Postoperative kidney injury does not decrease survival after liver transplantation[1]

Insuficiência renal pós-operatória não diminui a sobrevivência após transplante hepático

Olival Cirilo Lucena da Fonseca-Neto[I], Luiz Eduardo Correia Miranda[II], Thales Paulo Batista[III], Bernardo David Sabat[IV], Paulo Sérgio Vieira de Melo[V], Américo Gusmão Amorim[IV], Cláudio Moura Lacerda[VI]

[I]PhD, Division of Abdominal Surgery, Department of Surgery, UPE, Pernambuco, Brazil. Main author. Manuscript preparation.
[II]PhD, Associate Professor, Division of Abdominal Surgery, Department of Surgery, UPE, Pernambuco, Brazil. Acquisition and interpretation of data, statistical analysis, critical revision.
[III]Master, Division of Abdominal Surgery, Department of Surgery, UPE, Pernambuco, Brazil. Acquisition and interpretation of data, statistical analysis, manuscript writing, critical revision.
[IV]Master, Assistant Professor, Division of Abdominal Surgery, Department of Surgery, UPE, Pernambuco, Brazil. Acquisition and interpretation of data, technical procedures.
[V]PhD, Division of Abdominal Surgery, Department of Surgery, UPE, Pernambuco, Brazil. Acquisition and interpretation of data, technical procedures.
[VI]PhD, Chairman and Head, Division of Abdominal Surgery, Department of Surgery, UPE, Pernambuco, Brazil. Interpretation of data, supervised all phases of the study, critical revision.

ABSTRACT
PURPOSE: To explore the effect of acute kidney injury (AKI) on long-term survival after conventional orthotopic liver transplantation (OLT) without venovenous bypass (VVB).
METHODS: A retrospective cohort study was carried out on 153 patients with end-stage liver diseases transplanted by the Department of General Surgery and Liver Transplantation of the University of Pernambuco, from August, 1999 to December, 2009. The Kaplan–Meier survival estimates and log-rank test were applied to explore the association between AKI and long-term patient survival, and multivariate analyses were applied to control the effect of other variables.
RESULTS: Over the 12.8-year follow-up, 58.8% patients were alive with a median follow-up of 4.5-year. Patient 1-, 2-, 3- and 5-year survival were 74.5%, 70.6%, 67.9% and 60.1%; respectively. Early postoperative mortality was poorer amongst patients who developed AKI (5.4% vs. 20%, p=0.010), but long-term 5-year survival did not significantly differed between groups (51.4% vs. 65.3%; p=0.077). After multivariate analyses, AKI was not significantly related to long-term survival and only the intraoperative transfusion of red blood cells was significantly related to this outcome (non-adjusted Exp[b]=1.072; p=0.045).
CONCLUSION: The occurrence of postoperative acute kidney injury did not independently decrease patient survival after orthotopic liver transplantation without venovenous bypass in this data from northeast Brazil.
Key words: Liver Transplantation. Renal Insufficiency. Prognosis

RESUMO
OBJETIVO: Explorar o efeito da insuficiência renal aguda (IRA) na sobrevivência de longo prazo após o transplante hepático convencional ortotópico (THC) sem desvio venovenoso (DVV).
MÉTODOS: Estudo de coorte retrospectivo envolvendo153 pacientes portadores de doença hepática terminal transplantados pelo Departamento de Cirurgia Geral e Transplante Hepático da Universidade de Pernambuco, no período de agosto de 1999 a dezembro de 2009. O método de Kaplan-Meier e o teste log-rank foram aplicados para explorar a associação entre o IRA com a sobrevivência de longo prazo dos pacientes, aplicando-se o modelo multivariado de riscos proporcionais de Cox para controlar o efeito de outras variáveis.
RESULTADOS: A proservação atingiu 12,8 anos, durante a qual 58,8% dos pacientes permaneceram vivos com mediana de acompanhamento de 4,5 anos. As taxas de sobrevivência cumulativa de 1 -, 2 -, 3 - e 5 anos foram de 74,5%, 70,6%, 67,9% e 60,1%; respectivamente. A taxa de mortalidade pós-operatória precoce foi maior entre os pacientes que desenvolveram IRA (5,4% vs. 20%, p = 0,010), mas a sobrevivência de longoprazoem5 anos não diferiu significativamente entre os grupos (51,4% vs. 65,3%, p = 0,077). Após análise multivariada, a IRA nãofoisignificativamenterelacionado à sobrevivência a longo prazo e apenas transfusão intra-operatório de hemácias foi significativamente relacionado com este desfecho (Exp [b] não-ajustado = 1,072, p = 0,045).
CONCLUSÃO: A ocorrência de insuficiência renal aguda pós-operatória não diminuiu de forma independente a sobrevivência dos pacientes após transplante hepático convencional sem desvio venovenoso nesta casuística do nordeste do Brasileiro.
Descritores: Transplante de Fígado. Insuficiência Renal. Prognóstico.

