Right Hepatectomy for Living Liver Donation vs Right Hepatectomy for Disease

Intraoperative and Immediate Postoperative Comparison

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Hypothesis: Perioperative events of patients undergoing living donor (LD) right hepatectomy are similar to those of patients undergoing right hepatectomy for disease (DZ).

Design: Institutional review board–approved retrospective case-control study.

Setting: Eight hundred–bed tertiary care referral center.

Patients and Methods: We matched 40 patients who had LD with 40 patients who had DZ. Perioperative events (anesthesia, surgical events, transfusion, hemodynamic events, complications, and length of hospital stay) were compared using the signed rank test and exact McNemar test where appropriate.

Main Outcome Measures: Intraoperative time, transfusion requirements, postoperative complications, and hospital length of stay.

Results: There was a significant difference in surgical time between the LD and DZ groups (median, 4.1 vs 3.3 hours; \( P = .001 \)). There was also a significant difference in anesthesia time between the LD and DZ groups (median, 5.6 vs 4.2 hours; \( P < .001 \)). The level of autologous transfusion was higher in the LD group (median, 1.3 vs 0 U in the DZ group; \( P < .001 \)), and that of packed red blood cell transfusion was lower in the LD group (mean, 0 vs 0.5 U; \( P = .008 \)). There was no other significant intraoperative difference. Postoperative hemoglobin levels were significantly higher in the LD group (median, 12.6 vs 11.8 g/dL; \( P = .03 \)). Comparison of the number of complications in the immediate postoperative period revealed no other significant differences.

Conclusions: The LD procedure took longer to perform because of the time required for hilar dissection. The difference in intraoperative transfusions is attributable to use of cell salvage and retransfusion of salvaged blood for all donors; this was not routine for DZ procedures. Perioperative outcomes were similar in all other respects. The LD procedure has similar outcomes to those of the DZ procedure.

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Living donor (LD) liver transplantation has emerged as an excellent option for adult patients awaiting liver transplantation who are unlikely to receive a deceased donor liver. Since 1988, 2085 adult LD liver transplants have been performed in the United States. Donors are otherwise healthy individuals undergoing right hepatectomy, an operation with the potential to result in major complications and even death. Thus, there are serious concerns about the donors’ safety during and after LD liver procedures.

We began adult-to-adult LD liver transplantation at our institution in 2000. At that time, our paramount concern was donor safety. We wanted to do everything possible to ensure that all living donors received the best possible care. Our institution has a large experience with liver resection and a sizable hepatobiliary surgery practice. To take advantage of this experience, we decided that each and every potential living liver donor would be seen by our most experienced hepatobiliary surgeon and our most experienced liver transplant surgeon, and that the LD operation would be performed by a team including surgeons and operating room and anesthesia personnel with experience in both hepatobiliary and liver transplantation procedures. Our goals were to perform the LD hepatectomy safely, to match or to exceed results with liver resection for disease (DZ), and to avoid early mistakes commonly attributed to the “learning curve.”

We reviewed our 5-year experience with right hepatectomy for LD liver transplantation and compared results with those of a control group of patients who under-
went DZ-related right hepatectomy. Our primary aim was to determine whether the liver LD procedure is at least as safe as DZ liver resection. Our secondary aim was to determine whether our model of care—use of a combined liver transplant and hepatobiliary surgery team—enabled us to achieve our goals to maximize donor safety and avoid the learning curve.

**METHODS**

This study was performed with approval of the institutional review board of the Mayo Clinic. Data were abstracted from patient medical records and transplantation and anesthesiast databases maintained on all patients undergoing transplantation. We retrospectively compared a group of patients who underwent LD with a control group of patients who underwent DZ liver resection. The LD group included the first 40 donors who underwent LD right hepatectomy at the Mayo Clinic from June 2000 through January 2005. The DZ group was compiled by matching the LD group on age (within 10 years) and sex from patients who underwent right hepatectomy for benign and malignant disease during the same period. The LD operations were performed by the same team (a hepatobiliary surgeon [D.M.N.] and a transplant surgeon [C.B.R.]). The DZ operations were performed by the same hepatobiliary surgeon (D.M.N.).

