Predictive Factors of Early Mortality after Living Donor Liver Transplantation: A Single Center Experience of 780 Cases over 16 Years

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ABSTRACT

Introduction: Living-donor liver transplantation (LDLT) is a complex procedure requiring a special perioperative patients' care. Despite the improvements in the operative techniques and perioperative care, early postoperative mortality remains a disappointing event. The current study is conducted to determine the incidence, causes and potential predictive factors of early postoperative mortality after LDLT.

Methods: We reviewed the data of patients who underwent LDLT during the period between May 2004 till October 2020.

Results: During the study period, 780 cases underwent LDLT. Early Mortality occurred in 109 cases (14%). We divided our cases into two groups, Early Mortality group (n=109) and Survivors group (n=671). Higher preoperative INR, creatinine, and MELD score were found in Early Mortality group. More blood loss and perioperative transfusions were found in Early Mortality group. Longer ICU stay with higher incidence of pulmonary and vascular complications were found in Early Mortality group. Preoperative MELD score, blood transfusion, pulmonary complications, and vascular complications were significant predictors of early mortality in multivariate analysis.

Conclusion: Reduction of perioperative transfusions together with early detection and management of vascular and respiratory complications are essential to reduce early mortality after LDLT.

Key words: living-donor liver transplantation, early mortality, MELD score, blood transfusion

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INTRODUCTION

Hepatitis C virus (HCV) infection is recognized as a global health problem that

affects millions of individuals worldwide. HCV-infected individuals have a very high risk for mortality when they are compared to the non-infected individuals because of complications of liver decompensation and hepatocellular carcinoma (HCC)(1). Egypt is a densely inhabited country, which has one of the highest prevalence of HCV infection worldwide, with a predominance of genotype 4 (2).

Liver transplantation is widely accepted as the only effective treatment for patients with end stage liver disease (ESLD) and selected hepatic malignancies (3). In Egypt, deceased donor liver transplantation (DDLT) program is still awaited because of legal aspects, making living donor liver transplantation (LDLT) the only hope for patients with ESLD because of chronic HCV infection with or without HCC (4,5).

LDLT is a very complex surgical procedure requiring a special perioperative patients' care. Despite the improvements in the operative techniques and perioperative care, early postoperative mortality remains a disappointing event to the medical staff and patients' families. Several factors had been identified as potential risk factors that affect the outcomes of LDLT, especially during the early postoperative period (6-8). However, the early postoperative mortality after LDLT remains unpredictable.

The current study is conducted to review our center's experience of LDLT over 16 years to determine the incidence and causes of early postoperative mortality and to determine potential predictive factors for early postoperative mortality.

PATIENTS AND METHODS

Study design

We reviewed the data of patients who underwent LDLT at Liver Transplantation Unit, Gastrointestinal Surgery Center, Mansoura University, Egypt during the period between May 2004 till October 2020.

Patient data were reviewed from a prospectively maintained database for all patients undergoing LDLT. A written informed consent for the surgical procedure was obtained from each patient. This study was approved by the institutional review board and local ethical committee at Faculty of Medicine, Mansoura University.

Preoperative assessment

Preoperative evaluation protocol had been described previously (5,9). In summary, preoperative

evaluation of potential recipients included 4 phases:

Phase I included detailed laboratory evaluation including tumor markers and virological evaluation, detailed radiological evaluation, and anesthetic consultation. Phase II included detailed cardiopulmonary and neuro-psychiatric evaluation. Phase III included endoscopic evaluation, including upper and lower gastro-intestinal tract endoscopy. Phase IV included routine general consultations to exclude possible hidden septic foci.

Operative techniques

The operative technique had been described before (5,9). A standard right hemi-liver graft was commonly used for adult LDLT. The liver graft was implanted into the hepatic fossa. Reconstruction of the hepatic venous outflow was done first, followed by portal, arterial, and biliary reconstruction. After ensuring adequate hemostasis, abdominal drains were placed around the graft and near the raw surface.

