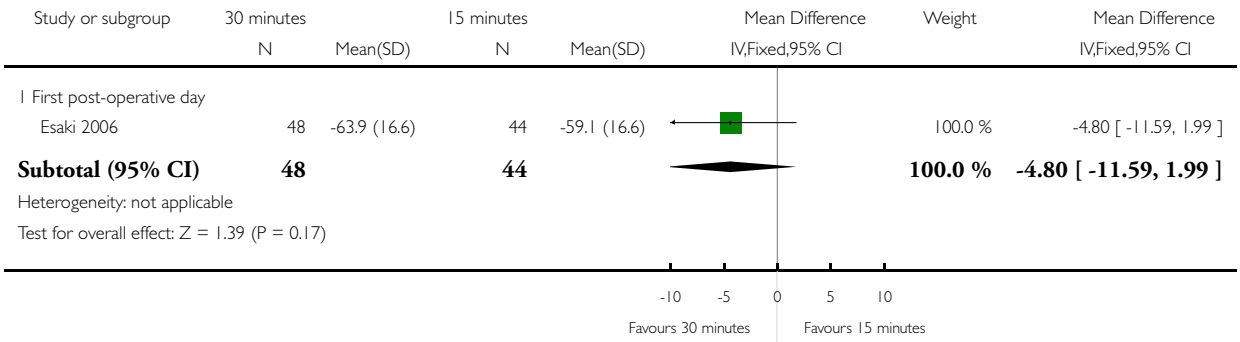
Outcome: 10 Prothrombin activity (percentage of normal)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

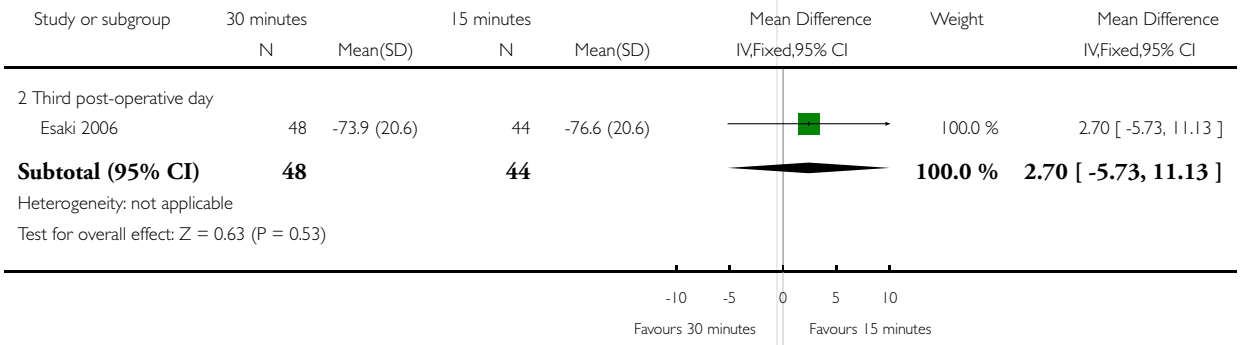
Outcome: 10 Prothrombin activity (percentage of normal)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

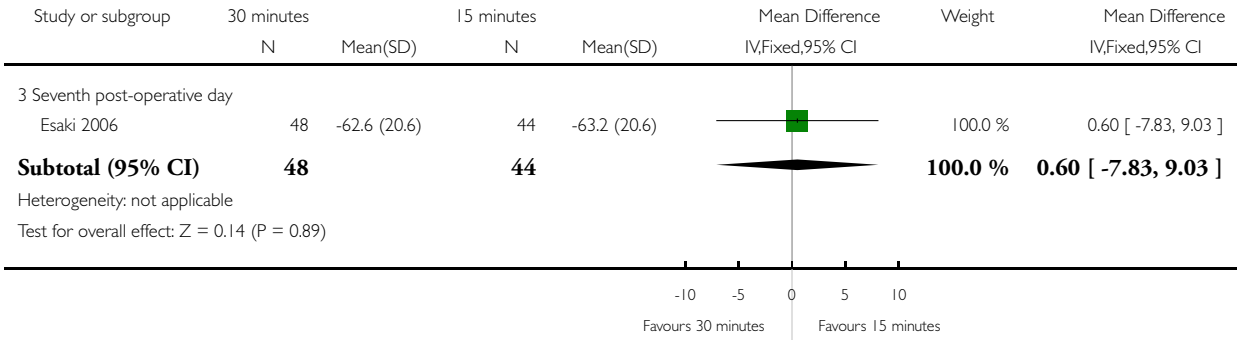
Outcome: 10 Prothrombin activity (percentage of normal)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 10 Prothrombin activity (percentage of normal)

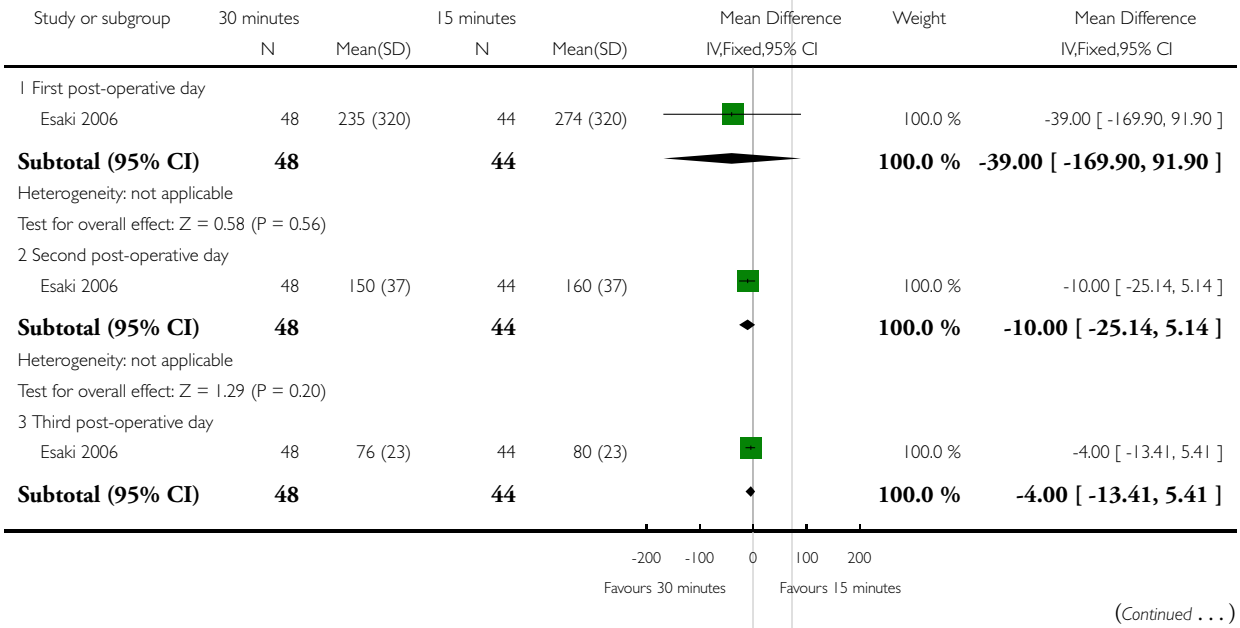


Analysis 4.11. Comparison 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC, Outcome 11 AST (aspartate transaminase) (IU/litre).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 11 AST (aspartate transaminase) (IU/litre)



(*Continued . . .*)

(. . . *Continued*)

Study or subgroup	30 minutes N	Mean(SD)	15 minutes N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Heterogeneity: not applicable							
Test for overall effect: Z = 0.83 (P = 0.40)							
4 Fifth post-operative day							
Esaki 2006	48	48 (23)	44	48 (23)		100.0 %	0.0 [-9.41, 9.41]
Subtotal (95% CI)	**48**		**44**			**100.0 %**	**0.0 [-9.41, 9.41]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.0 (P = 1.0)							
5 Seventh post-operative day							
Esaki 2006	48	39 (16)	44	37 (16)		100.0 %	2.00 [-4.55, 8.55]
Subtotal (95% CI)	**48**		**44**			**100.0 %**	**2.00 [-4.55, 8.55]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.60 (P = 0.55)							
Test for subgroup differences: Chi² = 2.92, df = 4 (P = 0.57), I² =0.0%							

-200 -100 0 100 200

Favours 30 minutes Favours 15 minutes

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 11 AST (aspartate transaminase) (IU/litre)

Study or subgroup	30 minutes N	Mean(SD)	15 minutes N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 First post-operative day							
Esaki 2006	48	235 (320)	44	274 (320)		100.0 %	-39.00 [-169.90, 91.90]
Subtotal (95% CI)	**48**		**44**			**100.0 %**	**-39.00 [-169.90, 91.90]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.58 (P = 0.56)							

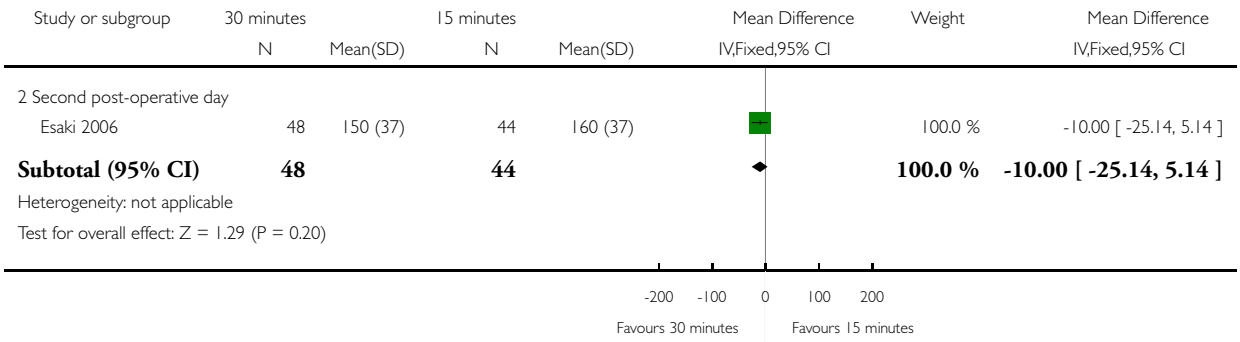
-200 -100 0 100 200

Favours 30 minutes Favours 15 minutes

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

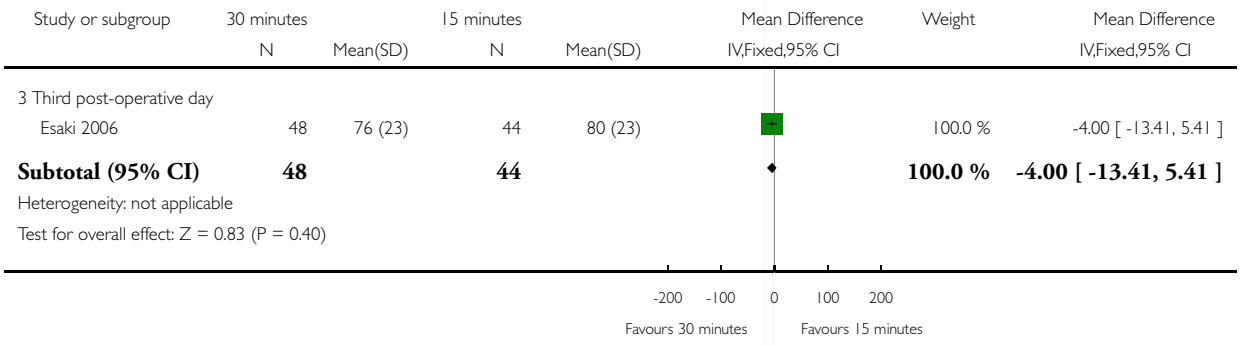
Outcome: 11 AST (aspartate transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