**LD GROUP**

All donors in the LD group underwent ultrasonography with Doppler examination and volumetric computed tomography. Selected patients underwent angiography and liver biopsy. Criteria for the LD group included (1) liver resection limited to 70% of the parenchyma, (2) anticipated right liver graft size exceeding 0.8% of recipient weight, and (3) vascular anatomy favorable for resection and transplantation.

Anesthetic management for all donors included neuraxial opioids to assist with postoperative analgesia before induction of general anesthesia. General anesthesia was maintained using volatile agents and fentanyl citrate. Intermediate-acting muscle relaxants were used. All patients had a central venous catheter placed, monitoring of central venous pressure throughout the procedure, and use of a low central venous pressure technique. Direct arterial pressure monitoring was used in all cases. Cell salvage was used in all of the LD procedures. The LD operation was performed through a bilateral subcostal incision with an upper extension in the midline to the xiphoid. After abdominal exploration and cholecystectomy, a cholangiogram was obtained through injection of the cystic duct. The right hepatic artery was dissected free from the bifurcation of the proper hepatic artery to the undersurface of the liver. If replaced, the replaced right hepatic artery was dissected free from the pancreas to the undersurface of the liver. The right portal vein was dissected free at the bifurcation of the portal vein. The right hepatic duct was not divided until midway through the parenchymal division. The right side of the liver and the retrohepatic vena cava were mobilized with division of the right adrenal vein. All small inferior right hepatic and caudate venous tributaries to the vena cava were divided, encircling the right hepatic vein and any additional veins larger than 0.5 cm in diameter. The falciform ligament was divided, but the other attachments to the left liver were left intact. The right hepatic artery and right portal vein were temporarily occluded, and the line of vascular demarcation was marked on the surface of the liver. The vessels were unclamped and left open throughout the parenchymal division (no in-flow occlusion). The parenchyma was divided using one of two commercially available dissectors (CUSA Excel [Tyco Healthcare, Mansfield, Mass] or Helix Hydro-Jet [Erbe, Tübingen, Germany]), ligating or oversewing bile ducts and larger vessels. The middle hepatic vein was identified early during the division and retained with the remnant left side of the liver. The right bile duct was divided during division of the parenchyma, probing the right duct, bifurcation, left duct, and common hepatic duct to ensure avoidance of injury to the remnant biliary system. The right hepatic duct stump was oversewn or ligated. All donors were treated with heparin after complete transection of the liver. The right side of the liver was removed by ligating and dividing the right hepatic artery, stapling and dividing the right portal vein, and dividing the right hepatic vein. The donor liver was exanguinated in the operative field to enable collection of the blood with the cell saver. Meticulous hemostasis was achieved without the use of topical hemostatic agents, and the resection interface was carefully checked for bile leakage. The falciform ligament was reconstructed, vascular patency to the remnant liver was ensured, and a drain was placed in the right liver fossa before closure. All donors in the LD group were observed in the recovery room before transfer to the intensive care unit for an overnight stay.

**DZ GROUP**

All patients in the DZ group received general anesthesia that included volatile agents and intermediate-acting muscle relaxants. Analgesia techniques were at the discretion of the attending anesthesiologist. Most patients received long-acting narcotics; however, intrathecal narcotics or epidural analgesia were used in some cases. All patients had central venous pressure monitoring, and a low central venous pressure technique was used; in addition, all patients had direct arterial pressure monitoring. Cell salvage was not used in most cases.