Postoperative care

Intensive care unit (ICU) care

After surgery, all cases were transferred to the ICU for monitoring. Patients underwent detailed laboratory evaluation twice daily during the ICU stay. Oral intake and ambulation were allowed on the third postoperative day. Patients were transferred to the ward on the fifth postoperative day, depending on clinical improvement.

Radiological evaluation

Our postoperative protocol included Doppler ultrasound (US) examinations once daily during the first week, every other day during the second and third weeks and before hospital discharge, then once weekly during the following 2 months. Further radiological work up was done upon suspicion of any postoperative complications.

Follow up

After discharge, patients were followed up regularly on outpatient visits. Patients were followed once every week in the first month, then every 2 weeks in the second and third months, then every month till the end of the first year, then every 3 months afterwards or on patient's demand.

Follow-up visit included detailed history taking, clinical examination, detailed laboratory evaluation including trough level of immunosuppression drugs, and Doppler US evaluation of hepatic vasculature.

Study definitions

Postoperative morbidities are defined as adverse events occurring during the postoperative course and graded according to Clavien-Dindo grades (10). Early mortality is defined as patient death during the first 90 days after liver transplantation. Overall survival (OS) is calculated from surgery to documented death or the last follow-up visit.

Statistical analysis

Shapiro-Wilki test was used to assess the normality of the data. Categorical variables were expressed as number and percentage, and continuous variables were expressed as median and range. Comparison between the two groups was done by chi-square or Mann-Whitney test when appropriate. Regression analysis was performed by Cox regression analysis. Significant variables of univariate analysis were included in the subsequent multivariate analysis. Statistical analysis was performed using the SPSS 20 software (IBM, Chicago, IL, USA). A p-value less than 0.05 was considered statistically significant.

RESULTS

During the period between May 2004 and October 2020, 780 cases underwent LDLT at Liver Transplantation Unit, Gastrointestinal Surgery Center, Mansoura University, Egypt. Early Mortality occurred in 109 cases (14%). After a median follow up duration of 41 month (4 – 189), late mortality occurred in 64 cases (8.2%), and 607 cases (77.8%) were alive. We divided our cases into two groups, Early Mortality group (n = 109) and Survivors group (n = 671).

Baseline characteristics of the recipients

The baseline characteristics of the study cases are summarized in *table 1*. There were no significant differences between the two groups except for pre-operative serum international normalized ratio (p = 0.015), serum creatinine (p = 0.022), and model for end-stage liver disease (MELD) score (p = 0.013).

Operative data of the recipients

The operative data of the study cases are summarized in *table 2*. A significantly longer warm ischemia time (p = 0.038) and anhepatic phase duration (p = 0.001) were found in Early Mortality group. More operative blood loss (p = 0.001) and peri-operative transfusion requirements (p = 0.001) were found in Early Mortality group.

Table 1 - Baseline characteristics of the study cases (INR, international normalized ratio; MELD, model for end stage liver disease)

Variables	Early Mortality (n = 109)	Survivors (n = 671)	P value
Waiting period (month)	5 (1.8 – 20)	5 (0.9 – 59)	0.941
Age (years)	53 (5 – 65)	51 (10 – 67)	0.09
Sex			0.56
Male	91 (83.5%)	575 (85.6%)	
Female	18 (16.5%)	96 (14.3%)	
Body mass index (kg/m ²)	28 (18 – 37)	28.7 (15 – 43.5)	0.614
Albumin (g/dl)	2.9 (1.7 – 5)	3 (1.5 – 5.5)	0.86
Bilirubin (mg/dl)	3 (0.6 – 16.5)	2.5 (0.3 – 33.6)	0.093
INR	1.5 (1 – 4)	1.4 (1 – 4.9)	0.015
Creatinine (mg/dl)	0.9 (0.9 – 2.2)	0.8 (0.5 – 2.2)	0.022
Child Pugh Score	9 (5 – 14)	9 (5 – 15)	0.096
MELD Score	16 (6 – 34)	14 (6 – 48)	0.013
Alpha feto-protein (ng/ml)	6 (1.4 – 235)	6 (1 – 521)	0.918
Cause of transplantation			0.156
Liver cirrhosis	79 (72.5%)	437 (65.1%)	
Hepatocellular carcinoma	30 (27.5%)	234 (34.9%)	