Introduction

The conventional technique of orthotopic liver transplantation (OLT) has been pointed as associated with increased rate of postoperative acute kidney injury (AKI)[1-3]; an overall major and frequent complication after OLT[4-7]. Following these patients, we have not found serious complications inherent to this approach[8,9]; however, whether this complication may contribute to independently decrease post-transplant survival remains unclear.

Previously, exploring predictors of AKI in a cohort of our patients who underwent conventional OLT without VVB, we observed a trend of lower short-term survival after this approach, but this difference did not reach the level of significance (six months survival of 71.6% vs. 82.2%; p=0.07)[10]. In this current study, we present our analysis with regard to effect of AKI on long-term survival using the same cohort of patients.

Methods

A retrospective cohort study was carried out on patients transplanted by the Department of General Surgery and Liver Transplantation of the Oswaldo Cruz University Hospital, University of Pernambuco, from August, 1999 to December, 2009. This study was approved by our Research on Human Beings Ethics Committee complying with current ethical guidelines. We limited our analysis to adults and adolescent patients (>16 years) who underwent deceased donor OLT using conventional technique. For patients who had undergone re-transplantations, data were collected from the first procedure only. We also excluded patients transplanted due to fulminant hepatic failure, recipients of modified techniques (i.e.: split-liver, sequential and venovenous transposition) or liver-kidney transplants, as well as patients with incomplete data in their medical records or deceased during surgical procedure.

Conceptual model

MELD score was calculated using laboratory results collected immediately prior to the LT with no adjustments for malignancy or other ‘‘special’’ conditions used to prioritize these patients on the waiting list. Serum markers were used to confirm viral hepatitis diagnosis. The preoperative diagnosis of hepatocellular carcinoma (HCC) was based on the Barcelona-2000 conference diagnostic criteria[11] and fits with Milan criteria to select patients for liver transplantation[12].

Donor livers were recovered using standard procurement techniques. Collins and Belzer UW (University of Wisconsin) solutions were used for perfusion procedures until 2007, when the latter was replaced by Celsior solution. The same surgical team performed all OLT using conventional (retrohepaticcaval resection) techniques without VVB based on surgeons' preference according to clinical and surgical parameters. After transplantation, tacrolimus, mycophenolate (sodium or mofetil) and prednisone were used as immunosuppressive treatment, with no major changes in the protocols applied. All patients were followed up routinely or when it was necessary because some clinical demand and the medical record were taken up to May, 2012.

We considered postreperfusion syndrome (PRS) a decrease in mean arterial pressure greater than 30% below the baseline for a minimum of one minute during the first five minutes of the reperfusion[13] and classified marginal grafts based on Briceño's score[14]. AKI was defined as a serum creatinine level of ≥1.5mg/dl or urinary output of <500ml/24h within the first three days following OLT, according to RIFLE criteria[15]. Early postoperative mortality were accessed in the first 30-days after OLT as we had published before[8,9].

Analytic approach

Descriptive statistics were summarized as medians (ranges) or frequencies (percentages) and analyzed using Mann-Whitney U-test and chi-square tests, including Yates's correction or Fischer's exact test as appropriated. The Kaplan–Meier survival estimates and log-rank test were applied to explore the association between AKI and long-term patient survival, and multivariate analyses were also applied to control the effect of other variables. In these settings, the association of each demographic variable with survival was first assessed using univariate Cox's proportional-hazards models or log-rank test. Then, variables whose association showed p-value <0.10 were tested in a multivariate Cox's model considering a p-value <0.05 as statistically significant. We additionally adjusted our multivariate analyses for temporal variables such as transplantation period (three consecutive periods including 53 patients) and allocation criteria (chronologic vs. MELD).

