A Question Seeking for an Answer: Use of T-tube in the Era of Liver Transplantation With Grafts From Extended Criteria Donors and Donors After Cardiac Death

To the Editor:

We read with great interest the recent publication of López-Andújar et al[1] presenting their results of a prospective and randomized clinical trial referring to the incidence and severity of biliary complications due to liver transplantation (LT) after choledochocholedochostomy for the biliary reconstruction with or without a temporary T-tube.

Biliary complications including leaks; strictures; and ischemic-type biliary lesions, stones, and sphincter of Oddi dysfunction still remain the Achilles' heel of the procedure because they contribute to its morbidity and mortality.

There is still controversy about the usefulness of T-tube for end-to-end biliary anastomosis to reduce the incidence of biliary complications. More specifically, there is ongoing debate regarding the use of a T-tube for biliary reconstruction in LT. There is emerging literature that suggests the application of T-tube because it provides easy access to the biliary tree, lowers the pressure in the biliary system, aids in monitoring the quality and output of bile, and might reduce the incidence of anastomotic stricture[2] without the increased rate of complications compared with the non–T-tube approach.[3] Moreover, a previous meta-analysis conducted by our group on this subject[4] evaluated the outcomes after duct-to-duct biliary reconstruction with or without T-tube in LT. We demonstrated nonsuperiority of performing duct-to-duct anastomoses with T-tube as far as anastomotic bile leaks or fistulas, need for postoperative choledochojejunostomies, and need for dilatation and stenting of anastomotic strictures is concerned. The evidence gathered in our study discourages the routine use of T-tubes in biliary reconstruction in LT.[2]

This is not the case according to the experience described in the prospective clinical randomized trial of López-Andújar et al,[1] because it was shown that complications after choledochocholedochostomy in LT are more severe in the non–T-tube group usually demanding more invasive treatment. Finally, they recommended the use of a rubber tube when either donor-bile duct or recipient-bile duct diameter is less than 7 mm, which is a value that seems to be chosen randomly, without any evidence-based criteria established from literature. It just offers a measurement of a parameter contributing to risky anastomosis in liver transplantation, but it should be evaluated taking into consideration all the parameters defining a risky anastomosis and thus facilitating the application of T-tube.

However, there are further issues not raised in this publication concerning the relative influence of factors and their interactions with other variables on the risk of biliary complications in contemporary liver transplant experience, which may indicate and strengthen the observation that the usage of T-tubes or stents in biliary reconstruction during LT is safe and an excellent tool for the quality control of the biliary anastomoses.

First of all, model for end-stage liver disease (MELD) has been adopted by transplant groups as an objective and evidence-based system for transplant listing, but not all patients requiring a LT are served by MELD criteria. The model for liver allocation in Spain is center-based, as it is in other European countries (eg, Scandiatransplant or United Kingdom Transplant), in contrast with the United States and certain European countries (eg, Eurotransplant), where the allocation model is patient-based. The study of López-Andújar et al[1] was conducted in the MELD era, which is between 2008 and 2010. This allocation system has shifted liver transplant allocation priority toward sicker patients, whereas at the same time donor criteria have expanded in an attempt to keep up with the growing list of LT candidates.

The advent of the MELD system has resulted in sicker patients being transplanted, but it has also coincided with the acceptance of the use of more extended criteria donors or marginal organs. This paradigm shift has reduced the number of patients dying on the waiting list for LT but runs the risk that certain patients may do worse after transplantation.

In this context, recent studies have shown that since the introduction of MELD there has been an increase in the rate of biliary complications after LT.[4] The decreased incidence of bile leak was certainly due to less use of T-tube in the post-MELD era.

On the contrary, recent resurgence of donation after cardiac death (DCD) has been embraced by the liver transplant community as one way of ameliorating the shortage of organs. Programs of Maastricht category III DCD-LT have been developed in the United States as well as in Western Europe and some centers have presented good results, comparable to the results of donation after brain death donors (DBD).

Recent literature on controlled DCD-LT includes additional single-center experiences that further establish the relative risks and benefits of DCD-LT. In a recent meta-analysis, it has been noticed that DCD-LT is associated with higher risk of biliary complications including ischemic cholangiopathy, which translates into higher rates of graft failure and retransplantation.[5] A multicenter Belgian study showed that 38% of DCD grafts surviving 3 months developed ischemic type biliary lesions, a rate of biliary complication higher than usually expected in DBD-LT, probably explained by the addition of donation warm ischemia time to cold ischemia time.[6]

However, biliary epithelium is particularly vulnerable to ischemia reperfusion injury and it has become a concern because DCD livers are prone to a high incidence of biliary strictures and/or bile cast syndrome and ischemic cholangiopathy. There is a paucity of high level of evidence recommendations on how to avoid biliary problems after DCD-LT, which suggests use of a T-tube to facilitate frequent interrogation of the ducts and early interventions to dredge sludge and dilate strictures before casting occurs.[7]

In conclusion, we believe that the use of a T-tube (according to the recommendations of López-Andújar et al[1]) or transcystic stent placement for the biliary reconstruction in contemporary liver transplant reality seems to be of increasing relevance regarding the fact of its increasing acceptance for diagnostic and therapeutic advantages, and it should be reconsidered for the biliary anastomosis in LT. Furthermore, identifying risk factors for poor outcome, discovering strategies to protect against ischemic injury, refining data reporting, and collaborating in multicenter research will expand the ability to safely perform biliary reconstruction in LT.

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Reply:

We thank Dr Moris for his comments and the interest shown in our study,[1] which may help to clarify the convenience of using a T-tube in biliary anastomosis during liver transplantation.

