The technique of Kyriakides et al. (*1*) included systematic division of the celiac trunk (CT) in all their 69 animals, isolation of the graft, and subsequent end-to-end anastomosis between the CT stump and distal HA, in order to restore hepatic blood flow. The arterial pedicle of the autograft included the CT, SA, and proximal HA. They are not explicit regarding the origin(s) of the pancreatic artery (PA) in their study, although it can be assumed that they needed more than the SA to preserve the blood supply to the grafts; were this not so, their technique would have been much simpler and similar to the one used in the dog model. Neither do they mention hepatic necrosis as a cause of postoperative death. More recently, Zimmermann et al. (*2*) have clearly stated that, in about two-thirds of their 15 autografted pigs, the PA supplying the left segment arose from the HA. In these cases, a segment of the HA had to be used as the graft-supplying artery, and the hepatic blood flow was maintained by means of a splenohepatic arterial bypass. Traverso and MacFarlane (*3*) have published very similar anatomical findings in 16 animals, and they conclude that the swine is an unsuitable candidate for pancreas autoX. Our own anatomical findings in 25 young swine of the "minipig" breed, weighing 25–35 kg, are in agreement with the aforementioned, and two-thirds of our pigs also had the blood supply to the left segment arising from the HA. Therefore, we had to prolong operative time with difficult techniques of hepatic vascular reconstruction, with very poor results in terms of animal survival. All these findings are in clear contrast to the detailed and careful report of Shokouh-Amiri et al. (*4*) in a group of 41 "farm" pigs; in the majority (71%) of their animals the main PA to the left segment arose from the SA. Given these favorable anatomical conditions, it is understandable that they consider the pig suitable for pancreatic autoX. Nevertheless, these authors compare their results only with those of Traverso and MacFarlane (*3*), failing to recognize those of Kyriakides et al. (*1*) and Zimmermann et al. (*2*).

In our opinion, it is difficult to explain these anatomical variations in a single animal species in terms of different pig breeds, since most groups seem to have used "farm" or "domestic" swine. Although acknowledging that the application of suitable bench procedures increases the number of animals eligible for autoX, in our experience and that of others (*3*), the added variables introduced by these hepatic vascular techniques reduce the economic feasibility of using the swine for pancreatic autoX to very low levels.

F. Turégano-Fuentes
C. Garcia-Menéndez
A. Larrad-Jiménez
E. Domínguez-Comesaña
M. Sanz-Sánchez
A. Pérez-Gallardo
The Departments of Experimental Medicine and Surgery, Surgery, and Anesthesiology,
Hospital General Gregorio Marañon
28007 Madrid, Spain

REFERENCES

1. Kyriakides GK, Arora VK, Lifton J, Nuttall FQ, Miller J. Porcine pancreatic transplantation: I. Autotransplantation of duct ligated segments. J Surg Res 1976; 20: 451.
2. Zimmermann FA, Pistorius G, Grabowsky K, et al. A new approach to duct management in pancreatic transplantation: temporary occlusion with fibrin sealing and enterostomies. Transplant Proc 1987; 19: 3941.
3. Traverso LW, MacFarlane S. Pancreas autotransplantation: unsuitability of the swine as a model. Transplantation 1987; 44: 450.
4. Shokouh-Amiri MH, Rahimi-Saber S, Andersen HO. Segmental pancreatic autotransplantation in the pig. Transplantation 1989; 47: 42.

HEPATIC ANATOMY

Recently Czerniak et al. reported on the evaluation of hepatic anatomy with respect to living-related grafting (*1*). They dissected 60 human cadaveric livers in the umbilical fissure to examine the possibility of obtaining a usable graft consisting of Couinaud's segments II and III. At present we are performing a study to assess the optimal plane of resection for living-related liver transplantation using plastic corrosion casts. Casts are made by injecting three colors of synthetic resin in the arterial, portal venous, and biliary systems of human cadaveric livers. We would like to comment on the report by Czerniak et al. because of the strikingly different conclusions we draw from our study (Table 1).

In our study all casts showed type III portal venous structure (separate orifices of portal vein branches to segments II and III), demanding a longitudinal section of the portal sinus in the umbilical fissure in all cases, as pointed out by Czerniak et al. We found arterial supply to segments II and III, consisting of more than one artery in 41%, and biliary drainage of segments II and III, consisting of two ducts in 44% of all casts. We conclude from our results that transection in the umbilical fissure, as suggested by Czerniak and coworkers (through or just left of the portal sinus), will create technical problems in many cases. Using this plane of resection, often several small arterial and biliary structures supplying and draining the graft have to be anastomosed. Reconstruction of these arterial and biliary branches as well as the portal sinus, which has to be transected using this plane of resection, will substantially increase the operative risk in the recipient.

Considering these problems we suggest a plane of resection that is located to the right of the umbilical fissure, through segment IV, to harvest segments II and III as a graft. This option will reduce the number of reconstructions in the recipient in most cases. At this plane we found a single arterial branch supplying the graft and a single biliary branch draining it in 77% and 95%, respectively. The problem of cleaving and reconstructing the portal sinus is also avoided. Although segment IV will be at least partially deprived of arterial and/or portal blood and will be partially resected, we do not consider this to be a great risk for the donor.