Results

Our surgical team performed 375 OLTs from August, 1999 to December, 2009. Two hundred twenty-two patients were not eligible or excluded mainly due to piggy-back approach (n=89), age younger than 16-year (n=75), fulminant hepatic failure (n=10), transoperative death (n=5), living-donor, split-liver or sequential transplants (n=9), liver-kidney transplantation (n=1), venovenous transposition (n=2), retransplant (n=10) and incomplete data in medical records (n=21). Baseline characteristics and descriptive statistics of remaining patients (n=153) included to analysis are summarized in Tables 1 and 2. Among them, 60 (39.2%) developed AKI after OLT. Hemodialysis was performed in 13 patients who developed AKI (8.5% of all sample and 21.6% of patients who developed AKI). Indications for renal replacement therapy included hypervolemy (n=5), uremia (n=5) or both (n=3).

TABLE 1 - Baseline characteristics and descriptive statistics of recipient-related variables.

		Liver transplant without venovenous bypass Median (range) or n (%)		
Variables	**Overall**	Non-AKI(n=93)	*AKI* (n=60)	**p-value**[1]
Age (years)	52 (16-71)	52 (16-69)	55 (23-71)	0.030
Gender (male)	111 (72.5)	65 (69.9)	46 (76.7)	0.464
Body Mass Index	25.2 (16.8-43.6)	24.7 (16.8-35.3)	25.9 (20.8-43.6)	0.007
ABO Blood Group				0.109
O	69 (45.1)	45 (48.4)	24 (40)	
A	61 (39.9)	34 (36.6)	27 (45)	
B	15 (9.8)	10 (10.7)	5 (8.3)	
AB	8 (5.2)	4 (4.3)	4 (6.7)	
MELD Score	16 (7-36)	15(7-29)	17(8-36)	0.0507
Child-Pugh Class				< 0.001
A	34 (22.2)	25 (27.5)	9 (15)	
B	70 (45.7)	50 (54.9)	20 (33.3)	
C	47 (30.7)	16 (17.6)	31 (51.7)	
Diabetes Mellitus	29 (18.9)	17 (18.3)	12 (20)	0.992
Systemic Arterial Hypertension	25 (16.3)	10 (10.7)	15 (25)	0.041
Primary Disease				0.413
Hepatitis Viral	52 (34)	30 (32.2)	22 (36.7)	
Alcoholic	25 (16.3)	11 (11.8)	14 (23.3)	
Others	76 (49.7)	52 (55.9)	24 (40)	
Preoperative Lab Tests				
Serum Creatinine	0.9 (0.2-2.9)	0.9 (0.2-1.6)	1.0 (0.4-2.9)	< 0.001
Blood Urea Nitrogen (mg/dL)	26 (9-112)	23.5 (9-68)	29 (12-112)	0.001
Serum Sodium	138 (112-161)	138 (122-146)	137 (112-161)	0.562
Serum Potassium	4.2 (3-5.8)	4.1 (3-5.7)	4.3 (3.3-5.8)	0.112
Albumin	3 (1.6-5)	3 (1.6-4.7)	2.9 (1.8-5)	0.135
Platelets Counts ($x10^4$)	8.3 (1.5-58.1)	8.4 (1.5-58.1)	8.1 (2.1-34.3)	0.981
INR[2]	1.5 (1.0-5.2)	1.5 (1.0-5.2)	1.6 (1.0-3.3)	0.022
Creatinine Clearance	92.3 (19.3-240.5)	105.3 (51.1-240.5)	81.4 (19.3-209-5)	< 0.001

[1]Comparisons between groups using the *Mann-Witney U* test or chi-square tests.
[2]International Normalized Ratio.

TABLE 2 - Baseline characteristics and descriptive statistics of Center-related variables.