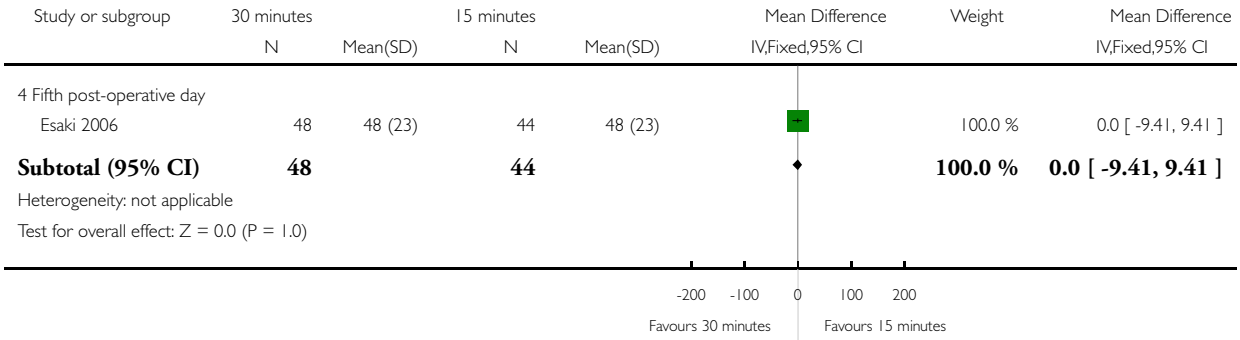
Outcome: 11 AST (aspartate transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

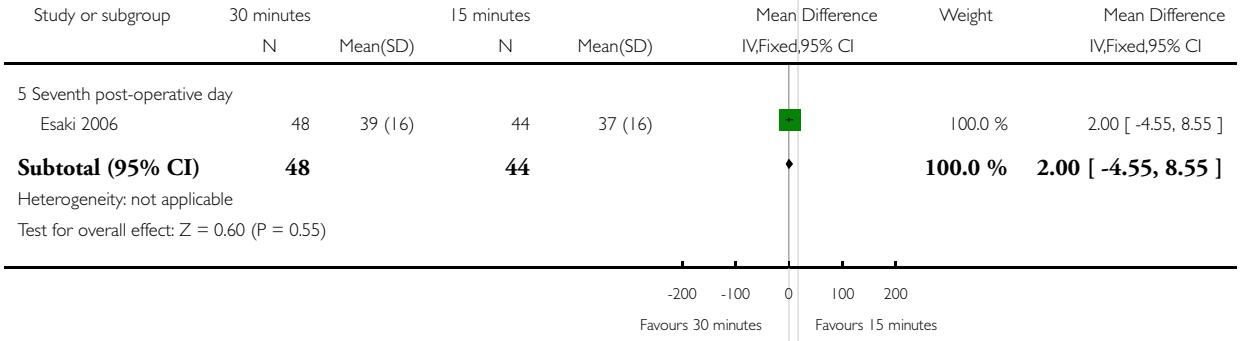
Outcome: 11 AST (aspartate transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 11 AST (aspartate transaminase) (IU/litre)

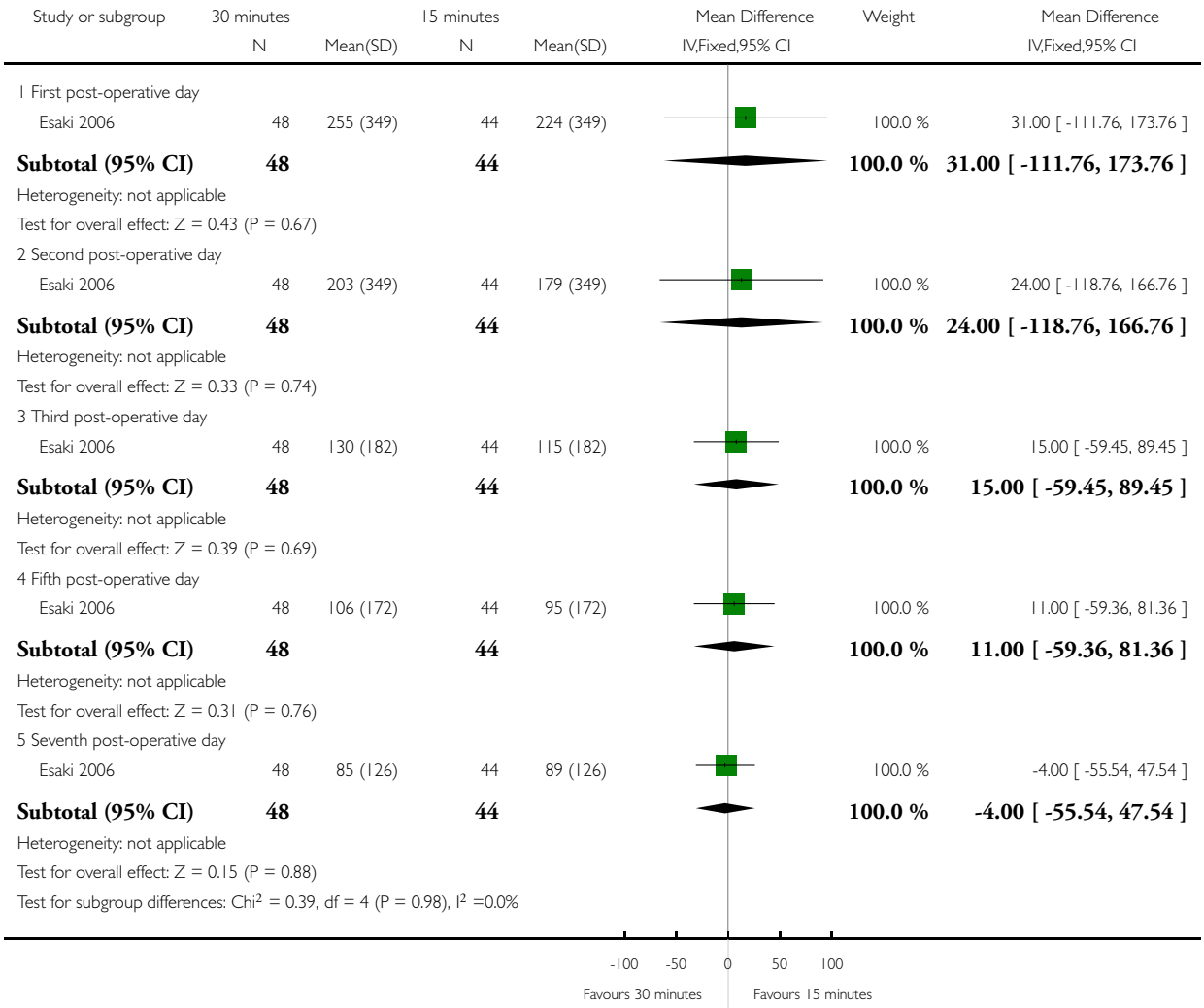


Analysis 4.12. Comparison 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC, Outcome 12 ALT (alanine transaminase) (IU/litre).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

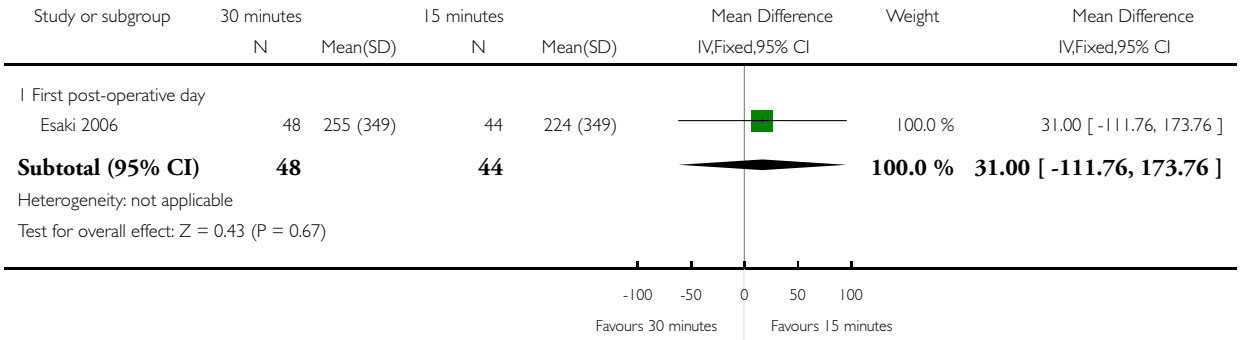
Outcome: 12 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

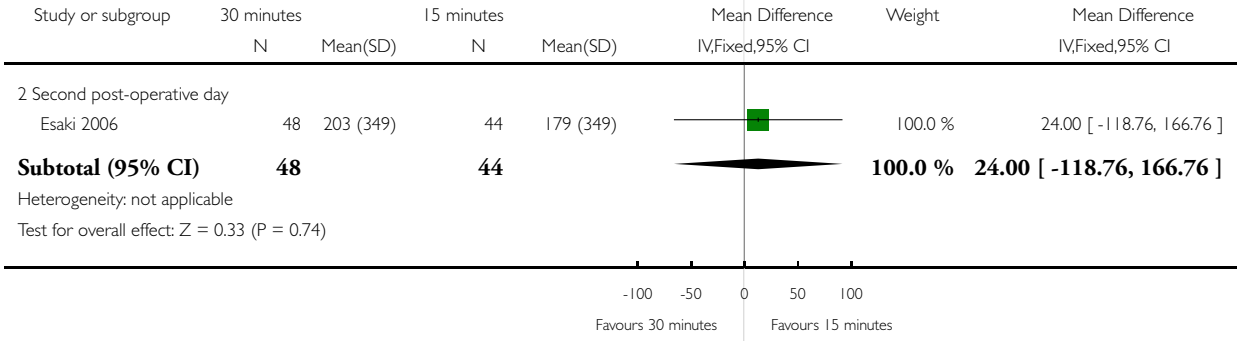
Outcome: 12 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