The variance in results between the study of Czerniak et al. and ours can partially be explained by the difference in technique used to determine the feasibility of in vivo resection of the left lobe. Cast studies proved to be an accurate way to show the precise course of vascular and ductal structures in the liver

TABLE 1. Comparison between the study by Czerniak et al. and our study with respect to the anatomy of supplying and draining structures of Couinaud's segments II and III of the human liver, while resecting at the plane in the umbilical fissure, as described by Czerniak et al.

	Czerniak et al (n=60)	Kazemier et al. (n=39)
Arterial blood supply to segments II and III:		
1 Artery	92%	59%
>1 Artery	8%	41%
Portal blood supply to segments II and III:		
Type I (single portal vein to segments II and III)	35%	0%
Type II (common orifice of portal vein branches to segments II and III)	35%	0%
Type III (separate orifices of portal vein branches to segments II and III)	30%	100%
Biliary drainage of segments II and III:		
Type I (single duct)	78%	56%
Type II (two ducts)	15%	44%

(*2*) although it is impossible to see whether a structure is situated intrahepatic or extrahepatic. Concluding from our data, we consider a plane right to the umbilical fissure to be more realistic to obtain segments II and III as a graft usable for living-related liver transplantation.

G. KAZEMIER
E. J. HESSELINK
O. T. TERPSTRA[1]
Department of Surgery
University Hospital Dijkzigt
Erasmus University
Rotterdam, The Netherlands

[1] Address correspondence to Prof. Dr. O. T. Terpstra, M.D., University Hospital Dijkzigt, 3015 GD Rotterdam, The Netherlands.

REFERENCES

1. Czerniak A, Lotan G, Hiss Y, Shemesh E, Avigad I, Wolfstein I. The feasibility of in-vivo resection of the left lobe of the liver and its use for transplantation. Transplantation 1989; 48: 26.
2. Hepatic segmentation. In: Williams PL, Warwick R, Dyson M, Bannister LH, eds. Gray's anatomy. 37th ed. Edinburgh: Churchill Livingstone, 1989: 1386.

REPLY TO KAZEMIER ET AL.

Thank you for allowing us to respond to the letter of Kazemier and colleagues. The central issue is the surgical anatomy of the umbilical fissure and its relevance to the resection of the left lobe for living-related liver grafting.

Various techniques have been employed for the anatomical study of the liver. While the cast method has the advantage of providing a three-dimensional representation of the vascular and ductal systems of the liver, it involves the destruction of liver surface, and thus the surgical-anatomical assessment of the relationship between the vascular and ductal anatomy and liver surface morphology may only be approximate (*1*).

We suggest that the difference in the technique used (dissection vs. the cast method) may explain the discrepancy between the results of our study and the study of Kazemier et al. Michels in his detailed dissection study of 200 livers, has found a single artery to the left lobe in 88.5% of cases (*2*). Couinaud reports the portal blood supply to segments II and III to consist of a single portal vein branch in 96% and 31%, respectively. A type I portal vein (though not named as such) is also described (*3*). In the same study, and based on dissection of 100 livers, a single bile duct draining the left lobe was found in 77% of livers (*3*). These results are comparable with ours.

There are often ducts and vessels coming from the liver substance underlying the umbilical fissure and the fossa for the ligamentum venosum (*2*), and it may be difficult to ascertain the relationship between these structures and the various structures of the left lobe by the cast method.

Moreover, using the cast method, judgement about the various planes of resection of the liver parenchyma as being within or adjacent to the umbilical fissure, is only approximate (*1*). Kazemier et al. have found a single artery to the left lobe in 59% and a type I bile duct in 56% of the 39 livers examined. However, when they examined a plane that is presumed to be to the right of the umbilical fissure, a single artery supplying the graft was obtained in 77%, and a single biliary branch in 95% of cases. When one considers the possible discrepancies in the planes of resection between the two studies, these results approximate ours (92% and 78%, respectively).

Based on our dissection studies, we suggest that the plane of resection of the liver should be within the umbilical fissure. Using this plane, both an accurate extrahepatic dissection and preparation of the portal structures to the left lobe, and avoidance of damage to segment IV structures can be achieved.

A. CZERNIAK
G. LOTAN
Y. HISS[1]
E. SHEMESH
I. AVIGAD
I. WOLFSTEIN
The Departments of Surgery and Gastroenterology
The Sheba Medical Center
The Institute of Forensic Medicine
Sackler School of Medicine
Tel-Aviv University
Tel-Aviv, Israel

[1] The Institute of Forensic Medicine.

REFERENCES

1. Hobsley M. Intrahepatic anatomy: a surgical evaluation. Br J Surg 1958; 45: 635.
2. Michels AM. Blood supply and anatomy of the upper abdominal organs. Philadelphia: Lippincott, 1955.
3. Couinaud C. Le foie. Etudes anatomiques et chirurgicales. Paris: Masson, 1957.