The technique for right hepatectomy (polysegmentectomy, segments 5-8) was similar for patients with benign and malignant disease in the matched control group. After a midline or bilateral subcostal incision without an apical vertical extension, the liver was mobilized and a cholecystectomy was performed without cholangiography. The right hepatic artery and right portal veins were encircled. The right hepatic artery was divided between ligatures, and the portal vein was divided with an endovascular stapler. Small hepatic veins (<5 mm) were divided, and the right hepatic vein was transected with an endovascular stapler before parenchymal transection. Parenchymal transection was performed along the line of vascular demarcation using the CUSA Excel device. Biliary and vascular structures were suture ligated on the remnant liver and clipped on the specimen liver. The middle hepatic vein was retained within the remnant liver unless invaded by malignancy. In-flow vascular occlusion was used selectively for interface bleeding during parenchymal transection. The right hepatic duct was divided during parenchymal division. Hemostasis was secured with cautery or suture ligatures. Topical hemostatic agents were not used. The remnant liver was rotated into the right subdiaphragmatic space so that the interface abutted the retroperitoneum. The falciform ligament was not reconstructed. Only patients with concerns about hemodynamic events or hemostasis were sent to the intensive care unit.

**DATA COLLECTION AND ANALYSIS**

Intraoperative records were reviewed for anesthesia time, surgical time, blood product transfusion, and significant pulmonary or hemodynamic events. Perioperative and postoperative information was collected, including blood product transfusion, cardiac and pulmonary complications, biliary complica-
tions, infections, and length of hospital stay. Readmission to the hospital and mortality at the time of data collection were also recorded. Complications were documented on the basis of predefined criteria. Statistical comparisons were made using the signed rank test for continuous outcomes and the exact McNemar test for categorical end points. \( P < 0.05 \) was considered statistically significant.

## RESULTS

The demographic data for the LD and DZ groups are shown in Table 1. One of the 40 patients in the LD group requested noninclusion of the demographic information during research activities before donation, so that person was excluded from the analysis along with the matched patient in the DZ hepatectomy group.

Comparison of intraoperative variables (Table 2) revealed a significant difference in surgical time, with a median of 4.1 hours for the LD group vs 3.3 hours for the DZ group (\( P = .001 \)). There was also a significant difference in anesthesia time, with a median of 5.6 hours for the LD group and 4.2 hours for the DZ group (\( P < .001 \)). Intraoperative transfusion of autologous blood was significantly different, with medians of 1.3 U for the LD group vs 0 U for the DZ group (\( P < .001 \)). Transfusion of packed red blood cells intraoperatively was significantly different, with means of 0 U for the LD group and 0.5 U for the DZ group (\( P = .008 \)). Estimated blood loss data were available on 17 of 39 matched pairs and were not significantly different between the LD and DZ groups, with medians of 900 and 425 mL, respectively (\( P = .29 \)). There were no significant differences in any other intraoperative variables, including transfusion of coagulation factors (fresh frozen plasma, \( P > .90 \)) or platelets (\( P > .90 \)), albumin infusion (\( P = .48 \)), and cardiac or pulmonary events (\( P > .90 \)). Postoperative hemoglobin levels were significantly higher in the LD group (median, 12.6 vs 11.8 g/dL; \( P = .03 \)). Postoperative transfusion of coagulation products was similar in both groups (\( P = .63 \)). The postoperative infection rate was not statistically significant (\( P = .38 \)).

Surgical complications are listed in Table 3. There were more biliary complications in the LD group (6 vs 1). Although the difference did not reach statistical significance (\( P = .12 \)), we were concerned about these leaks and changed our operative approach after encountering them early in our experience. We switched from oversewing the right bile duct stumps to simple ligation (as is done during the DZ procedure) and have avoided leaks since that time.

There were no differences in the number of postoperative pulmonary, cardiac, vascular, or infectious complications (\( P = .19 \)). The maximum number of complications for a patient in either group was 2, with a median of 0. Postoperative complications by the modified Clavien classification are shown in Table 3. The distributions of the type and total number of complications were similar between the groups.

No cardiac events (ie, arrhythmia, myocardial infarction, or cardiac arrest) were noted in either group. One patient in the LD group required reintubation postoperatively for hypopnea, and 1 patient from each group required thoracentesis for a pleural effusion. No clinically apparent problems with pulmonary atelectasis or pneumonia were noted in either group. One patient in the DZ group had an ileus and another had pancreatitis. One patient in the LD group required ultrasound-guided drainage of a hematoma. There were no episodes of sepsis, acute renal failure, deep venous thrombosis, nerve palsy, or cerebrovascular accidents noted in either group. Lengths of stay for both groups were similar, with a mean stay of 7.4 days for the LD group and 7.2 days for the DZ group (\( P = .21 \)). There was no significant difference in readmission rates for perioperative complications between the 2 groups, with 4 pa-
patients in the DZ group and 5 in the LD group readmitted within 1 month of surgery (P > .90).