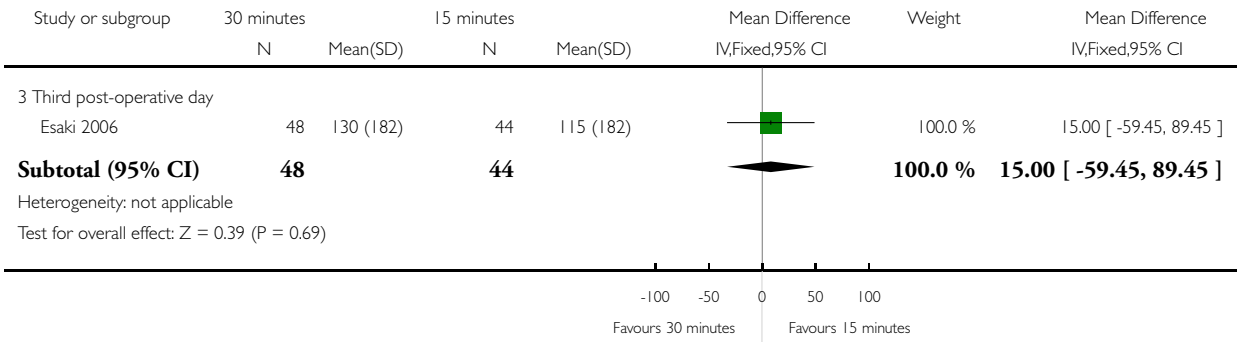
Outcome: 12 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

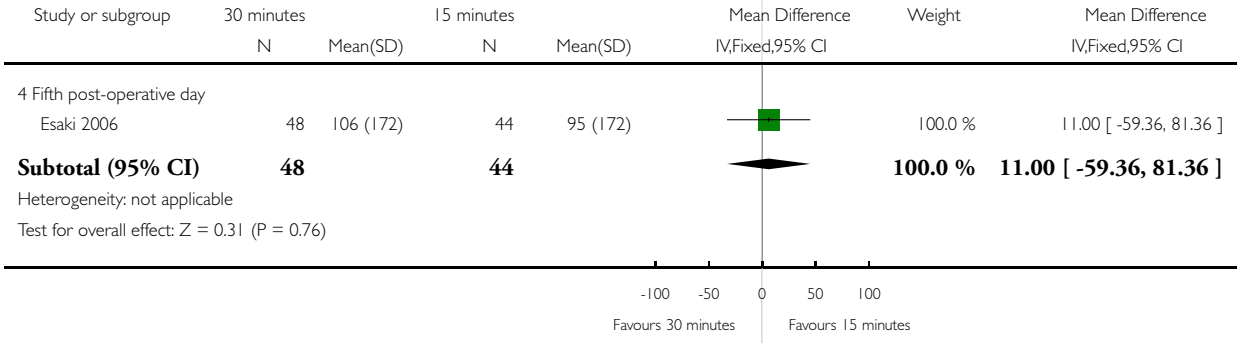
Outcome: 12 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

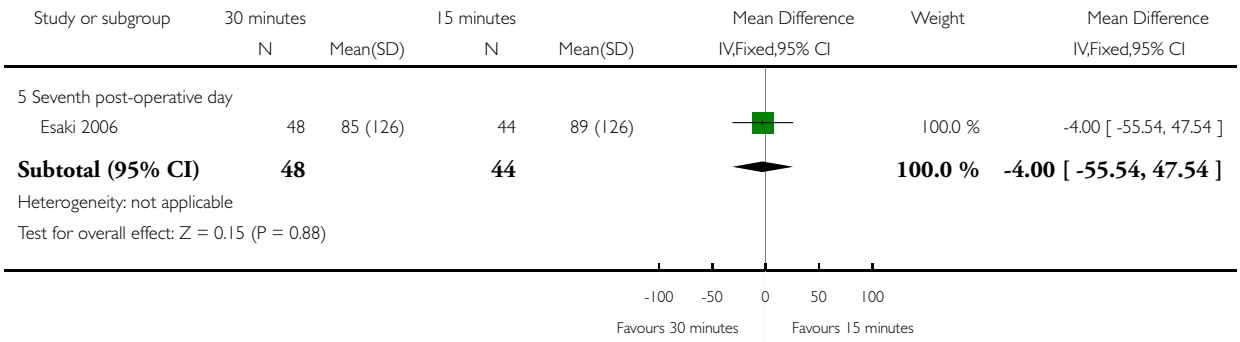
Outcome: 12 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 4 30 minutes intermittent PTC versus 15 minutes intermittent PTC

Outcome: 12 ALT (alanine transaminase) (IU/litre)

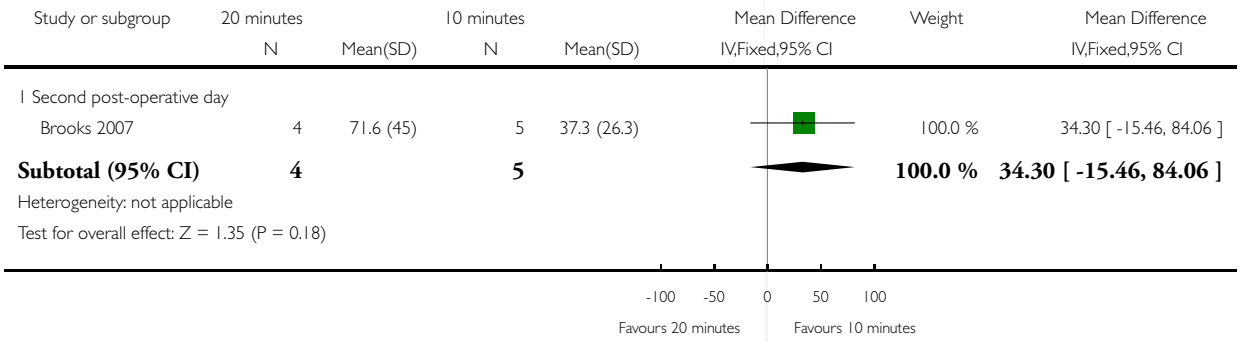


Analysis 5.1. Comparison 5 20 minutes intermittent PTC versus 10 minutes intermittent PTC, Outcome 1 Bilirubin (micromole/litre).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 5 20 minutes intermittent PTC versus 10 minutes intermittent PTC

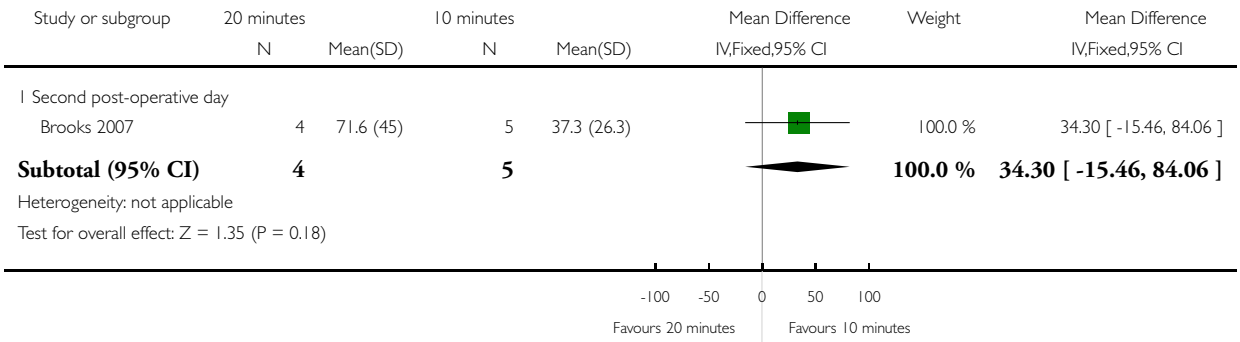
Outcome: 1 Bilirubin (micromole/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 5 20 minutes intermittent PTC versus 10 minutes intermittent PTC

Outcome: 1 Bilirubin (micromole/litre)

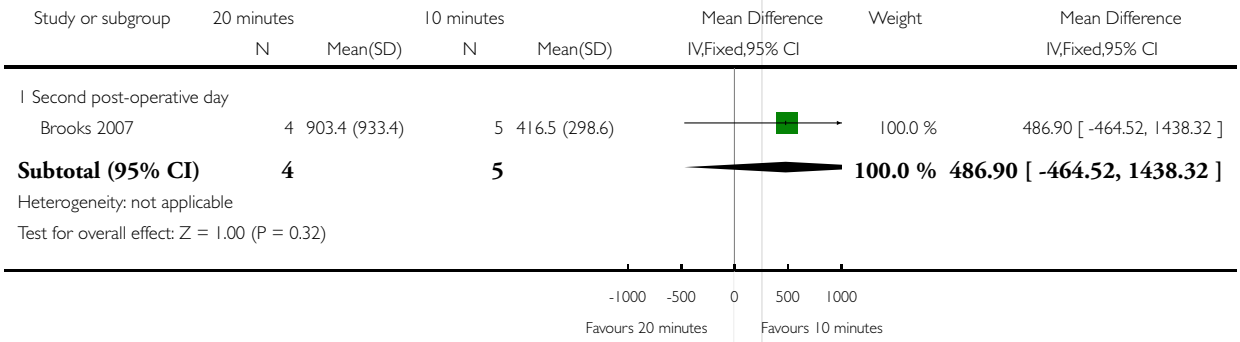


Analysis 5.2. Comparison 5 20 minutes intermittent PTC versus 10 minutes intermittent PTC, Outcome 2 ALT (alanine transaminase) (IU/litre).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 5 20 minutes intermittent PTC versus 10 minutes intermittent PTC

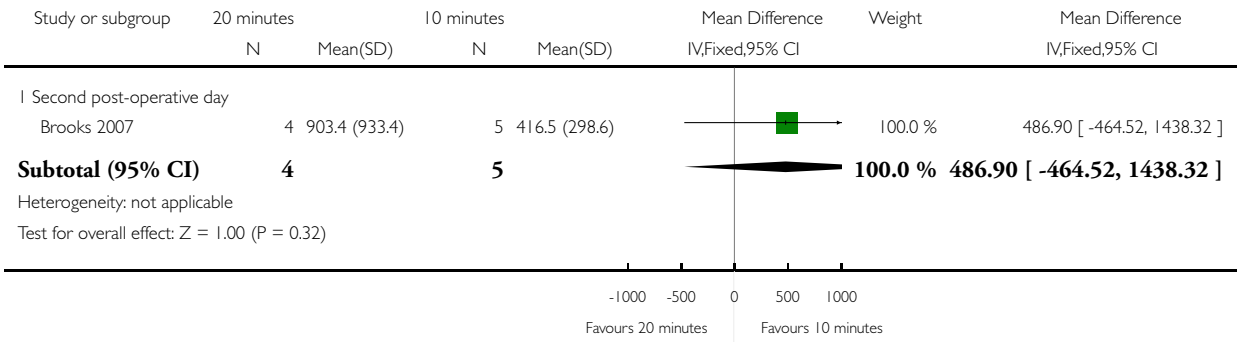
Outcome: 2 ALT (alanine transaminase) (IU/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 5 20 minutes intermittent PTC versus 10 minutes intermittent PTC

Outcome: 2 ALT (alanine transaminase) (IU/litre)