In several meta-analyses published in the last few years,[2–4] the use of T-tubes is not systematically recommended because of their inherent complications, despite their highlighted role in the prevention of anastomotic stricture. Consequently, one of the aims of our study was to identify the group of patients with an increased risk of developing an anastomotic stenosis, and so determine the ideal scenario in which T-tubes should be used. Multivariate analysis showed that only biliary anastomosis without a T-tube ($P = 0.008$; odds ratio $= 0.19$) and a donor or recipient bile duct diameter of less than 7 mm ($P = 0.02$; odds ratio $= 3.96$) were statistically significant predictors of anastomotic stenosis.[1] Therefore, a bile duct diameter of less than 7 mm was not an arbitrary value chosen a priori, as noted in Dr Moris' comments.

We agree with the view expressed by Dr Moris regarding the changes in recent years in the characteristics of donors (highest percentage of suboptimal donors due to the need to increase the pool of donors) and recipients (generally transplanted under worse situations because of the implementation of the Model for End Stage Liver Disease (MELD) system to prioritize patients on the waiting list), which could contribute to the increased frequency of biliary complications.[5] Randomization of the 2 series analyzed in our study and that all patients were recruited during a relatively short and recent period prevented us from evaluating the MELD value as an influential variable in the development of complications. I would like to clarify that the prioritization of recipients during the recruitment period was performed using the MELD system, despite being a single list, so most of the recipients were in a worse overall situation. Moreover, in Spain, the expansion of the donor pool has resulted in donors with increasingly unfavorable factors being accepted. In our series, the mean age of donors was 55 years, and other associated unfavorable factors could be found in more than 50% of donors.

A progressive shift in the type of biliary anastomosis toward discontinuation of the use of T-tubes in biliary anastomosis has been accepted by most liver transplantation groups. Changing this standard practice will be difficult unless grade A evidence to favor its use can be shown.

Regarding total biliary complications, meta-analyses have highlighted high heterogeneity ($I^2 > 90\%$).[2–4] Thus, we wondered whether T-tube material could play an important role in complications, an issue that was not considered in most previous meta-analyses.

One of the compelling messages we want to communicate is that, in minimizing the main complication inherent to the T-tube (bile leakage after removal), the benefits of T-tube usage outweigh the disadvantages due to protection against anastomotic stenoses and the fewer occurrences of complex complications.

According to our previous experience,[1] the use of rubber T-tubes dramatically reduces bile leakage after its removal. Thirteen patients (13.6%) were diagnosed with an intra-abdominal bile leak after T-tube removal at the third month after transplantation. In 12 of them, a latex T-tube was used (12/53; 22.6%), and a rubber T-tube was used in the remaining patient (1/42; 2.4%) ($P < 0.001$). Such differences aroused our interest, and we further analyzed the influence of T-tube material (unpublished data) (Table 1). The results show that the type of T-tube material has a significant effect on the overall number of complications; that is, 35.8% of patients with latex T-tubes had complications versus 9.5% in the rubber T-tube group ($P < 0.001$). The frequencies of anastomotic bile leakage, anastomotic stenosis, nonanastomotic stenosis, choledocholithiasis, and cholangitis were similar in both groups, but the frequency of bile leakage after T-tube removal showed a significant difference ($P < 0.001$); bile leakage during T-tube insertion occurred in 3 cases (7.1%) with latex as the material versus none with rubber as the material ($P = 0.07$). The clinical impact of these results is of great interest because the rate of biliary complications is reduced by 79% with rubber T-tubes compared with latex T-tubes, indicating that the use of rubber T-tubes in only 3 patients would prevent 1 patient from having a complication. Similar experiences have been reported by other groups.[6,7]

In an attempt to increase the pool of donors, the donation rate of donors after cardiac death is increasing in Western centers. This has led to a greater number of ischemic cholangiopathy cases because the biliary epithelium is particularly sensitive to ischemia-reperfusion with biliary strictures and/or bile cast syndrome.[8,9] T-tubes have been shown to be effective in preventing anastomotic stenosis, but not in preventing nonanastomotic strictures or ischemic-type biliary lesions

TABLE 1. Complication Rates

	Group 1 (Latex T-tube) (n = 53)	Group 2 (Rubber T-tube) (n = 42)	*P*
Biliary complications (patients)	19 (35.8%)	4 (9.5%)	<0.001
Primary complications (events)			
Anastomotic stenosis	0	1 (2.4%)	ns
Anastomotic bile leak	2 (3.8%)	1 (2.4%)	ns
Secondary complications (events)			
Nonanastomotic stenosis	0	1 (2.4%)	ns
Choledocholithiasis	1 (2.4%)	0	ns
T- tube inherent complications (events)			
Bile leak after T-tube removal	12 (22.6%)	1 (2.4%)	<0.001
Cholangitis	4 (7.5%)	3 (7.1%)	ns
Bile leak in T-tube insertion	3 (5.7%)	0	0.07

ns indicates not significant.

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secondary to ischemic cholangiopathy. However, T-tubes allow an early diagnosis and an easy approach to the biliary tree, thus overcoming many of the secondary complications of ischemic cholangiopathy that occur in the early posttransplant period.

In conclusion, on the basis of our results, we recommend and currently apply in our clinical practice the use of the rubber T-tube in the presence of any risk factors for biliary complications, such as a donor or recipient bile duct diameter of less than 7 mm, large discrepancies between bile duct sizes, split or reduced grafts, donors after cardiac death, and retransplantations. We also extend this recommendation with suboptimal donors to control the quantity and quality of bile in the immediate posttransplant period.

Therefore, we agree with Dr Moris' prediction of a future resurgence of the use of T-tubes in biliary anastomosis during liver transplantation because the T-tube material affects the frequency of complications, and the use of a rubber T-tube will dramatically decrease the bile leak rate compared to that in the past.

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