Four patients in the DZ group died after recovery from their operations. All 4 deaths occurred at least 6 months after the operations, and all 4 patients had significant metastatic disease. There were no deaths in the LD group.

### Table 3. Surgical Complications by Modified Clavien Classification

<table>
<thead>
<tr>
<th>Complication*</th>
<th>LD Group</th>
<th>DZ Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>Jaundice</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Pancreatitis</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Ileus</td>
<td>0</td>
</tr>
<tr>
<td>Grade II</td>
<td>Wound infection/abscess</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Reintubation for respiratory distress</td>
<td>1</td>
</tr>
<tr>
<td>Grade IIIa</td>
<td>Bile leak with stent via ERCP</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Hematoma with ultrasound-guided drainage</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Pleural effusion requiring thoracentesis</td>
<td>1</td>
</tr>
<tr>
<td>Grade IIIb</td>
<td>Hematoma and return to OR</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Return to OR × 2 for bleeding</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Return to OR for removal of foreign body</td>
<td>0</td>
</tr>
<tr>
<td>Grade IV</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Grade V</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Abbreviations: DZ, disease; ERCP, endoscopic retrograde cholangiography; LD, living donor; OR, operating room.

*The modified Clavien classification is described in Dindo et al.

We found that overall morbidity, as measured by the modified Clavien classification, was similar between the groups of patients undergoing right hepatectomy for living liver donation and disease, with complications arising in 13 (33%) of the 39 patients in the LD group and 7 (18%) of the 39 patients in the DZ group. (One patient in each group had 2 complications.) We also found that the type of modified Clavien classification outcomes was similar.

Although published complication rates for LD vary widely, a systematic review found reported rates ranged from 0% to 67%. More recently, Shah and colleagues reported a 37% complication rate, with 6.9% grade IIIa and 12.9% grade IIIb complications according to the modified Clavien classification and no grade IV complications. Bak and colleagues noted complications in 17% of donors, including 2.4% grade I, 4.9% grade IIa, and 9.8% grade IIb complications according to the modified Clavien classification (see the complication grade key in Table 3). Most of these reports assessing morbidity and mortality after liver donation are compiled without comparison with a control group. A recent review of LD outcomes noted that morbidity ranged from 0% to 100%, with a median of 16%. The authors of that review commented that underreporting may have occurred in some of these studies of LD, and most of the data were from case series. Nevertheless, our LD results are comparable with the overall results reported in the literature.

The right side of the liver is the most frequent site of graft donated by living donors in the West and at our institution. Consequently, patients undergoing the DZ procedure constitute the patient group most comparable to living liver donors. A previous report from our group found complications in 16.2% of patients after hepatic resection, and our current results compare favorably with that earlier report.

We conducted our review using case-matched patients who underwent the DZ procedure. We recognize and acknowledge the limitations of our control group. Clearly, morbidity may differ significantly because of differences in operative techniques, residual functioning liver volume after hepatectomy, and patient characteristics related to the concurrent diseases. Despite reports that patient age has not significantly affected morbidity (32.2% for those <70 years and 39.1% for those ≥70 years), we did attempt to match the control group by age as a surrogate marker for comorbidity, given the differences in the overall LD and DZ populations.

We would have also preferred to use only patients with benign disease in the control group (especially because we use the cell saver for all of our patients undergoing LD operations but avoid its use for patients with malignant disease). Unfortunately, it would have been impractical to limit our control group to benign disease owing to the relative infrequency of benign vs malignant disease requiring right hepatectomy.