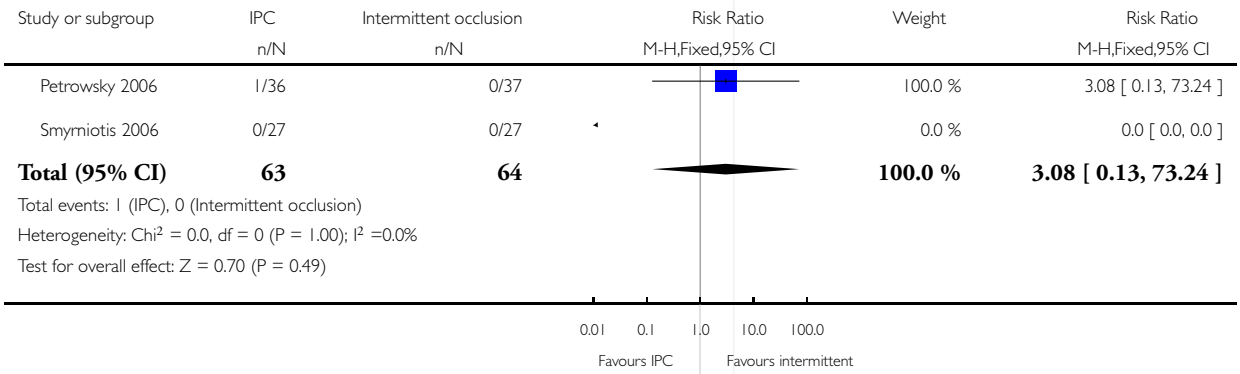


Analysis 6.1. Comparison 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion, Outcome 1 Mortality.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 1 Mortality

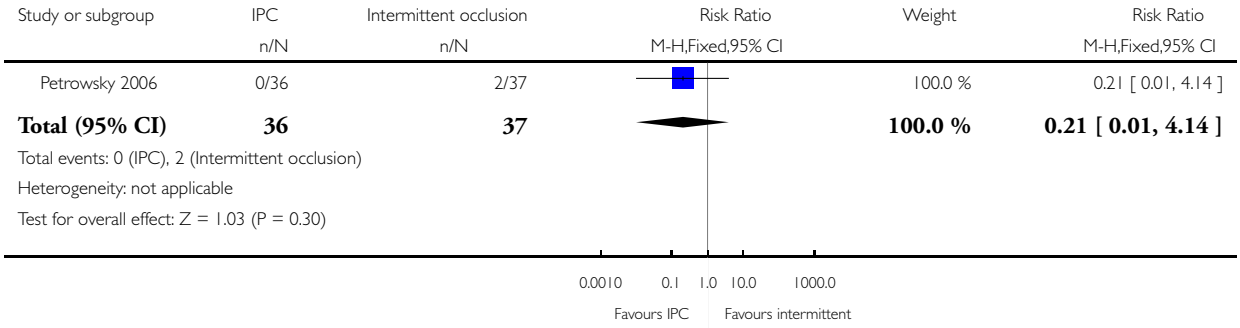


Analysis 6.2. Comparison 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion, Outcome 2 Liver failure.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 2 Liver failure

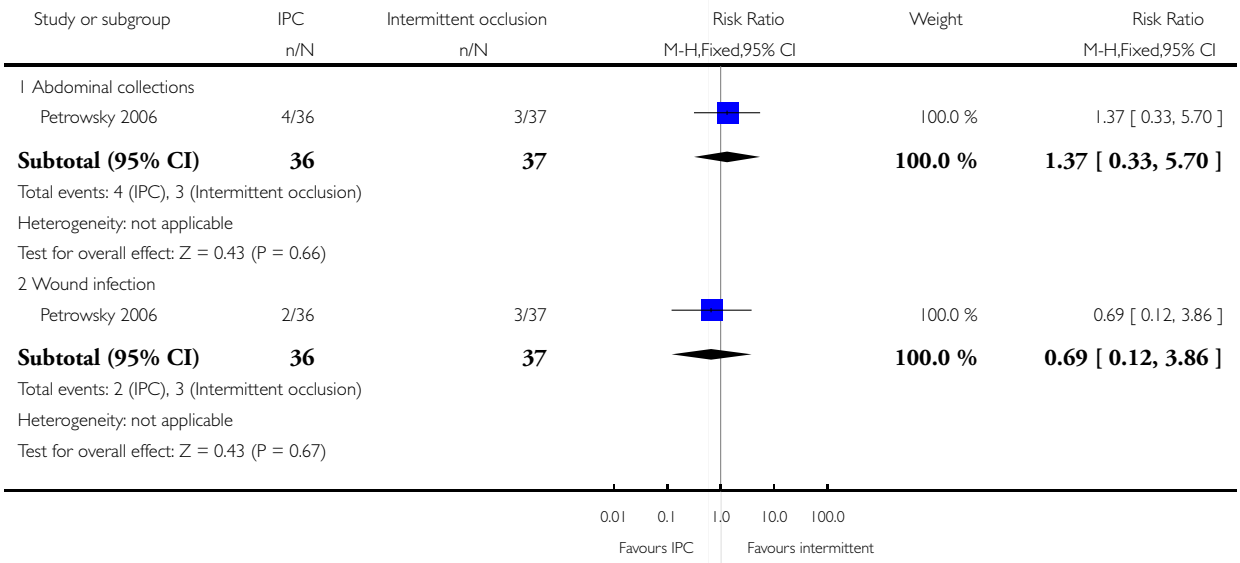


Analysis 6.3. Comparison 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion, Outcome 3 Peri-operative morbidity.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 3 Peri-operative morbidity



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Study or subgroup	IPC n/N	Intermittent occlusion n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
3 Pulmonary complications					
Petrowsky 2006	3/36	1/37		11.0 %	3.08 [0.34, 28.28]
Smyrniotis 2006	6/27	8/27		89.0 %	0.75 [0.30, 1.87]
Subtotal (95% CI)	**63**	**64**		**100.0 %**	**1.01 [0.44, 2.29]**
Total events: 9 (IPC), 9 (Intermittent occlusion)					
Heterogeneity: Chi^2 = 1.38, df = 1 (P = 0.24); I^2 =27%					
Test for overall effect: Z = 0.01 (P = 0.99)					
4 Bile leak					
Petrowsky 2006	4/36	3/37		59.7 %	1.37 [0.33, 5.70]
Smyrniotis 2006	3/27	2/27		40.3 %	1.50 [0.27, 8.28]
Subtotal (95% CI)	**63**	**64**		**100.0 %**	**1.42 [0.48, 4.25]**
Total events: 7 (IPC), 5 (Intermittent occlusion)					
Heterogeneity: Chi^2 = 0.01, df = 1 (P = 0.94); I^2 =0.0%					
Test for overall effect: Z = 0.63 (P = 0.53)					

Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

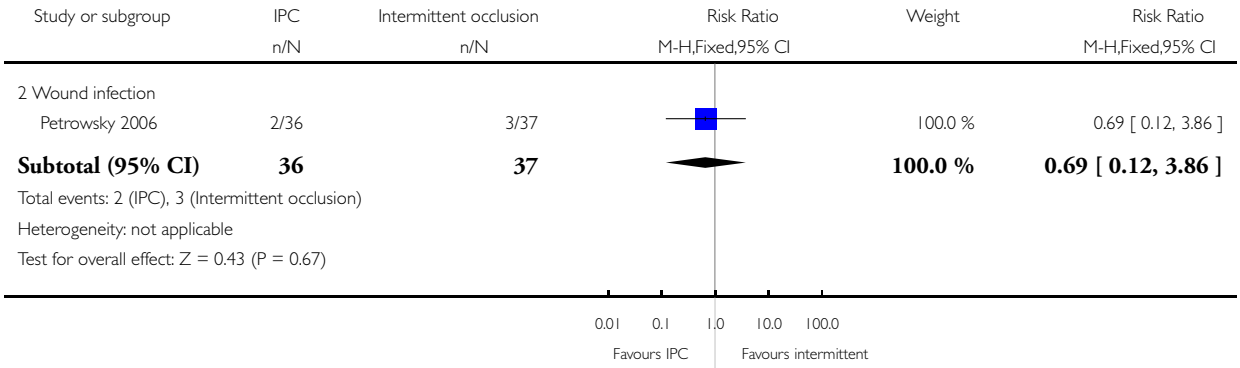
Outcome: 3 Peri-operative morbidity

Study or subgroup	IPC n/N	Intermittent occlusion n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 Abdominal collections					
Petrowsky 2006	4/36	3/37		100.0 %	1.37 [0.33, 5.70]
Subtotal (95% CI)	**36**	**37**		**100.0 %**	**1.37 [0.33, 5.70]**
Total events: 4 (IPC), 3 (Intermittent occlusion)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.43 (P = 0.66)					

Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

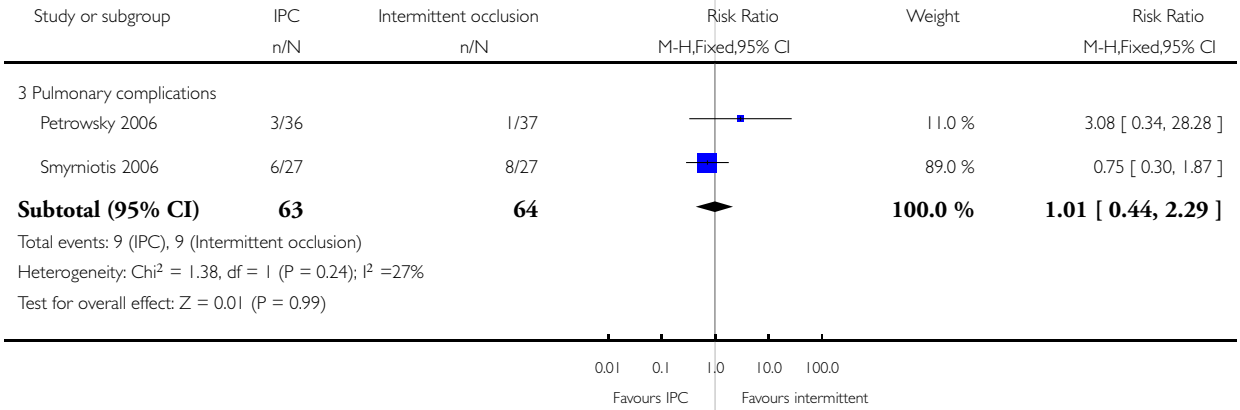
Outcome: 3 Peri-operative morbidity



Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 3 Peri-operative morbidity

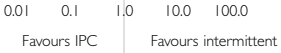


Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 3 Peri-operative morbidity

Study or subgroup	IPC n/N	Intermittent occlusion n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
4 Bile leak					
Petrowsky 2006	4/36	3/37		59.7 %	1.37 [0.33, 5.70]
Smyrniotis 2006	3/27	2/27		40.3 %	1.50 [0.27, 8.28]
Subtotal (95% CI)	**63**	**64**		**100.0 %**	**1.42 [0.48, 4.25]**
Total events: 7 (IPC), 5 (Intermittent occlusion)					
Heterogeneity: Chi^2 = 0.01, df = 1 (P = 0.94); I^2 =0.0%					
Test for overall effect: Z = 0.63 (P = 0.53)					



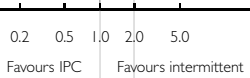
Analysis 6.4. Comparison 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion, Outcome 4 Number needing transfusion.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 4 Number needing transfusion

Study or subgroup	IPC n/N	Intermittent occlusion n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Petrowsky 2006	9/36	11/37		100.0 %	0.84 [0.40, 1.78]
Total (95% CI)	**36**	**37**		**100.0 %**	**0.84 [0.40, 1.78]**
Total events: 9 (IPC), 11 (Intermittent occlusion)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.45 (P = 0.65)					



Analysis 6.5. Comparison 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion, Outcome 5 Number of units transfused.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 5 Number of units transfused

Study or subgroup	IPC N	Mean(SD)	Intermittent occlusion N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Petrowsky 2006	36	1.7 (1.8)	37	2.9 (3)		57.6 %	-1.20 [-2.33, -0.07]
Smyrniotis 2006	27	0 (1.8)	27	0 (3)		42.4 %	0.0 [-1.32, 1.32]
Total (95% CI)	**63**		**64**			**100.0 %**	**-0.69 [-1.55, 0.17]**

Heterogeneity: Chi^2 = 1.83, df = 1 (P = 0.18); I^2 =45%

Test for overall effect: Z = 1.58 (P = 0.11)

Analysis 6.6. Comparison 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion, Outcome 6 Hospital stay (in days).