Table 2 - Operative data of the study cases

Variables	Early Mortality (n = 109)	Survivors (n = 671)	P value
Graft weight (gm)	782 (391 – 1654)	857 (436 – 1545)	0.069
Graft weight to Recipient weight Ratio (GRWR)	0.95 (0.75 – 2.4)	1.03 (0.78 – 2.58)	0.264
Ascites volume (L)	2 (0 – 21)	0.3 (0 – 26)	0.059
Cold ischemia time (minutes)	34 (12 – 150)	30 (10 – 175)	0.31
Warm ischemia time (minutes)	42 (23 – 130)	37 (17 – 137)	0.038
Anhepatic phase duration (minutes)	78 (40 – 175)	66 (25 – 173)	0.001
Operation time (minutes)	660 (420 – 1080)	600 (345 – 900)	0.061
Blood loss (ml)	11750 (900 – 7000)	6750 (300 – 39000)	0.001
Blood transfusion	78 (71.9%)	549 (81.8%)	0.001
Hepatic veins number			0.008
1	50 (45.9%)	383 (57.1%)	
2	35 (32.1%)	202 (30.1%)	
3	22 (20.2%)	68 (10.1%)	
4	1 (0.9%)	17 (2.5%)	
5	1 (0.9%)	1 (0.1%)	
Portal vein number			0.494
1	102 (93.6%)	637 (94.9%)	
2	7 (6.4%)	34 (5.1%)	
Portal thrombectomy	6 (5.5%)	15 (2.2%)	0.063
Hepatic artery number			0.073
1	105 (96.3%)	663 (98.8%)	
2	4 (3.7%)	8 (1.2%)	
Bile duct number			0.915
1	62 (56.9%)	396 (59%)	
2	44 (40.4%)	258 (38.5%)	
3	3 (2.8%)	17 (2.5%)	

Post-operative data of the recipients

Early mortality occurred in 109 cases (14%). Causes of early mortality are summarized in *table 3*. The most common causes of early postoperative mortality were respiratory problems (24 cases – 22%), vascular problems (20 cases – 18.3%), and sepsis (14 cases – 12.8%).

The postoperative data of the study cases are summarized in *table 4*. Longer intensive care unit stay was noted in Early Mortality group ($p = 0.001$). There were no significant differences between the two groups regarding wound-related problems ($p = 0.519$), overall biliary complications ($p = 0.193$), and abdominal collections ($p = 0.72$). Higher incidence of pulmonary complications ($p = 0.001$) and vascular complications ($p = 0.001$) were found in Early Mortality group.

Predictors of early postoperative mortality

Predictive factors for early postoperative mortality are summarized in *table 5*. On univariate analysis, serum bilirubin, serum creatinine, Child-Pugh score, MELD score, graft weight, warm ischemia time,