		Liver Transplant Without Venovenous Bypass Median (range) or n (%)		
Variables	**Overall**	Non-AKI(n=93)	AKI (n=60)	**p-value[3]**
Operative Variables				
Operative Time (hours)	7.3 (3.8─15.4)	7.3 (3.8─14.3)	7.3 (4.2─15.4)	0.362
Warm Ischemia (minutes)	50 (11─143)	50 (11─143)	51.5 (25─82)	0.895
Cold Ischemia (hours)	6.8 (3.4─15.5)	7 (3.4─15.5)	6.8 (3.8─12.8)	0.992
Urine Output (L)	1.5 (0.3─5.7)	1.6 (0.3─5.7)	1.4 (0.3─4.8)	0.409
Postreperfusion Syndrome	49 (32)	24 (25.8)	25 (41.7)	0.051
Red Blood Cells (units)	3 (0─27)	3 (0─27)	5 (0─23)	<0.001
Platelets Transfusion (units)	0 (0─30)	0 (0─18)	5.5 (0─30)	0.003
Fresh─frozen Plasma (units)	4 (0─32)	3 (0─32)	6 (0─20)	0.003
Marginal liver graft[4]	57 (37.2)	30 (32.2)	27 (45)	0.155
Hospital Stay (days)	11 (1─204)	11 (1─63)	12 (2─204)	0.164
ICU Stay (≥ 3─day)	78 (51)	38 (40.9)	40 (66.7)	0.003
Mechanical Ventilation (> 1─day)	115 (75.21)	62 (66.7)	53 (88.3)	<0.001
Postoperative Complications				
Sepsis	19 (12.4)	9 (9.6)	10 (16.6)	0.303
Hemoperitoneum	13 (8.5)	8 (8.6)	5 (8.3)	0.811
Biliary Fistula	4 (2.6)	3 (3.2)	1 (1.6)	1.000
Biliary Stenosis	18 (11.8)	8 (8.6)	10 (16.6)	0.209
Hepatic Artery Thrombosis	12 (7.8)	5 (5.4)	7 (11.6)	0.269
Portal Vein Thrombosis	2 (1.3)	1 (1.1)	1 (1.66)	1.000
Non-bleeding Reoperation	15 (9.8)	8 (8.6)	7 (11.6)	0.730
Primary Non-function Graft	4 (2.6)	3 (3.2)	1 (1.7)	1.000
Primary Dysfunction	8 (5.2)	3 (3.2)	5 (8.3)	0.236

[1]Comparisons between groups using the *Mann-Witney U* test or chi-square tests.
[4]According to Briceño score for marginal liver graft.

Over the 12.8-year follow-up, 90 (58.8%) patients were alive with a median follow-up of 4.5-year (Q25= 3.3 – Q75= 7.3). Overall early postoperative mortality (30-day) was 11.7% (n=18) following a cumulative three and six months survival of 83.7% and 78.4%, respectively. Patient 1-, 2-, 3- and 5-year cumulative survival were 74.5%, 70.6%, 67.9% and 60.1%; respectively (Figure 1). Early postoperative mortality (30-day) was poorer amongst patients who developed AKI (5.4% vs. 20%, p=0.010), but long-term 5-year survival did not significantly differed between groups (51.4% vs. 65.3%; p=0.077) (Figure 2). After multivariate analyses (Table 3), AKI was not significantly related to long-term survival after conventional OLT without VVB and only the intraoperative transfusion of red blood cells was significantly related to long-term survival after transplantation (non-adjusted Exp[b]=1.072; p=0.045).

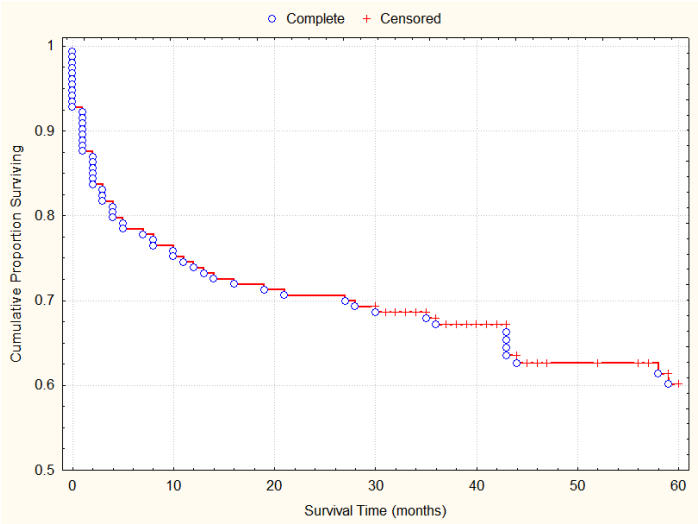

FIGURE 1 - Patient survival (Kaplan-Meier) after conventional OLT without VVB. The 1-, 2-, 3- and 5-year cumulative survival were 74.5%, 70.6%, 67.9% and 60.1%; respectively.