Review: Methods of vascular occlusion for elective liver resections

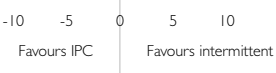
Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 6 Hospital stay (in days)

Study or subgroup	IPC N	Mean(SD)	Intermittent occlusion N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Petrowsky 2006	36	14.7 (9.6)	37	12.7 (8.5)		30.1 %	2.00 [-2.16, 6.16]
Smyrniotis 2006	27	10 (4)	27	11 (3)		69.9 %	-1.00 [-2.89, 0.89]
Total (95% CI)	**63**		**64**			**100.0 %**	**-0.10 [-2.79, 2.60]**

Heterogeneity: Tau^2 = 1.78; Chi^2 = 1.65, df = 1 (P = 0.20); I^2 =40%

Test for overall effect: Z = 0.07 (P = 0.94)

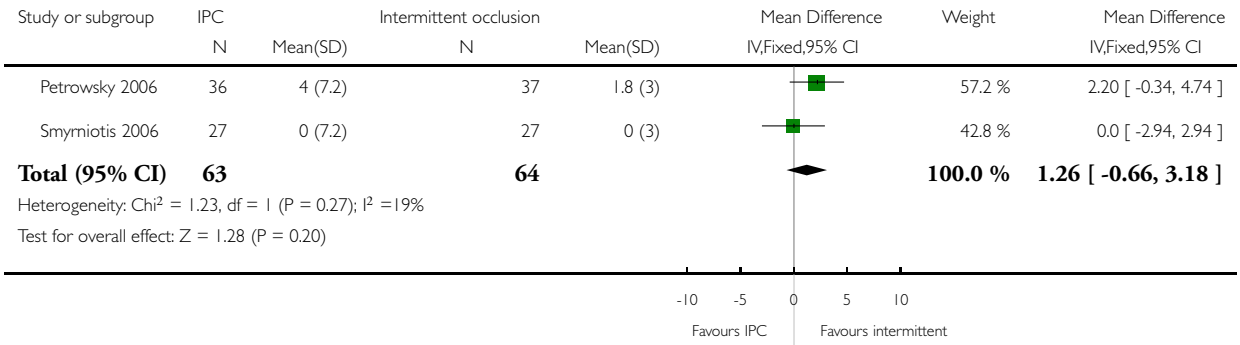


Analysis 6.7. Comparison 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion, Outcome 7 ITU stay (in days).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 7 ITU stay (in days)

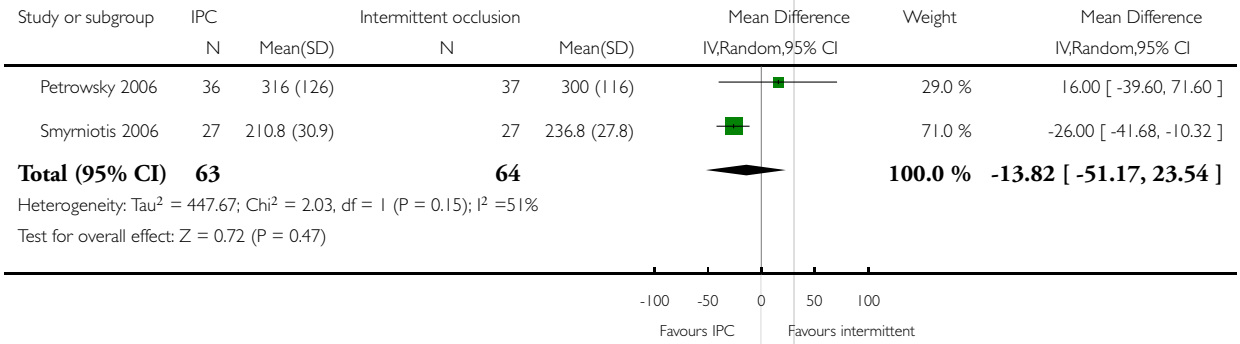


Analysis 6.8. Comparison 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion, Outcome 8 Operating time.

Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 8 Operating time

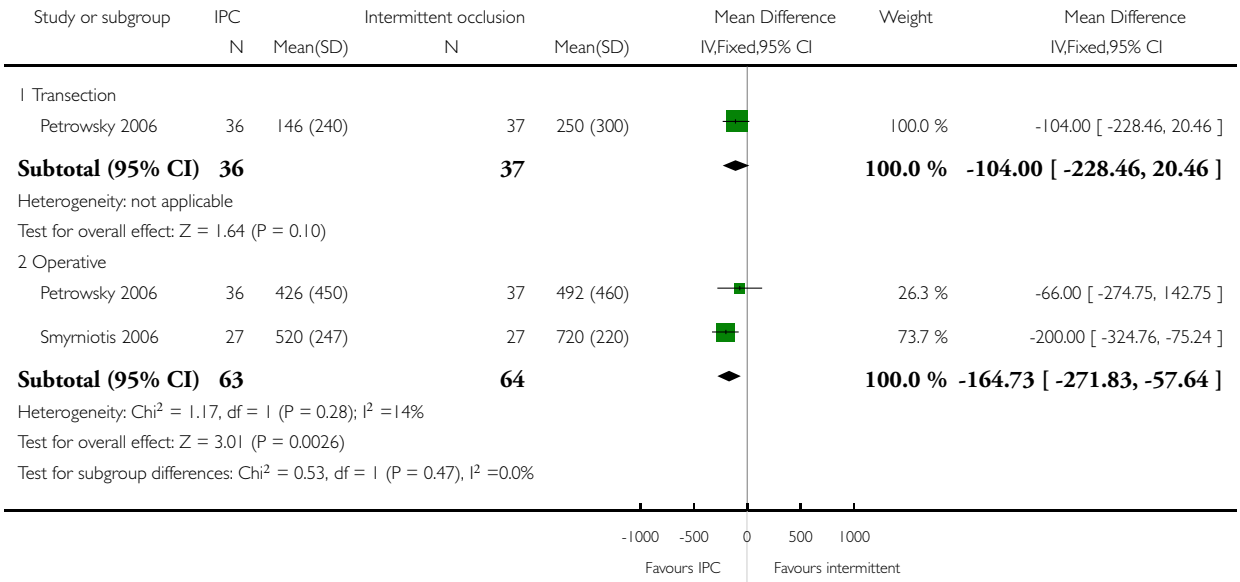


Analysis 6.9. Comparison 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion, Outcome 9 Blood loss (ml).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

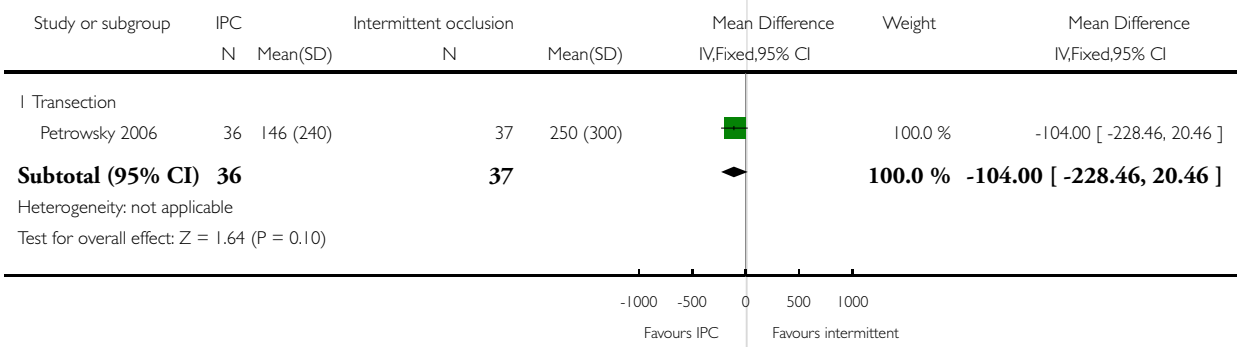
Outcome: 9 Blood loss (ml)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

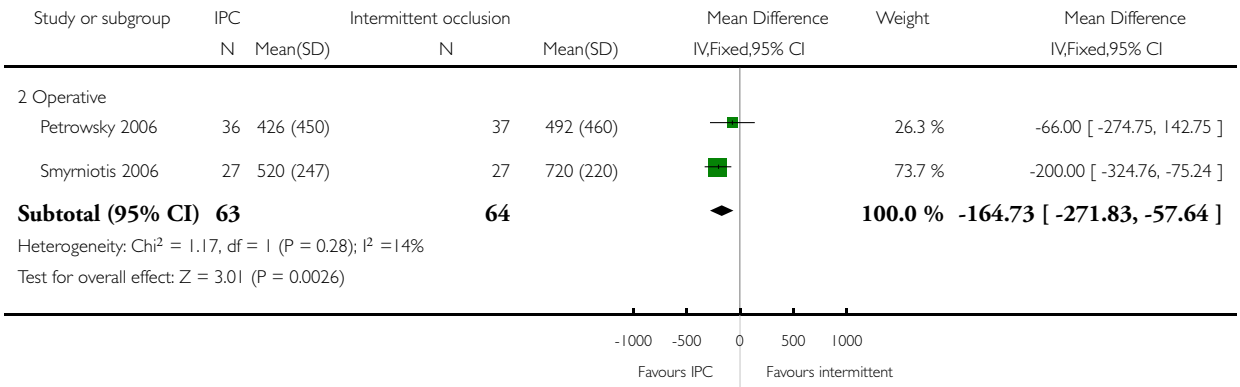
Outcome: 9 Blood loss (ml)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 9 Blood loss (ml)

