REVIEW ARTICLE

Portal triad clamping versus other methods of vascular control in liver resection: a systematic review and meta-analysis

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Abstract

Background: Portal triad clamping (PTC) is the most commonly used method of achieving vascular control during liver resection. However, the efficacy and safety of PTC, compared with those of other methods of vascular control, are uncertain.

Methods: A systematic review was conducted to identify randomized controlled trials (RCTs) comparing PTC with other methods of vascular control during liver resection. Endpoints included in-hospital mortality, need for transfusion, number of complications and length of hospital stay. Meta-analyses were performed using a random-effects model.

Results: Ten RCTs were identified; these included a total of 820 patients. No statistically significant differences between PTC and other forms of vascular control in liver resection were demonstrated.

Conclusions: There is no evidence, on the basis of this meta-analysis of RCTs, of any difference between PTC and other forms of vascular control in liver resection.

Keywords

resection, liver, haemorrhage, portal triad clamping, hepatectomy, vascular control

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Introduction

Haemorrhage has historically represented one of the major risks in liver resection and the amount of blood lost is proportionally linked to operative morbidity and mortality.[1–3] Moreover, blood transfusion is associated with increased tumour recurrence after hepatectomy for both hepatocellular cancer and colorectal metastases.[4–6] This effect seems to be present with both autologous and allogeneic blood products.[7] In the 1970s, major liver resection was associated with operative mortality rates of > 20% and a significant proportion of these deaths resulted from intraoperative haemorrhage.[8] Over the last three decades, there have been significant improvements in the results of liver resection. Operative mortality is < 5% in most modern series[9–12] and > 90% of all hepatectomies are performed without transfusion.[13–15] These improvements reflect better understanding of liver anatomy,[16] improved surgical techniques (including the maintenance of low central venous pressure),[17,18] more sophisticated equipment, advances in perioperative care and superior methods of anaesthesia.[19] Portal triad clamping (PTC) has traditionally been the preferred method of vascular control, but, more recently, other means of vascular control during hepatic resection have been described. These include selective hepatic vascular exclusion (SHVE),[20] total hepatic vascular exclusion (THVE)[21,22] and hepatic vascular exclusion with caval flow preservation.[23,24] Specialized techniques for liver mobilization, such as the hanging manoeuvre, combined with the various types of vascular control have also been reported.[25]

Although both intermittent and continuous PTC have been widely used, ≤ 60 min of continuous clamping has been shown to be safe under normothermic conditions, provided there is no pre-existing parenchymal liver disease rendering the organ more susceptible to ischaemia.[26,27] More recently, it has been suggested that intermittent PTC can be detrimental to outcome through damage to the liver parenchyma during multiple reperfusion episodes, associated with bleeding during reperfusion and a longer operating time.[28] Ischaemic preconditioning consists of a short period (e.g. 10 min) of clamping, followed by reperfusion (often

10 min) applied prior to the prolonged clamping.[14] Although the possible benefit of preconditioning was first seen in models of coronary occlusion,[29] a recent meta-analysis failed to show any benefit of the technique in liver resection.[30] The aim of this systematic review and meta-analysis was to review the efficacy and safety of PTC compared with those of other forms of vascular control in patients undergoing liver resection.

Materials and methods

Literature search

A systematic literature search was independently conducted by two authors (AJR and VWTL). The following electronic databases were searched: MEDLINE (1950–2011); EMBASE (1974–2011); the Cochrane Controlled Trials Register, and the Science Citation Index. Combinations of medical subject headings (MeSH), as well as keywords, were used, including the following terms: 'inflow occlusion'; 'hepatic vascular exclusion'; 'vascular occlusion'; 'portal triad occlusion'; 'Pringle manoeuvre'; 'hepatectomy'; 'liver resection'; 'hemi-hepatectomy'; 'hepatic surgery', and 'liver surgery'. The literature search was not restricted by language or year of publication, but was restricted to human trials. The last search was performed on 14 October 2011. All the relevant articles identified were manually searched and independent experts were contacted in order to retrieve other relevant articles.