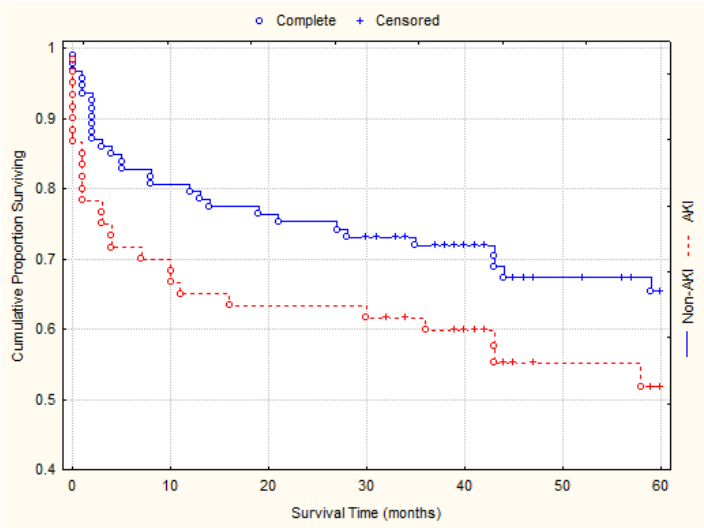

FIGURE 2 - Kaplan-Meier analysis of patients stratified according to development of acute kidney injury. Log-rank test did not show statistically significant difference between patient survival at 5-years (51.4% vs. 65.3%; p=0.077).

TABLE 3 - Multivariate analysis.

Variables	Univariate[5]	Multivariate[6]		
		Unadjusted	Allocation Criterion	Transplantation Era
Red Blood Cells Tranfusion	0.001	0.045	0.053	0.095
Platelets Transfusion	0.052	0.532	0.530	0.674
Postreperfusion Syndrome	0.053	0.141	0.148	0.233
Acute Kidney Injury	0.077	0.500	0.487	0.476

[5]Univariate analysis using the log rank test (categorical data) or the Cox-proportional hazards model (continuous data).
[6]Multivariate analysis using the Cox-proportional hazards model. This analysis was also adjusted to allocation criterion (Chronologic vs. MELD) and transplantation era (three consecutive periods including 51 patients).

Discussion

The conventional technique of OLT without VVB is considered simpler and has been safely performed with recognized swiftness by our team even in patients suffering of advanced liver disease. Amongst our patients underwent transplantation by this approach, we have reported AKI rates of 39.2%[10], according to RIFLE criteria[15]. In line with our findings, Tinti *et al.*[15] reported AKI occurred in 37.5% of patients, using these same criteria. Similarly, when comparing conventional vs. piggy-back techniques, Cabezuelo *et al.*[1] found AKI rates of 39% associated to the former. However, these rates may reach 50% in some Centers, where it has been linked to poor survival outcomes after OLT[4]. Accordingly, even in those who had normal renal function before surgery, postoperative AKI may occur in 30% of patients receiving OLT[5].

Several variables have been pointed as risk factors or predictors of AKI. Often, patient/liver disease severity (i.e.: as measured by MELD score or Child-Pugh class)[7,15,16], hypoalbuminemia[15,17], preoperative decreased renal function[7,17], hemocomponents transfusion[1,5,18], postreperfusion syndrome[5,19] and surgical technique[1,2] have been highlighted in the most current literature. Some preoperative co-morbidity such as hypertension, obesity (i.e.: increased BMI) and diabetes mellitus have also been related to outcomes after OLT when the renal dysfunction is explored in the settings of OLT[4,7,20]. Using this same cohort, we previous presented that patient/liver disease severity (i.e.: as measured by Child-Pugh) was the main factor related to AKI after conventional OLT without VVB[10]. In this settings, MELD score was not found as a predictor of AKI[10], which probably result from the poor accuracy of this score (i.e.: as a continuous variable) in predicting post-OLT outcomes in low degrees of hepatic dysfunction (i.e.: low median MELD scores)[8,21]. Thus, we

hypothesized that higher potential of Child-Pugh classification to point patients at increased risk to develop postoperative AKI possibly results from adding some clinical parameters, such as ascites and encephalopathy, that comprehensively best reflect the complex and dynamic interaction between liver and kidney dysfunction in patients suffering of end-stage liver disease.