Although the control group operations were performed by the same hepatobiliary surgeon involved who shared responsibility for the LD operations, there were major differences in the operative approaches between the 2 groups. These differences included routine use of neuroaxial analgesia and the cell saver, extensive dissection of the right hepatic vessels before parenchymal transection, and division of the right bile duct close to the common hepatic duct bifurcation for the LD operation. Likewise, division of the right hepatic vessels (ie, artery, portal vein, and hepatic vein) before parenchymal transection and selective use of in-flow occlusion were used in the DZ group but not in the LD group operations. These differences had the potential to affect our results. However, these differences would only be important had we found major differences in morbidity between the 2 groups. Thus, our control group is not perfect, but it is the best group available with whom to compare our LD results.

There was a significant difference in both the operative and anesthesia times between the LD and DZ groups. We attribute these differences to the additional time required for vascular dissection and administration of neuroaxial analgesia before induction in the LD group. Most importantly, however, is that the longer operative and anesthesia times between the 2 groups. Thus, our control group is not perfect, but it is the best group available with whom to compare our LD results.

The higher autologous transfusion rate in the LD group was due to the routine use of intraoperative blood salvage, which is recommended for LD surgery and is routine for every such case at our institution. Cell saver was not routinely performed in the DZ group, because most of the patients were undergoing hepatectomy for malignant dis-
ease. Use of cell salvage may also explain the comparative increase in intraoperative packed red blood cell transfusion in the DZ group and account for the higher hemoglobin level postoperatively in the LD group. Despite these differences, there was no significant difference in postoperative transfusion of red blood cells between the 2 groups.

Although the difference did not reach statistical significance, the percentage of patients with biliary complications was higher in the LD group. Biliary complications are the most frequent cause for LD morbidity, arising in 0% to 38.6% (mean, 6.2%) of living donors. We had biliary complication rates of 15% (6 occurrences) in the LD group compared with 3% (1 occurrence) in the DZ group. Despite our goal to avoid the learning curve, we had more biliary complications in the LD group. We had decided to oversew the bile duct stumps in the LD group in contrast to our practice of simple ligation in the DZ group. Reverting back to our standard approach of simple ligation avoided further problems. Despite our better results with bile duct stump ligation, we continue to be concerned about duct identification and division during the LD operation. Protection of the LD patient’s ductal system is vital, as any injury is potentially devastating to the donor’s future health.

Infection is the second most commonly reported complication in LD subjects, with rates of 0% to 28.6% (median, 5.8%). Our infection rate was 10% (4 occurrences) in the LD group and 3% (1 occurrence) in the DZ group, which did not reach statistical significance. Major respiratory complications were reported in 9.8% of donors by Dondero et al., including pulmonary embolism, emphysema, and bacterial pneumonia. Minor respiratory complications were noted in 7.1%. In comparison, we encountered 5% major and minor complications in our LD group (1 postoperative reintubation and 1 pleural effusion requiring thoracentesis).

Fortunately, there were no deaths in our LD group and no postoperative deaths in the DZ group. All of the deaths in the DZ group were due to metastatic disease and occurred more than 6 months after the operative procedure.

Length of stay was not statistically different between the groups, with a median of 7.0 days for the LD group and 6.0 days for the DZ group. These results compare favorably with those reported by others.

One of our goals when we began to perform LD liver transplantation was to avoid complications commonly attributed to the learning curve. We took advantage of our experience in both hepatobiliary and transplantation surgery to avoid these early problems. This study attests to our avoidance of the learning curve. Indeed, there were few differences in the perioperative and postoperative courses and minimal differences in morbidity for patients undergoing right hepatectomy for living donation vs disease. Our results demonstrate that LD right hepatectomy can be accomplished safely and with morbidity limited to that associated with DZ right hepatectomy by an experienced hepatobiliary surgical team.

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Author Contributions: Study concept and design: Gali, Findlay, Plevak, and Rosen. Acquisition of data: Gali. Analysis and interpretation of data: Gali, Findlay, Plevak, Rosen, and Dierkhising. Drafting of the manuscript: Gali, Findlay, Plevak, Rosen, and Nagorney. Critical revision of the manuscript for important intellectual content: Gali, Findlay, Plevak, Rosen, Dierkhising, and Nagorney. Statistical analysis: Plevak and Dierkhising. Obtained funding: Gali. Administrative, technical, and material support: Rosen. Study supervision: Findlay, Plevak, and Nagorney.