Study selection and primary endpoints

Only randomized controlled trials (RCTs) were included in the review. Studies comparing intermittent or continuous PTC with other means of vascular control in liver resection with or without ischaemic preconditioning were included. Studies describing paediatric liver resections, procedures related to transplantation or laparoscopic liver resection were excluded, as were animal trials. Studies comparing continuous with intermittent PTC were excluded.

The primary endpoints analysed were in-hospital mortality and number of patients receiving a blood transfusion. The secondary endpoints analysed were intraoperative blood loss, postoperative liver failure, total number of complications and operative time. Total number of complications was a composite endpoint that referred to incidences of myocardial infarction, chest infection, pulmonary embolus, bile leak and intra-abdominal collections. Studies with insufficient data relating to the defined primary or secondary outcomes were excluded. The reporting was conducted in accordance with the PRISMA criteria.[31] Two reviewers independently performed study selection (AJR and VWTL) and disagreements were resolved by discussion with the third author (JML).

The methodological quality of studies was assessed to establish whether each study fulfilled the following criteria: use of adequate sequence generation; allocation concealment; use of blinding; addressing of incomplete data, and freedom from selective reporting and other biases.

Statistical analysis

Meta-analyses were performed using RevMan 5.0 (Review Manager Version 5.0; Cochrane Collaboration, Oxford, UK). Primary outcomes were expressed as odds ratios (ORs) with 95% confidence intervals (95% CIs) derived by the mean difference (MD) method with a random-effects model.[32] The Mantel–Haenzsel (M–H) method was used for dichotomous outcomes and the inverse variance method was used for continuous outcomes. Heterogeneity was assessed using Cochran's Q statistic and an I^2 statistic, where values of $\leq 25\%$ were considered to indicate low heterogeneity and values of $\geq 75\%$ were taken to indicate high heterogeneity.[33] Forest plots were constructed and P-values of < 0.05 were considered to indicate statistical significance. Funnel plots were constructed to assess for potential publication bias.

Results

Description of studies

Ten studies[34–43] met the predefined criteria for inclusion in the meta-analysis; these are summarized in Table 1. The search strategy is shown in Fig. 1. The studies originated from China, France, Hong Kong, Germany, Greece and Italy. Outcomes for a total of 820 patients reported in the RCTs were available for meta-analysis. These included 409 and 411 patients undergoing hepatectomy with PTC and SHVE, respectively. The mean ± standard error of the mean (SEM) of the mean ages was 52.3 ± 3.3 years in the PTC group and 51.4 ± 3.3 years in the SHVE group. Methods of PTC and the control SHVE technique with which they were compared varied substantially across the studies analysed (Table 2). Methods of SHVE ranged from no vascular control at all, to complete vascular isolation of the liver achieved using both infra- and suprahepatic inferior vena cava clamping or clamping of all hepatic veins. The PTC technique was also variably continuous or intermittent with or without ischaemic preconditioning.

Study quality

Statistically significant heterogeneity was observed in analyses of blood loss ($I^2 = 92\%$), operative times ($I^2 = 84\%$), postoperative stays ($I^2 = 94\%$) and transfusion requirements ($I^2 = 80\%$), but not in analyses of mortality ($I^2 = 0\%$), postoperative liver failure ($I^2 = 0\%$) or incidences of postoperative complications ($I^2 = 29\%$). Given the small number of studies reporting data appropriate for analysis, funnel plot analysis could only be used to explore bias[44,45] in mortality (Fig. 2a), transfusion requirements (Fig. 2b) and incidences of postoperative complications (Fig. 2c). No significant funnel plot asymmetry was observed in these analyses. A risk for bias diagram is shown in Fig. 3. Only two studies reported the method of randomization.[38,40]

Mortality

There were six deaths in the PTC group and five in the SHVE group. Data were available in all 10 studies analysed and there was