Continuous Versus Interrupted Suture for Hepatic Artery Anastomosis in Liver Transplantation: Differences in the Incidence of Hepatic Artery Thrombosis


ABSTRACT
Background. Hepatic artery thrombosis (HAT) is a serious complication after orthotopic liver transplantation (OLT) and remains a significant cause of graft loss. HAT following OLT has been reported in 3% to 9% of patients. Among the surgical factors considered to be associated with HAT, arterial reconstruction might be the most important. The goal of this study was to compare the incidence of HAT between interrupted suture (IS) and continuous suture (CS) techniques during hepatic artery reconstruction in liver transplantation.

Methods. We performed a retrospective analysis of 200 consecutive liver transplantsations occurring between May 2002 and December 2006, including medical records for: age, gender, cold ischemic time, warm ischemic time, type and number of arterial anastomosis. Hepatic artery anastomoses were performed using a 7-0 prolene with a running CS in the first 105 patients (CS group), and with an IS in the last 95 patients (IS group).

Results. Statistical analysis of age, gender, cold and warm ischemia time, and number of hepatic artery anastomoses was not different between the CS and IS groups. Eleven episodes of HAT were identified in the CS group (10%) and two episodes (2%) in the IS cohort, a significant difference (P = .0173).

Conclusions. Our results suggested that IS might be a better choice for hepatic artery anastomosis with a lower incidence of HAT.

HEPATIC ARTERY THROMBOSIS (HAT) is a serious complication after orthotopic liver transplantation (OLT) and remains a significant cause of graft loss. Other hepatic artery complications include stenosis, aneurysm, and steal syndromes. HAT following OLT has been reported in 3% to 9% of patients. HAT can be early (within 4 weeks) or delayed (after 4 weeks). In the first case, patients may present with acute graft failure, sepsis, liver abscess, and bile duct complications or be asymptomatic. When HAT is delayed, clinical presentation is more variable, including features of cholangitis, with or without strictures or abscesses, bile leaks, or even clinically silent HAT with altered liver function tests. Many nonsurgical and surgical risk factors are associated with HAT. Nonsurgical factors include multiple rejection episodes, a long cold ischemia time, cytomegalovirus infection, excessive transfusion of frozen fresh plasma, cigarette smoking, ischemia-reperfusion injury, immunologic factors, coagulation abnormalities, and transplantation across ABO blood group. Among the surgical factors considered to be associated with HAT, arterial reconstruction may be the most important. Treatment of early HAT could be performed by radiological interventional techniques even in pediatric patients or by surgical intervention. Urgent revascularization with...
thrombectomy has been successful in selected patients.\(^1\) Sometimes a repeat liver transplantation is necessary, albeit with a high mortality rate. The goal of this study was to compare the incidence of HAT between an interrupted suture (IS) and a continuous suture (CS) technique during artery hepatic reconstruction in liver transplantation.

**PATIENTS AND METHODS**

We performed a retrospective analysis of 200 consecutive liver transplants from cadaveric donors, occurring between May 2002 and December 2006. Medical records of all transplanted patients were reviewed for age, gender, cold ischemic time, warm ischemic time, type and number of arterial anastomosis. Hepatic artery anastomoses were performed using 7-0 prolene with a running CS in the first 105 patients (CS group) and with an IS technique in the last 95 patients (IS group). In both groups, the anastomoses were performed using the donor celiac artery trunk to the recipient’s hepatic artery by the same surgeon, who had previous experience in vascular anastomosis. Doppler ultrasonography was performed on days 1 and 7 after transplantation and selectively afterward. If HAT was detected by Doppler ultrasonography, it was confirmed by angiography. Immunosuppression regimen was based on steroids and tacrolimus. We did not use anticoagulation therapy in our protocol. Hematocrit level was maintained at about 30%; we monitored liver function and blood coagulation time. We excluded all patients with aortic conduits.

Data were analyzed using Statistical Package for the Social Sciences, SPSS, Chicago, Ill, USA) with chi-square tests.

**RESULTS**

We analyzed 200 patients with end-stage liver disease, 151 men and 49 women, who underwent liver transplantation. The most common etiology of cirrhosis was hepatitis virus C or alcohol. The mean recipient age was 48 years. We observed 13 episodes of HAT, an overall complication rate of 6%. Nine patients presented with early and four with late HAT. Among the nine patients with early HAT, seven presented in the first week after transplantation. All patients were diagnosed by Doppler ultrasonography and confirmed by angiography. Statistical analysis of age, gender, cold ischemia time, and warm ischemia time, as well as number of hepatic artery anastomoses was not different between the CS and IS groups (Table 1).