Regarding the effect of surgical technique on post-transplant renal function, several authors demonstrate that the piggy-back technique significantly reduces the probability of AKI after OLT[1-3,22]. However, the benefit of this surgical approach appears to be not fully achieved when it is used with VVB[3] and there is currently no clear evidence to recommend or refute the use of piggy-back method of OLT in general, according to a recent systematic review from Cochrane Database[23]. At our Department, we have performed OLT without VVB using either conventional or piggy-back techniques[9,24]. Recently, we retrospectively reviewed our data in order to compare these different approaches and no significantly differences were noted in relation to kidney function[9]. In our experience, AKI appears mainly related to patient severity than to the surgical technique itself. In other words, we clearly observed that AKI was associated to variables linked to disease severity (see Tables 1 and 2) that may serve to identify those sickest patients, for whom poorer outcomes are usually expected.

In this present study, we avoided dichotomizing most of the continuous variables in order to minimize some loss in the statistical power of our analysis and the occurrence of residual confounding factors[25,26]. Similarly, we applied multivariate analysis to control the effect of each variable for the others and also adjusted these tests for temporal variables such as allocation criteria and transplantation periods that have influenced survival outcomes at our Department, as previously reported[8,21]. Herein, separate regression models were first fit to each group and the log-likelihoods for those models were summed up. This log-likelihood was then compared to that of the overall model (collapsed across groups). Accordingly, AKI did not significantly correlated with long-term survival and only the intraoperative transfusion of red blood cells appeared to significantly influence this outcome.

Although the need for blood transfusion may act only as a marker of disease severity of the patients undergoing liver transplantation[18], lower post-transplantation survival[8,21,27-31] mainly stems from transfusion-related immunomodulation (TRIM syndrome) and changes of its components resulting from the storage process[32], which may increase the risk of nosocomial infections, acute lung injury and development of late autoimmune diseases[33]. In agreement with some of our previous reports[8,21], this study revealed the trend of poorer survival associated to AKI probably resulted from the higher volume of intraoperative red blood cell transfusion that accompanies this complication, suggesting that transfusion of blood components might be independently able to decrease patient survival after OLT without VVB.

Our study has several strengths. In the first place, our own database has been prospectively maintained and continuously updated. Secondly, we have accumulated considerable experience with the management of marginal grafts[34,35] and use of conventional technique without VVB[8,9,24]. Additionally, to our best knowledge, this is the longest series in the Brazilian literature discussing a single-center experience in AKI after OLT without VVB and its consequences for long-term patient survival.

Conclusions

The occurrence of postoperative acute kidney injury (AKI) did not independently decrease patient survival after orthotopic liver transplantation (OLT) without venovenous bypass (VVB) in this data from northeast Brazil. Although being a common postoperative complication in these settings, our study suggests that AKI might work just as a marker of greater disease severity and its related poorer survival appears mainly related to patient severity than to occurrence of AKI itself.

References

1. Cabezuelo JB, Ramirez P, Acosta F, Torres D, Sansano T, Pons JA, Bru M, Montoya M, Rios A, Sánchez Bueno F, Robles R, Parrilla P. Does the standard vs piggy-back surgical technique affect the development of early acute renal failure after orthotopic liver transplantation? Transplant Proc. 2003;35(5):1913-4.
2. Nikeghbalian S, Dehghani M, Salahi H, Bahador A, Kazemi K, Kakaei F, RajaeiE, Gholami S, Malek-Hosseini SA. Effects of surgical technique on postoperative renal function after orthotopic liver transplant. Exp Clin Transplant. 2009;7(1):25-7.
3. Sakai T, Matsusaki T, Marsh JW, Hilmi IA, Planinsic RM. Comparison of surgical methods in liver transplantation: retrohepatic caval resection with venovenous bypass (VVB) versus piggy-back (PB) with VVB versus PB without VVB. Transpl Int. 2010;23(12):1247-58.
4. Zhu M, Li Y, Xia Q, Wang S, Qiu Y, Che M, Dai H, Qian J, Ni Z, Axelsson J, Yan Y. Strong impact of acute kidney injury on survival after liver transplantation. Transplant Proc. 2010;42(9):3634-8.
5. Koo M, Sabaté A, Ramos E, Dalmau A, León E, Fabregat J, Rafecas A. Factors related to renal dysfunction after liver transplantation in patients with normal preoperative function. Rev Esp Anestesiol Reanim. 2006;53(9):538-44.
6. Gainza FJ. The kidney is the liver's best friend. Liver Transpl. 2010;16(3):411.
7. Iglesias JI, DePalma JA, Levine JS. Risk factors for acute kidney injury following orthotopic liver transplantation: the impact of changes in renal function while patients await transplantation. BMC Nephrol. 2010;11:30.
8. Batista TP, Sabat BD, Melo PS, Miranda LE, Fonseca-Neto OC,