Table 3 - Causes of early postoperative mortality

Causes	Number (109)
Chest troubles	24 (22%)
• Acute respiratory distress syndrome	5 (4.6%)
• Pneumonia	15 (13.8%)
• Viral pneumonia	2 (1.8%)
• Pulmonary edema	1 (0.9%)
• Pulmonary embolism	1 (0.9%)
Vascular troubles	20 (18.3%)
• Anterior sector congestion	1 (0.9%)
• Hepatic venous outflow obstruction	7 (6.4%)
• Portal vein thrombosis	5 (4.6%)
• Hepatic artery thrombosis	7 (6.4%)
Sepsis	14 (12.8%)
Surgery related (bleeding and transfusion related lung injury)	13 (11.9%)
Neurological troubles	12 (11%)
• Cerebral hemorrhage	5 (4.6%)
• Cerebellar hemorrhage	1 (0.9%)
• Multiple brain infarctions	2 (1.8%)
• Central pontine myelolysis	1 (0.9%)
• Subarachnoid hemorrhage	1 (0.9%)
• Tacrolimus (FK) induced neurotoxicity	1 (0.9%)
• Withdrawal syndrome	1 (0.9%)
Primary non function of the graft	10 (9.2%)
Small for size syndrome	6 (5.5%)
Cardiac troubles (acute myocardial infarction)	5 (4.6%)
Renal troubles (acute renal failure)	3 (2.8%)
Sarcopenia and wasting	2 (1.8%)

Table 4 - Postoperativedataof the study cases

(ICU, intensive care unit; HAT, hepatic artery thrombosis; PVT, portal vein thrombosis; PVS, portal vein stenosis)

Variables	Early Mortality (n = 109)	Survivors (n = 671)	P value
ICU stay (days)	7 (2 – 45)	6 (4 – 60)	0.001
Hospital stay (days)	16 (2 – 90)	21 (7 – 135)	0.001
Wound problems			0.519
Infection	0	5 (0.7%)	
Hematoma	0	3 (0.4%)	
Internal hemorrhage	13 (11.9%)	19 (2.8%)	0.01
Biliary complications			
Overall	16 (14.7%)	137 (20.4%)	0.193
Leak	9 (8.3%)	56 (8.3%)	1
Biloma	10 (9.2%)	59 (8.8%)	0.856
Stricture	0	85 (12.7%)	0.001
Abdominal collections	6 (5.5%)	26 (3.9%)	0.72
Vascular complications			
Overall	26 (23.9%)	51 (7.6%)	0.001
HAT	7 (6.4%)	7 (1%)	0.017
PVT	5 (4.6%)	6 (0.9%)	0.005
PVS	0	6 (0.9%)	0.001
Venous congestion	18 (16.5%)	37 (5.5%)	0.001
Significant pulmonary complications	24 (22%)	18 (2.7%)	0.001

Table 5 - Predictors of early postoperative mortality

(HR, hazard ratio; CI, confidence interval; INR, international normalized ratio; MELD, model for end-stage liver disease; PV, portal vein; HV, hepatic vein; HA, hepatic artery)

Variables	Univariate Analysis		Multivariate Analysis	
	HR (95% CI)	P value	HR (95% CI)	P value
Age	1.012 (0.991-1.034)	0.256		
Sex	1.179 (0.711-1.954)	0.524		
Body mass index	0.986 (0.944-1.029)	0.518		
Albumin	0.843 (0.608-1.167)	0.303		
Bilirubin	1.061 (1.017-1.017)	0.006	1 (0.85-1.176)	0.996
INR	1.03 (0.907-1.168)	0.65		
Creatinine	1.723 (1.49-3.13)	0.03	2.442 (0.486-12.275)	0.279
Child Pugh Score	1.156 (1.02-1.311)	0.023	1.113 (0.759-1.633)	0.582
MELD Score	1.049 (1.017-1.083)	0.003	1.056 (1.03-1.237)	0.01
Pathologic diagnosis	0.74 (0.486-1.126)	0.16		
Ascites volume	1.024 (0.989-1.06)	0.188		
Graft weight	0.24 (0.069-0.835)	0.025	1.156 (0.953-1.403)	0.141
GRWR	0.976 (0.827-1.152)	0.774		
Cold ischemia time	1.006 (0.998-1.013)	0.118		
Warm ischemia time	1.011 (1.002-1.02)	0.015	0.954 (0.89-1.022)	0.177
Anhepatic phase duration	1.01 (1.006-1.014)	0.001	1.015 (0.998-1.032)	0.085
Operation time	1.005 (1.003-1.006)	0.001	1 (0.995-1.004)	0.936
Blood loss	1 (1-1)	0.001	1 (1-1)	0.887
Blood transfusion	1.124 (1.092-1.156)	0.001	1.134 (1.012-1.271)	0.03
PV thrombectomy	3.095 (0.998-9.597)	0.05		
HV number	1.286 (1.042-1.586)	0.019	1.303 (0.644-2.635)	0.461
PV number	1.283 (0.597-2.76)	0.523		
HA number	2.829 (1.041-7.689)	0.041	1.129 (0.171-7.556)	0.9
Bile duct number	1.064 (0.758-1.495)	0.719		
Wound problems	1.2 (0.423-11.939)	0.656		
Significant pulmonary complications	6.327 (4.012-9.98)	0.001	0.017 (0.001-0.377)	0.01
Internal hemorrhage	2.625 (1.327-5.193)	0.006	3.254 (0.749-14.18)	0.115
Biliary complications	0.676 (0.397-1.149)	0.147		
Vascular complications	2.06 (1.969-4.755)	0.001	3.534 (1.061-11.769)	0.04
Abdominal collections	1.149 (0.75-1.759)	0.523		