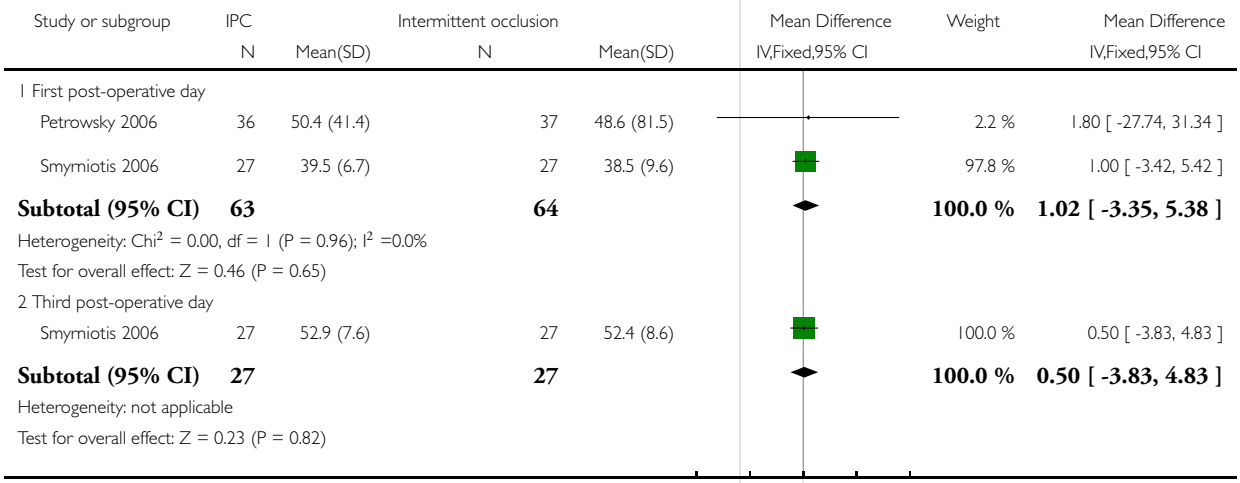


Analysis 6.10. Comparison 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion, Outcome 10 Bilirubin (micromole/litre).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 10 Bilirubin (micromole/litre)



(*Continued . . .*)

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Study or subgroup	IPC N	Mean(SD)	Intermittent occlusion N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
3 Sixth post-operative day							
Smyrniotis 2006	27	34.3 (9.1)	27	30.5 (7)		100.0 %	3.80 [-0.53, 8.13]
Subtotal (95% CI)	**27**		**27**			**100.0 %**	**3.80 [-0.53, 8.13]**

Heterogeneity: not applicable

Test for overall effect: Z = 1.72 (P = 0.085)

Test for subgroup differences: Chi^2 = 1.29, df = 2 (P = 0.52), I^2 =0.0%

Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 10 Bilirubin (micromole/litre)

Study or subgroup	IPC N	Mean(SD)	Intermittent occlusion N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 First post-operative day							
Petrowsky 2006	36	50.4 (41.4)	37	48.6 (81.5)		2.2 %	1.80 [-27.74, 31.34]
Smyrniotis 2006	27	39.5 (6.7)	27	38.5 (9.6)		97.8 %	1.00 [-3.42, 5.42]
Subtotal (95% CI)	**63**		**64**			**100.0 %**	**1.02 [-3.35, 5.38]**

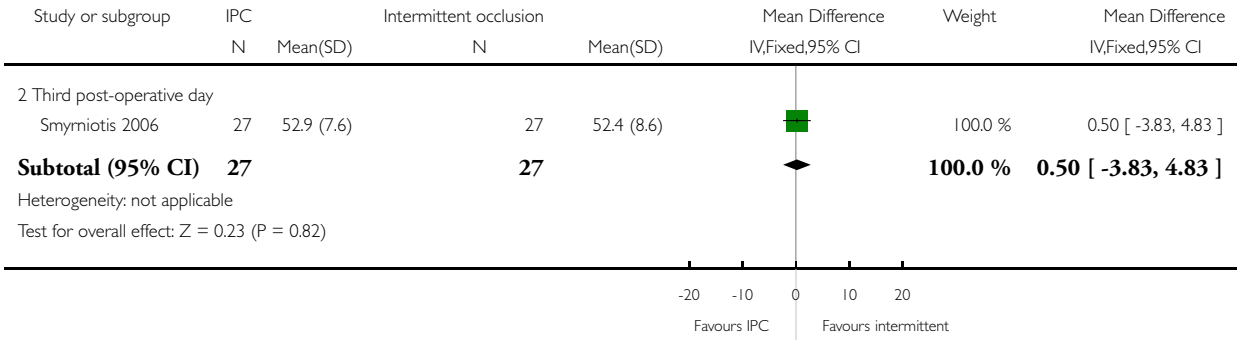
Heterogeneity: Chi^2 = 0.00, df = 1 (P = 0.96); I^2 =0.0%

Test for overall effect: Z = 0.46 (P = 0.65)

Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

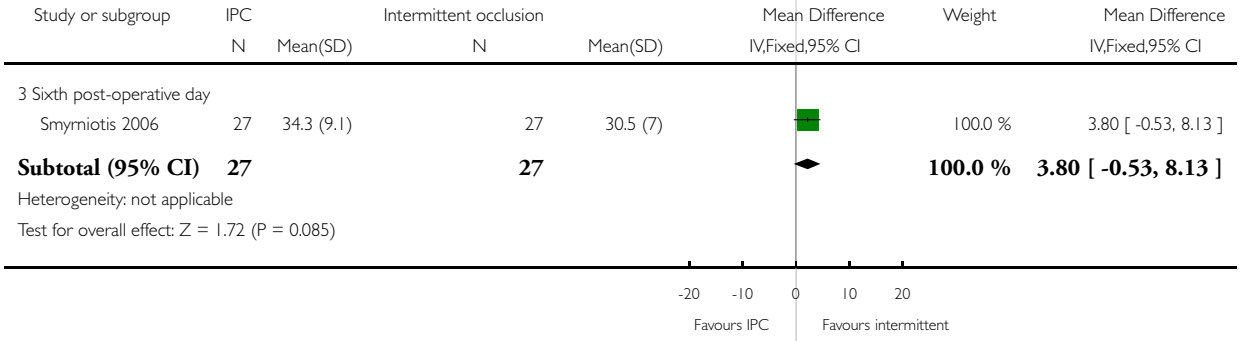
Outcome: 10 Bilirubin (micromole/litre)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 10 Bilirubin (micromole/litre)



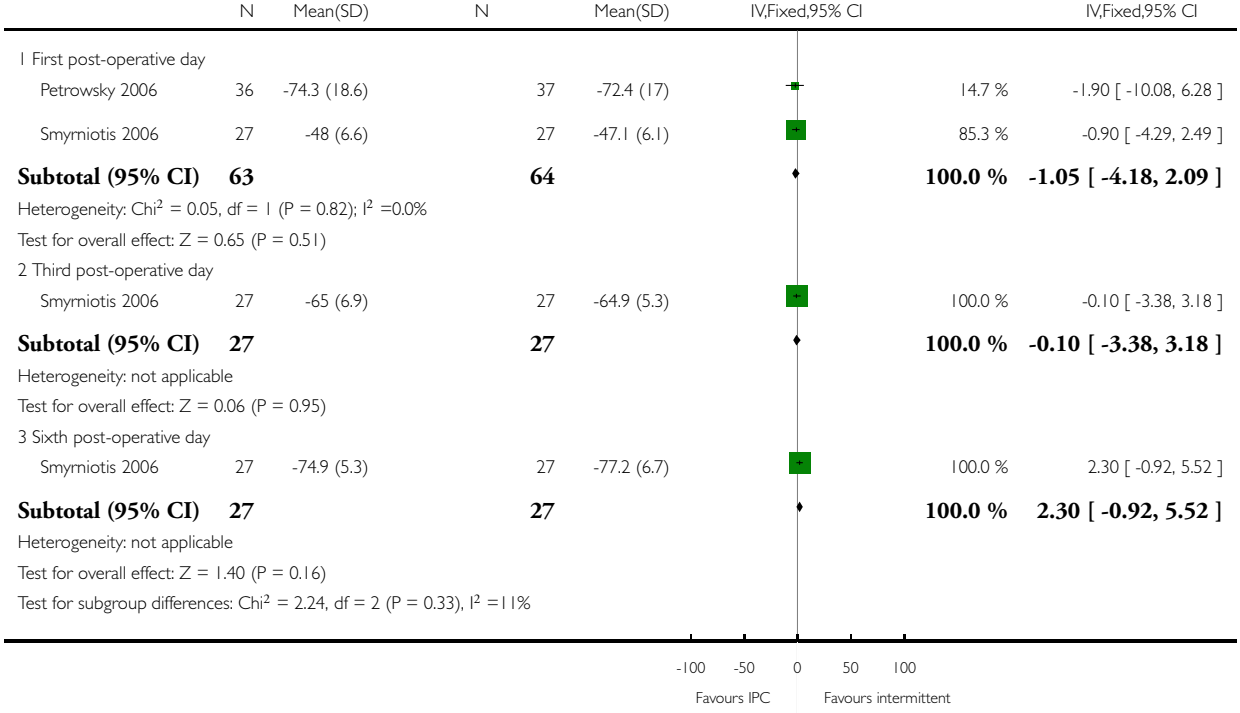
Analysis 6.11. Comparison 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion, Outcome 11 Prothrombin activity (percentage of normal).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 11 Prothrombin activity (percentage of normal)

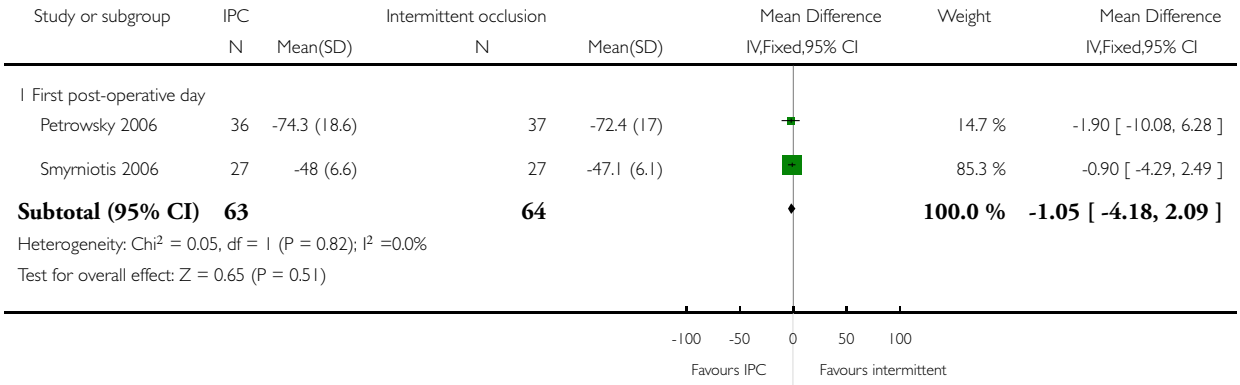
Study or subgroup	IPC N	Mean(SD)	Intermittent occlusion N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 First post-operative day							
Petrowsky 2006	36	-74.3 (18.6)	37	-72.4 (17)		14.7 %	-1.90 [-10.08, 6.28]
Smyrniotis 2006	27	-48 (6.6)	27	-47.1 (6.1)		85.3 %	-0.90 [-4.29, 2.49]
Subtotal (95% CI)	**63**		**64**			**100.0 %**	**-1.05 [-4.18, 2.09]**
Heterogeneity: Chi^2 = 0.05, df = 1 (P = 0.82); I^2 =0.0%							
Test for overall effect: Z = 0.65 (P = 0.51)							
2 Third post-operative day							
Smyrniotis 2006	27	-65 (6.9)	27	-64.9 (5.3)		100.0 %	-0.10 [-3.38, 3.18]
Subtotal (95% CI)	**27**		**27**			**100.0 %**	**-0.10 [-3.38, 3.18]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.06 (P = 0.95)							
3 Sixth post-operative day							
Smyrniotis 2006	27	-74.9 (5.3)	27	-77.2 (6.7)		100.0 %	2.30 [-0.92, 5.52]
Subtotal (95% CI)	**27**		**27**			**100.0 %**	**2.30 [-0.92, 5.52]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.40 (P = 0.16)							
Test for subgroup differences: Chi^2 = 2.24, df = 2 (P = 0.33), I^2 =11%							



Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

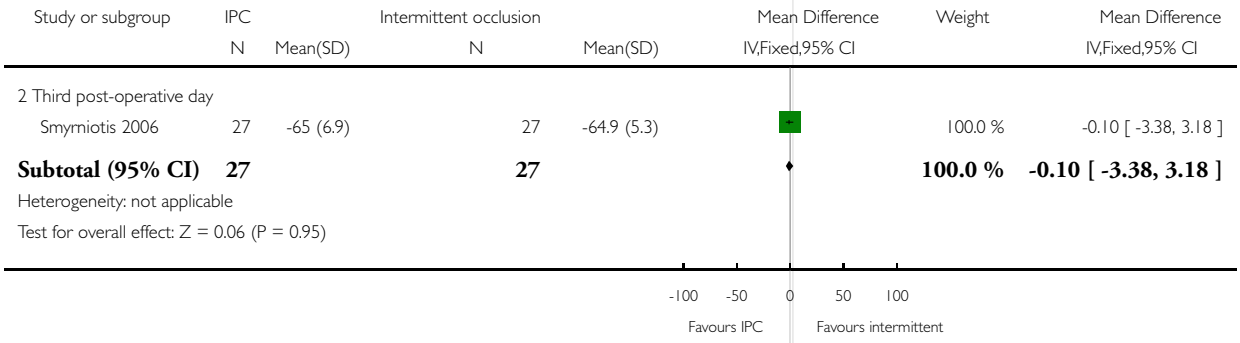
Outcome: 11 Prothrombin activity (percentage of normal)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

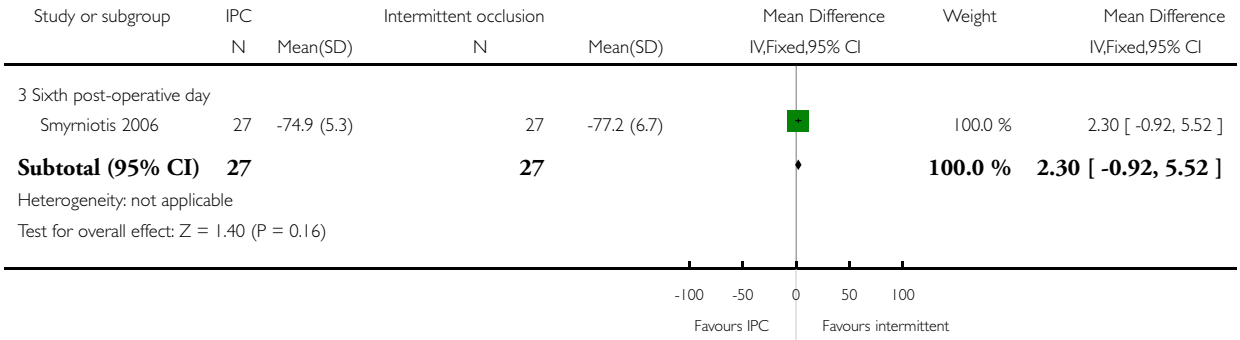
Outcome: 11 Prothrombin activity (percentage of normal)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 11 Prothrombin activity (percentage of normal)

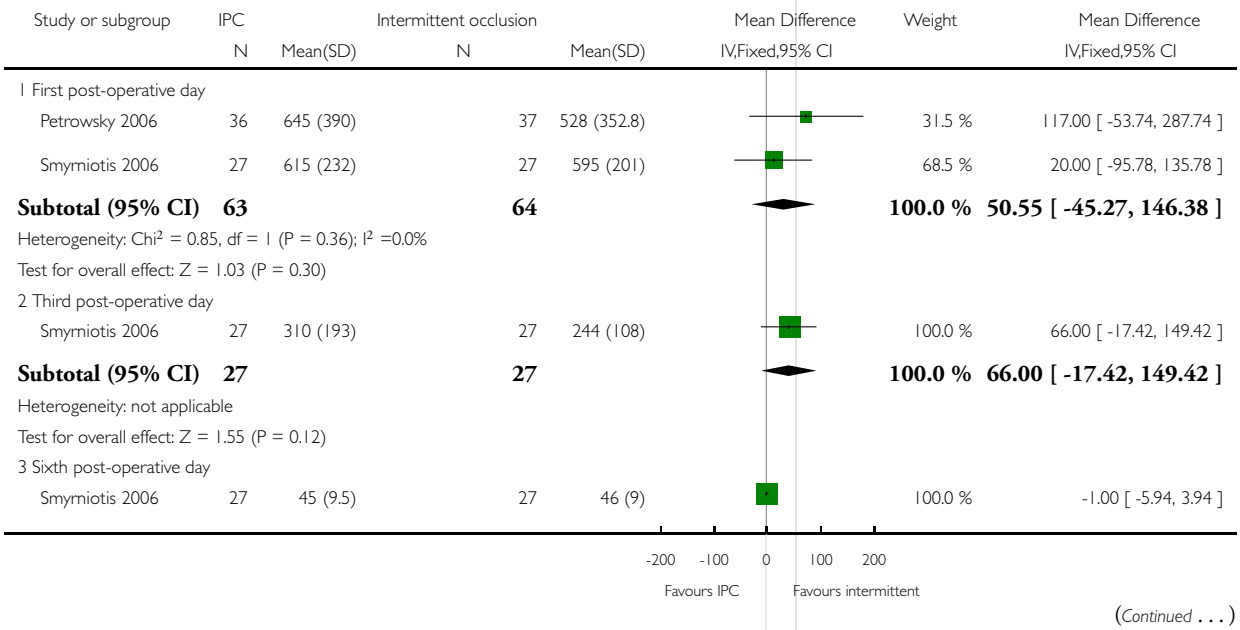


Analysis 6.12. Comparison 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion, Outcome 12 AST (IU/L).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 12 AST (IU/L)



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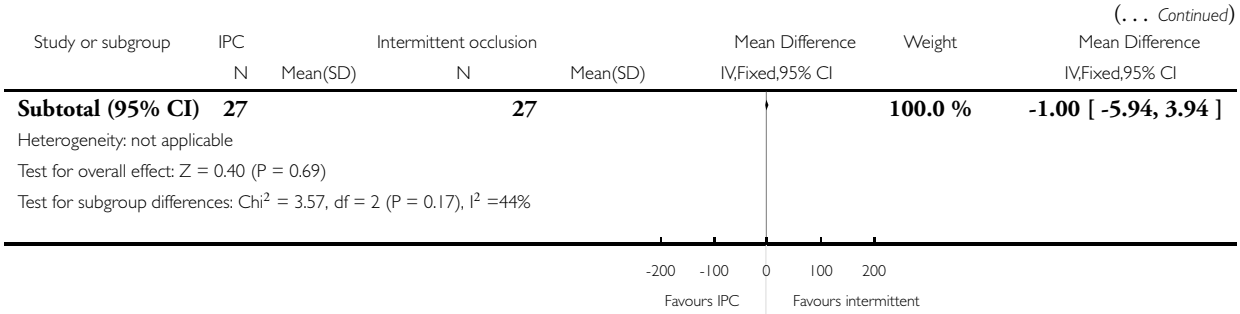
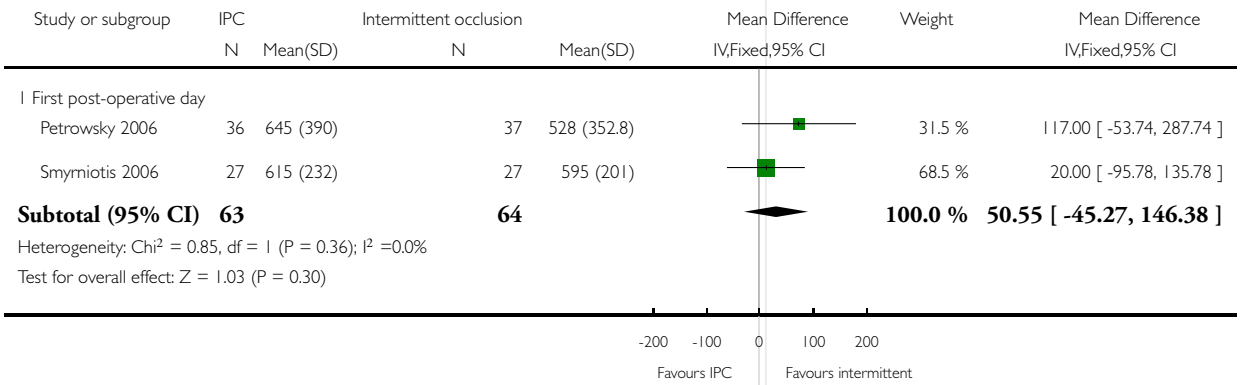


Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

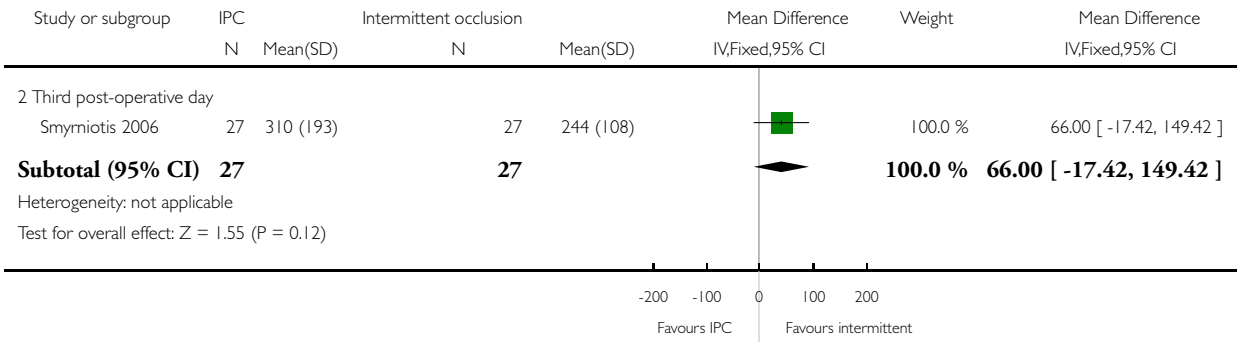
Outcome: 12 AST (IU/L)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