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REFERENCES


DISCUSSION

John J. Brems, MD, Burr Ridge, Ill: Drs Gali, Nagorney, and their coauthors compared the outcome and complications between right hepatectomies for disease and transplantation. When LD liver transplantation emerged as a therapeutic option for adults, it was imperative that this would be a safe operation for the donor. Therefore, I congratulate the Mayo Clinic on the wisdom of having their most experienced hepatobiliary surgeon, who does the majority of hepatectomies for disease, perform the LD operations in conjunction with their most experienced liver transplant surgeon. As the authors
mention in their manuscript, there can be no learning curve for this operation.

When you compare these 2 groups, you are really comparing apples to oranges. With right hepatectomies for disease, the primary goal is to resect the tumor with negative margins. Therefore, the blood supply to the right lobe of the liver is divided early before the parenchymal dissection. In right hepatectomies for liver transplantation, the goal is to prevent ischemia to the right lobe and, consequently, the blood supply to the right lobe is preserved until after the parenchymal dissection. Therefore, these are 2 fundamentally different operations with 2 very different outcomes goals. Thus, it is difficult to compare them. I have a few questions for the authors.

The authors state that after a right hepatectomy for disease, the remnant liver is rotated into the right subdiaphragmatic space to abut the retroperitoneum. This is not done in their donor transplant hepatectomies. Many hepatobiliary surgeons don't do this either because of concerns that it may cause hepatic venous outflow obstruction. I was wondering why they do it in the DZ group and not the transplant group.

Also, with the LD operation, you are performing 2 simultaneous operations. I assume many of their LD livers were transplanted into recipients with hepatocellular or cholangiocarcinoma. Therefore, from a logistical standpoint, how did they perform these operations? Did they start with the recipient operation to ensure that there wasn't extrhepatic disease, or did they begin both the donor and recipient operations simultaneously? Did they ever have an instance where they began the donor operation and had to abort it because of problems with the recipient operation? If so, what did they do with the orphan donor liver?

Last, I noted that they had 4 wound infections in the donor group and only 1 in the DZ group. I would have expected it to be the other way around, since many patients in the DZ group had probably received chemotherapy and were less healthy than patients in the donor group. Do they have any thoughts on why this may have occurred or happened?

In closing, I would like to congratulate this group on their outstanding results. They have demonstrated how you can have a successful marriage between surgical oncologists and liver transplant surgeons. And, in the end, the patient is the one who benefits the most from this.

Dr Nagorney: Thank you. Dr Brems. You are very kind with your comments. First, I admit that there were clear differences in patient groups and operative techniques. You wondered about rotating the liver into the right liver fossa with a potential concern for hepatic venous outflow obstruction. We didn't let the liver rotate into the subdiaphragmatic space for living liver donors to ensure that the normal anatomic position of the remaining middle and left hepatic veins was maintained to reduce any remote chance of hepatic venous outflow obstruction. In my own clinical practice for disease, most patients are at risk for disease progression. Intervention through the right subcostal space or flank directly, especially for percutaneous ablation, is easier if the liver is rotated. Thus, I let the liver rotate to the right. If there is no engorgement, I leave it there. If there is any engorgement or venous bleeding from the liver, I will ultrasound the hepatic veins. If there is hepatic venous outflow obstruction, I return the liver remnant to its original position.

You asked a very important question about living liver donors. We utilize living liver donors for patients with malignancy, predominantly sclerosing cholangitis and associated bile duct cancer. Each recipient who is a candidate for a living liver donor is staged several days before the LD liver operation. If metastatic malignancy is confirmed at the staging operation, that finding precludes retrieving a right liver, aborting a donor operation, and potentially discarding that organ. How-ever, after staging, the 2 operations do proceed concurrently. Thus, such a case may still arise. We can abort the LD liver operation anytime before removal of the graft. Technically, even if we split the liver completely, liver donor function will be preserved. If the bile ducts haven't been divided, aborting the donor operation isn't a major technical issue.