Amorim AG, Lacerda CM. Impact of MELD allocation policy on survival outcomes after liver transplantation: a single-center study in northeast Brazil. Clinics (Sao Paulo). 2011;66(1):57-64.
9. Vieira de Melo PS, Miranda LE, Batista LL, Neto OC, Amorim AG, Sabat BD, Cândido HL, Adeodato LC, Lemos RS, Carvalho GL, Lacerda CM. Orthotopic liver transplantation without venovenous bypass using the conventional and piggy-back techniques. Transplant Proc. 2011;43(4):1327-33.
10. Fonseca-Neto OC, Miranda LE, Melo PS, Sabat BD, Amorim AG, Lacerda CM. Predictors of acute kidney injury in patients undergoing a conventional orthotopic liver transplant without veno-venous bypass. ABCD Arq Bras Cir Dig. 2011;24(2):152-8.
11. Bruix J, Sherman M, Llovet JM, Beaugrand M, Lencioni R, Burroughs AK, Christensen E, Pagliaro L, Colombo M, Rodés J, EASL Panel of Experts on HCC. Clinical management of hepatocellular carcinoma. Conclusions of the Barcelona-2000 EASL conference. European Association for the Study of the Liver. J Hepatol. 2001;35(3):421-30.
12. Mazzaferro V, Regalia E, Doci R, Andreola S, Pulvirenti A, Bozzetti F, Montalto F, Ammatuna M, Morabito A, Gennari L. Liver transplantation for the treatment of small hepatocellular carcinomas in patients with cirrhosis. N Engl J Med. 1996;334:693-9.
13. Bukowicka B, Akar RA, Olszewska A, Smoter P, Krawczyk M. The occurrence of postreperfusion syndrome in orthotopic liver transplantation and its significance in terms of complications and short-term survival. Ann Transplant. 2011;16(2):26-30.
14. Briceño J, Solórzano G, Pera C. A proposal for scoring marginal liver grafts. Transpl Int. 2000;13(Suppl 1):S249-52.
15. Tinti F, Umbro I, Meçule A, Rossi M, Merli M, Nofroni I, Corradini SG, Poli L, Pugliese F, Ruberto F, Berloco PB, Mitterhofer AP. RIFLE criteria and hepatic function in the assessment of acute renal failure in liver transplantation. Transplant Proc. 2010;42(4):1233-6.
16. Umbro I, Tinti F, Mordenti M, Rossi M, Ianni S, Pugliese F, Ruberto F, GinanniCorradini S, Nofroni I, Poli L, Berloco PB, Mitterhofer AP. Model for end-stage liver disease score versus simplified acute physiology score criteria in acute renal failure after liver transplantation. Transplant Proc. 2011;43(4):1139-41.
17. Cabezuelo JB, Ramírez P, Ríos A, Acosta F, Torres D, Sansano T, Pons JA, Bru M, Montoya M,Bueno FS, Robles R, Parrilla P. Risk factors of acute renal failure after liver transplantation. Kidney Int. 2006;69(6):1073-80.
18. deMorais BS, Sanches MD, Ribeiro DD, Lima AS, de Abreu Ferrari TC, Duarte MM, Cançado GH. Association between the use of blood components and the five-year mortality after liver transplant. Rev Bras Anestesiol. 2011;61(3):286-92.
19. Paugam-Burtz C, Kavafyan J, Merckx P, Dahmani S, Sommacale D, Ramsay M, Belghiti J, Mantz J. Postreperfusion syndrome during liver transplantation for cirrhosis: outcome and predictors. Liver Transpl. 2009;15(5):522-9.
20. Nair S, Verma S, Thuluvath PJ. Obesity and its effect on survival in patients undergoing orthotopic liver transplantation in the United States. Hepatology. 2002;35(1):105-9.
21. Batista TP, Sabat BD, Melo PS, Miranda LE, Fonseca-Neto OC, Amorim AG, Lacerda CM. Employment of meld score for the prediction of survival after liver transplantation. Rev Col Bras Cir. 2012;39(2):105-11.