Eleven episodes of HAT were identified in the CS group (10%). Nine were treated with retransplant, one died a waiting a liver retransplantation, and one had conservative treatment with survival. In the IS group were two episodes HAT (2%). One patient died after liver retransplantation and another one survived after conservative treatment. Among 13 HAT episodes, 11 were diagnosed after liver enzyme elevations and just two did not experience these, the latter cohort being treated without retransplantation. Patients undergoing conservative treatment are still alive with good graft function and without biliary complications after 12-month follow-up. There was a significant difference in the incidence of HAT between the CS and IS groups (\(P = .0173\)).

**DISCUSSION**

Despite the improvements in surgical technique, arterial anastomosis in orthotopic liver transplantation shows a high risk for thrombosis.\(^3\) Among the variety of risk factors for HAT, the type of anastomosis has a major impact.\(^4\) HAT remains a major cause of graft loss and death. In our center, the same surgeon, with previously experience in vascular anastomosis, performed the arterial reconstructions in all patients using magnifying lenses with magnification \(\times 3.0\) zoom. During the transplantation procedure, we manipulated the hepatic artery carefully to avoid damage to the vascular endothelium, which is an important risk factor for HAT.

Patients who developed HAT had a variety of clinical presentations, from asymptomatic to graft loss or death. Some patients underwent liver retransplantation. In our study, HAT occurred mainly in the first week after transplantation, thus following the patient with Doppler ultrasonography at least once a day for the first week is important to diagnose HAT rapidly. However, for economic reasons, we do not have Doppler ultrasonography available every day. We did not use other techniques, like surgical revascularization or interventional radiology, to treat HAT because we had a late diagnosis, by elevation of liver enzymes, in almost every case with graft impairment and indication for liver retransplantation. Analyzing the difference in the incidence of HAT between the IS and CS groups, we observed that the IS group experienced only 2% HAT versus 10% in the CS group, a significant difference, indicating that an IS anastomosis might be associated with a reduced incidence of HAT. It is unlikely that the difference in HAT incidence was related to the learning curve, because among 11 HAT episodes in the CS groups, five occurred in the first 50 transplanted patients and six in the last 55 ones (\(P > .05\)). Both groups showed no significant difference in demographic operative data, indicating that hepatic artery anastomosis technique might be the main variable contributing to the results.

**Table 1. Demographic and Operative Data of Patients in CS and IS Groups**

<table>
<thead>
<tr>
<th>Variable</th>
<th>CS group (n = 105)</th>
<th>IS group (n = 95)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recipient age (y)</td>
<td>48 ± 13</td>
<td>49 ± 13</td>
<td>NS</td>
</tr>
<tr>
<td>Gender ratio (M:F)</td>
<td>1:3</td>
<td>1:3</td>
<td>NS</td>
</tr>
<tr>
<td>Cold ischemic time (min)</td>
<td>414 ± 122.8</td>
<td>349 ± 84.2</td>
<td>NS</td>
</tr>
<tr>
<td>that HAT</td>
<td>379 ± 93.2</td>
<td>362 ± 123.7</td>
<td>NS</td>
</tr>
<tr>
<td>Warm ischemic time</td>
<td>57 ± 20.4</td>
<td>48 ± 12.0</td>
<td>NS</td>
</tr>
<tr>
<td>that HAT</td>
<td>58 ± 12.8</td>
<td>57 ± 10.6</td>
<td>NS</td>
</tr>
<tr>
<td>Patients with more than 1 hepatic artery anastomoses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>that HAT</td>
<td>19</td>
<td>14</td>
<td>NS</td>
</tr>
<tr>
<td>Early/delayed</td>
<td>(8/3)</td>
<td>(2/0)</td>
<td>.0173</td>
</tr>
</tbody>
</table>

Data are presented as mean and standard deviations or as percentiles. CS, continuous suture; IS, interrupted suture; HAT, hepatic artery thrombosis; NS, not significant.
Our results suggested that an IS may be a better choice for hepatic artery anastomosis with a lower incidence of hepatic artery thrombosis. However, randomized prospective controlled studies should be performed to validate these results.

REFERENCES