Your final question related to wound infections. I don't have a good explanation for our findings. Clearly, many recipients had chemotherapy, though most had been off chemotherapy for at least several weeks. We do ensure that the nadir of their white blood cell count has occurred and is returning to normal levels. Perhaps that fact may account for the lower than expected incidence of infection in that group.

Theodore X. O'Connell, MD, Los Angeles, Calif: I have 2 questions for you.

First, your basic hypothesis is that LD hepatectomy should be as safe as DZ hepatectomy. Shouldn't it be safer, since the patients having it for disease are having it for their own benefit, and obviously for life-threatening problems, while the people having it as a donor are simply doing it out of largesse and not for their own benefit? I would think that it should be safer for these individuals.

Second, even though the complication rate in the live liver donors is 36% and 21% in the patients with hepatectomy for disease, you say there is no statistical difference, although there is almost a doubling in complication rate. Even though it is not statistically significant, it seems to be clinically significant, and I think you have a type II error in that you really don't have enough patients in either arm to prove that this is statistically significant.

Dr Nagorney: I agree. An LD liver operation should be safer than that for one of disease. All I can say is that we try to make it as safe as we can. The operation itself precludes similar controls; thus, we compared it with patients undergoing a similar operation with disease.

You asked an important statistical question about the clinically greater incidence of overall infections with the donor operation than those with disease. According to our statistician, we would have needed many more discordant pairs to show a statistical difference. Clinically we remained concerned about any complications in our living donors. I think we are reducing the frequency of complications from our initial experience, but I don't think we will ever abrogate it.

Timothy Sielaff, MD, Minneapolis, Minn: Thank you very much for bringing this really interesting discussion to the meeting. A comment and a question.

First the comment. About 3 years ago, we did essentially an identical analysis of our living donors and right liver resections and found actually that the length of stay was longer for living donors than in the resection for diseased patients, 7 days vs about 5 days. And that was almost entirely ascribable to increased pain medication requirements of ileus in the donor population.

And my question is, could you comment about your routine use of drains and how often they are effective in avoiding problems or identifying problems?

Dr Nagorney: Our drainage policy is changing. For the LD operations, we are still going to place drains to recognize bile leaks as soon as possible. We believe that we can act upon leaks earlier and avert subsequent complications like an infected biloma. We believe that we can act upon leaks earlier and avert subsequent complications like an infected biloma. In our patients with disease, my policy toward drainage has been to place drains in major liver resections. A comment and a question.

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In our patients with disease, my policy toward drainage has changed. There are numerous randomized trials that show that drains are unnecessary. Even though personally I have drained patients for years and found them effective, the need is really minimal. So, over the study period, I have minimized the use of drains in major liver resections.

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board pass rate), programmatic deficiencies need to be identified and effective remediation should be instituted. Focused exposure can be effected through disease-based rotations and involve intense outpatient exposure, attendance at multidisciplinary conferences, and continuity of care supplemented with adequate operative volume and novel techniques. The continuing challenge is overcoming the limited availability of residents to follow such rotations given the current work-hour restrictions and the perceived higher acuity of patients who require continuous, meticulous attention from house staff.

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Author Contributions: Study concept and design: Longo. Acquisition of data: Longo. Analysis and interpretation of data: Longo and Friedman. Drafting of the manuscript: Longo. Critical revision of the manuscript for important intellectual content: Friedman. Administrative, technical, and material support: Longo. Study supervision: Longo.

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Correction

Error in Text. In the paper by Gali et al titled "Right Hepatectomy for Living Liver Donation vs Right Hepatectomy for Disease: Intraoperative and Immediate Postoperative Comparison," published in the May issue of the Archives (2007;142[5]:467-472), an error occurred in the first paragraph of the text on page 467. In that paragraph, the second sentence should have read as follows: "Since 1988, 2085 adult LD liver transplantations have been performed in the United States." This article was corrected on May 21, 2007, prior to publication of the correction in print.