22. Khan S, Silva MA, Tan YM, John A, Gunson B, Buckels JA, David Mayer A, Bramhall SR, Mirza DF. Conventional versus piggy-back technique of caval implantation; without extra-corporeal veno-venous bypass. A comparative study. Transpl Int. 2006;19(10):795-801.
23. Gurusamy KS, Pamecha V, Davidson BR. Piggy-back graft for liver transplantation. Cochrane Database Syst Rev. 2011;(1):CD008258.
24. Fonseca-Neto OC. Clinical liver transplantation without venovenous bypass. Arq Bras Cir Dig. 2011;24(2):164-7.
25. Altman DG, Royston P. The cost of dichotomising continuous variables. BMJ. 2006;332(7549):1080.
26. Royston P, Altman DG, Sauerbrei W. Dichotomizing continuous predictors in multiple regression: a bad idea. Stat Med. 2006;25(1):127-41.
27. Boin IFSF, Leonardi MI, Udo EY, Sevá-Pereira T, Stucchi RSB, Leonardi LS. The application of MELD score in patients submitted to liver transplantation: a retrospective analysis of survival and the predictive factors in the short and long term. Arq Gastroenterol. 2008;45(4):275-83.
28. Ramos E, Dalmau A, Sabate A, Lama C, Llado L, Figueras J, Jaurrieta E. Intraoperative red blood cell transfusion in liver transplantation: influence on patient outcome, prediction of requirements, and measures to reduce them. Liver Transpl. 2003;9(12):1320-7.
29. Hendriks HG, van der Meer J, de Wolf JT, Peeters PM, Porte RJ, de Jong K, Lip H, Post WJ, Slooff MJ. Blood transfusion requirement is the main determinant of early surgical reintervention after orthotopic liver transplantation. Transpl Int. 2005;17(11):673-9.
30. Massicotte L, Sassine MP, Lenis S, Roy A. Transfusion predictors in liver transplant. Anesth Analg. 2004;98(5):1245-51.
31. de Boer MT, Christensen MC, Asmussen M, van der Hilst CS, Hendriks HG, Slooff MJ, Porte RJ. The impact of intraoperative transfusion of platelets and red blood cells on survival after liver transplantation. Anesth Analg. 2008;106(1):32-44.
32. Vamvakas EC, Blajchman MA. Transfusion-related immunomodulation (TRIM): an update. Blood Rev. 2007;21(16):327-48.
33. Raghavan M, Marik PE. Anemia, allogenic blood transfusion, and immunomodulation in the critically ill. Chest. 2005;127(1):295-307.
34. Fonseca-Neto OC, Miranda LE, Sabat BD, Amorim AG, Adeodato LC, Melo PS, Lopes HC, Lacerda CM, Pereira LM. The marginal donor: a single-center experience in orthotopic liver transplantation. ABCD Arq Bras Cir Dig. 2008;21(1):1-5.
35. Fonseca-Neto OC, Amorim AG, Sabat BD, Adeodato LC, Miranda LE, Lacerda CM. Liver transplantation from non-heart-beating donors: initial results from Oswaldo Cruz University Hospital's liver transplantation group, Pernambuco University. Rev Col Bras Cir. 2005;32(5):270-2.

Correspondence:
Olival Cirilo Lucena da Fonseca Neto
Rua Jacobina, 45/1002
52011-180 Recife – PE Brasil
Tel.: (55 81)9989-0208/3184-1360
Fax: (55 81)3184-1484
olivalneto@globo.com

Received: June 18, 2012
Review: August 20, 2012
Accepted: September 21, 2012
Conflict of interest: none
Financial source: none

[1]Research performed at Division of Abdominal Surgery, Department of Surgery, University of Pernambuco (UPE), Brazil.