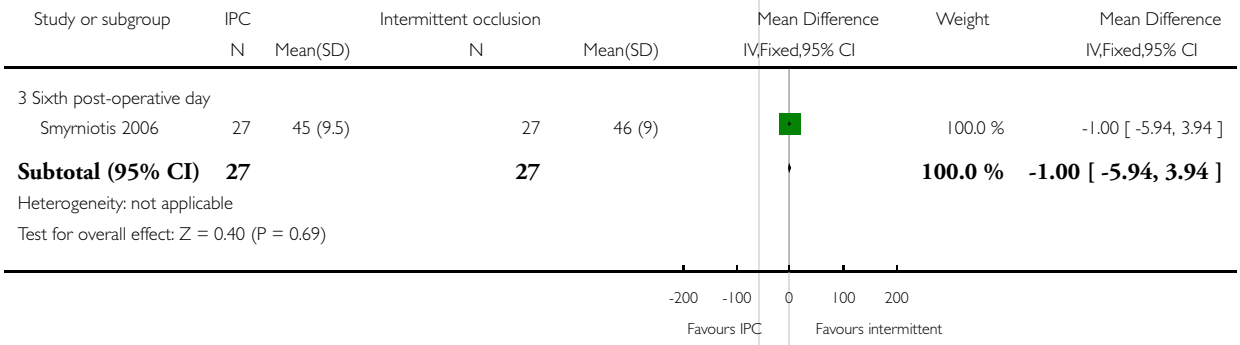
Outcome: 12 AST (IU/L)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 12 AST (IU/L)

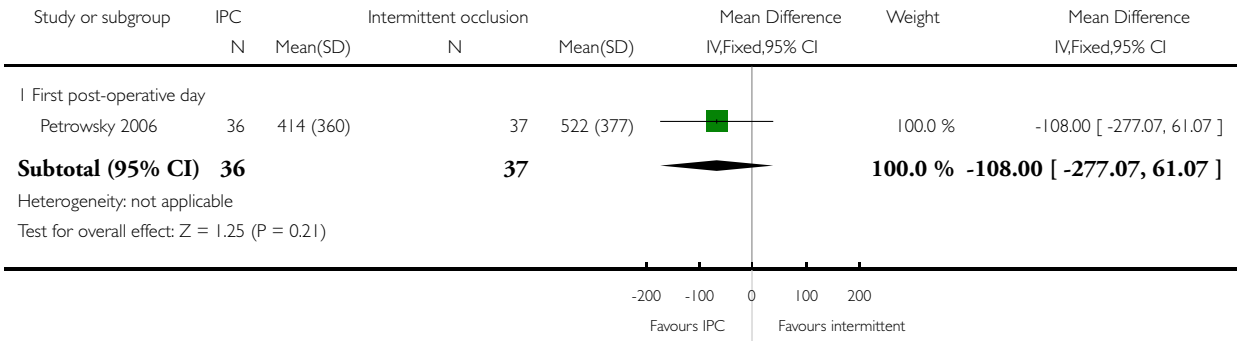


Analysis 6.13. Comparison 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion, Outcome 13 ALT (IU/L).

Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

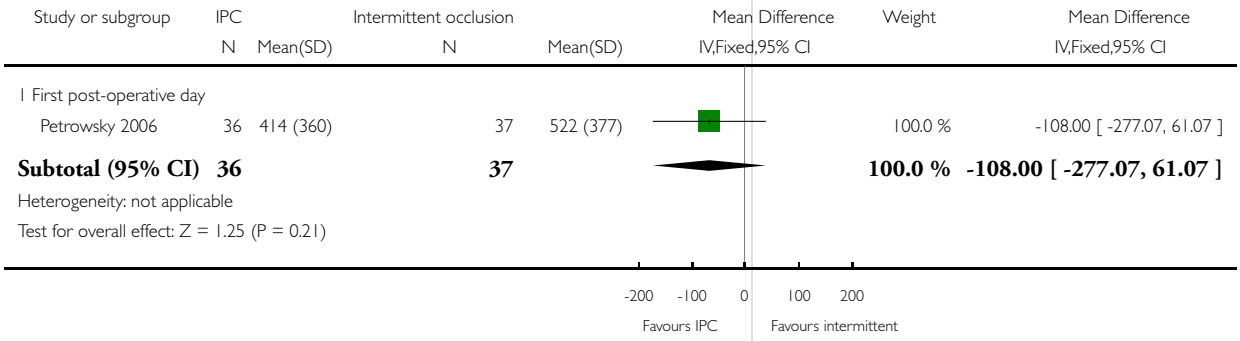
Outcome: 13 ALT (IU/L)



Review: Methods of vascular occlusion for elective liver resections

Comparison: 6 Ischaemic preconditioning followed by continuous occlusion (IPC) versus intermittent occlusion

Outcome: 13 ALT (IU/L)



APPENDICES

Appendix 1. Search strategies

Database	Period	Search strategy used
The Cochrane Hepato-Biliary Group Controlled Trials Register	August 2008	(((occlusion OR clamping OR exclusion) AND (vascular OR vessel OR arter* OR venous OR vein OR hepatic or portal)) OR pringle OR ((ischaemi* OR ischemi*) AND (precondition*))) AND (liver OR hepatic) AND (segmentectomy OR resection OR transplant* OR graft*)
Cochrane Central Register of Controlled Trials (CENTRAL) in The Cochrane Library	Issue 3, 2008	#1 ((occlusion OR clamping OR exclusion) AND (vascular OR vessel OR arter* OR venous OR vein OR hepatic or portal)) OR pringle in All Fields in all products #2 (ischaemi* OR ischemi*) AND precondition* in All Fields in all products #3 MeSH descriptor Ischemic Preconditioning explode all trees in MeSH products #4 MeSH descriptor Ischemia explode all trees in MeSH products #5 (#1 OR #2 OR #3 OR #4) #6 liver OR hepatic in All Fields in all products #7 MeSH descriptor Liver explode all trees in MeSH products #8 MeSH descriptor Liver Diseases explode all trees in MeSH products #9 MeSH descriptor Liver Neoplasms explode all trees in MeSH products #10 (#6 OR #7 OR #8 OR #9) #11 segmentectomy OR resection OR transplant* OR graft* in All Fields in all products #12 (#10 AND #11) #13 MeSH descriptor Hepatectomy explode all trees in MeSH products #14 MeSH descriptor Liver Transplantation explode all trees in MeSH products #15 (#12 OR #13 OR #14) #16 (#5 AND #15)
MEDLINE (PubMed; http://www.ncbi.nlm.nih.gov/sites/entrez/)	January 1950 to August 2008	((((occlusion OR clamping OR exclusion) AND (vascular OR vessel OR arter* OR venous OR vein OR hepatic or portal)) OR pringle) OR (((ischaemi* OR ischemi*) AND precondition*) OR "ischemic pre-

(*Continued*)

		conditioning"[MeSH Terms] OR "ischemia"[MeSH Terms])) AND ((("Liver"[MeSH] OR "Liver Neoplasms"[MeSH] OR "Liver Diseases"[MeSH] OR liver OR hepatic) AND (segmentectomy OR resection OR transplant* OR graft*)) OR "Hepatectomy"[MeSH] OR "Liver Transplantation"[MeSH]) AND ((randomized controlled trial [pt] OR controlled clinical trial [pt] OR randomized [tiab] OR placebo [tiab] OR drug therapy [sh] OR randomly [tiab] OR trial [tiab] OR groups [tiab]) AND humans [mh])
EMBASE (NHS National Library for Health; http://www.library.nhs.uk/booksandjournals	January 1974 to August 2008	1 (((occlusion OR clamping OR exclusion) AND (vascular OR vessel OR arter* OR venous OR vein OR hepatic OR portal)) OR pringle).af 2 ((ischaemi* OR ischemi*) AND precondition*).af 3 exp REPERFUSION INJURY/ 4 exp ISCHEMIC PRECONDITIONING/ 5 exp ISCHEMIA/ 6 1 OR 2 OR 3 OR 4 OR 5 7 (((liver OR hepatic OR hepato) AND (segmentectomy OR resection OR transplant* OR graft*)) OR hepatectomy).af 8 exp LIVER RESECTION/ 9 exp LIVER TRANSPLANTATION/ 10 7 OR 8 OR 9 11 6 AND 10 12 exp CROSSOVER PROCEDURE/ 13 exp DOUBLE BLIND PROCEDURE/ 14 exp SINGLE BLIND PROCEDURE/ 15 exp RANDOMIZED CONTROLLED TRIAL/ 16 (RANDOM* OR FACTORIAL* OR CROSSOVER* OR CROSS AND OVER* OR PLACEBO* OR (DOUBL* AND BLIND*) OR (SINGL* AND BLIND*) OR ASSIGN* OR ALLOCAT* OR VOLUNTEER*).af 17 12 OR 13 OR 14 OR 15 OR 16 18 11 AND 17
Science Citation Index Expanded (http://apps.isiknowledge.com/WOS˙Advar	January 1970 to August 2008	#1 TS=(((occlusion OR clamping OR exclusion) AND (vascular OR vessel OR arter* OR venous OR vein OR lvancedSearch) hepatic or portal)) OR pringle) #2 TS=((ischaemi* OR ischemi*) AND precondition*) #3 #2 OR #1 #4 TS=(liver OR hepatic) #5 TS=(segmentectomy OR resection OR transplant* OR graft*)

(*Continued*)

		#6 #5 AND #4 #7 #6 AND #3 #8 TS=(random* OR blind*OR placebo* OR meta-analysis) #9 #8 AND #7
Lilacs (http://www.bireme.br/php/index.php?lang	August 2008	liver OR hepatic [Palavras] and segmentectomy OR resection OR transplant OR graft [Palavras] and (occlusion OR clamping OR exclusion OR pringle [Palavras]

HISTORY

Protocol first published: Issue 1, 2007

Review first published: Issue 1, 2009

31 August 2008	Amended	Searches for new trails were performed in August 2008.
23 April 2008	Amended	Converted to new review format.

CONTRIBUTIONS OF AUTHORS

K Gurusamy wrote the review after identifying the trials for inclusion, extracting data, and performing the statistical analysis. H Sheth and Y Kumar independently identified trials and extracted the data from the trials. D Sharma and BR Davidson critically commented on the review and made suggestions to improve the review.

DECLARATIONS OF INTEREST

BR Davidson is currently performing a pilot study to evaluate the benefit of remote ischaemic preconditioning in liver resection surgery and transplantation.

SOURCES OF SUPPORT

Internal sources

- None, Not specified.

External sources

- None, Not specified.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Two new outcomes, ie, operating time and haemodynamic parameters, were added because procedures, such as hepatic vascular exclusion, involve additional procedure and may increase the operating time and may cause haemodyanmic instability.

Differences between previous version and current version

The outcomes have been revised and ordered according to the clinical significance. The non-clinical outcomes ie, mediators of ischaemia-reperfusion injury (eg, neutrophil count, reactive oxygen species; apoptosis and mediators of apoptosis; and evidence for breakdown of adenosine 5'-triphosphate (ATP) (adenosine, metabolites of adenosine like xanthine, hypoxanthine) have been removed in order to improve the flow and give importance to clinical outcomes. The methods of assessment of risk of bias have been updated in line with the updated Cochrane Handbook (Higgins 2008) and the Cochrane Hepato-Bilairy Group Module (Gluud 2008). Imputation of standard deviation has been performed, and trials, which could not be included for meta-analysis previously, have been now included for meta-analysis. Risk ratios rather than odds ratios have been calculated. Minor errors in data extraction and data entry have been corrected.

NOTES

The present 'Methods of vascular occlusion for elective liver resections' together with 'Vascular occlusion for liver resection' and 'Ischaemic pre-conditioning for liver resections performed under vascular occlusion' reviews is one of the three new, up-to-date reviews evolved from the previously published in 2007 review with the same title 'Methods of vascular occlusion for elective liver resections' review (Gurusamy 2007).