anhepatic phase duration, operation time, blood loss, blood transfusion, hepatic veins anastomosis number, hepatic artery anastomosis number, postoperative pulmonary complications, postoperative internal hemorrhage, and postoperative vascular complications were significantly associated with early post-operative mortality. On multivariate analysis, pre-operative MELD score, blood transfusion, postoperative pulmonary complications, and postoperative vascular complications were significant predictors of early postoperative mortality.

DISCUSSION

Liver transplantation has been established as the only effective treatment for patients with ESLD due to various causes as viral hepatitis and metabolic disorders, and certain hepatic malignancies (3). LDLT has been rapidly developing all over the world and is currently established as a safe and acceptable alternative to DDLT (3,11). In Egypt, DDLT program is still awaited due to several legal limitations, making LDLT the only hope for patients with ESLD with or without HCC (4,5). In our unit, LDLT program was started in 2004 for the management of patients from a highly populated Delta region in the north side of Egypt (2). The liver transplantation team in our unit is a totally independent team. All team members including surgeons, hepatologists, anesthesiologists, intensivists, radiologists and pathologists are exclusively Mansoura University staff.

LDLT is a very complex surgical procedure requiring a special perioperative patients' care and a complex infrastructure availability. Despite the improvements in the operative techniques and perioperative patients' care, early postoperative mortality remains a disappointing event. Previous studies had reported varying incidence of early mortality after liver transplantation (table 6). Li et al. reported early mortality incidence of 11.9% after LDLT with 3-month overall

survival of 88.1% (12). Vrochides et al. reported early-mortality incidence of 12.4% after liver transplantation (7). In a study from Egypt, Elkholy et al. reported early mortality among 29 patients (23%) who underwent LDLT (13). In another study, El Amir et al. reported 3-month mortality rate of 24.4% and 1-year mortality of 31.4% among patients who underwent LDLT (14). In our study, early postoperative mortality occurred in 109 cases (14%) who underwent LDLT. The relatively high early mortality rate could be attributed to several factors. Firstly, and most essential, is the lack of a back-up of DDLT program which is still awaited in our locality (4). In our opinion, active legalization of DDLT program in our locality is essentially needed to overcome the shortage of available liver grafts in Egypt and to back-up the ongoing LDLT programs. In our study, more than 20% of early mortality cases, owing to primary non-function of the graft or severe vascular complications, could be saved with the availability of DDLT program. Secondly, higher preoperative MELD score among patients undergoing LDLT as a major proportion of our patients are referred at a late disease stage. Finally, acceptance of donors with multiple anatomical variations due to the problem of donor shortage as we allow only living-related transplantation (4).

Previous studies had identified different causes of early postoperative mortality after liver transplantation. Elkholy et al. found that sepsis was the commonest cause of early mortality after LDLT (13). Nafea et al. found that sepsis followed by acute rejection were the commonest causes of early mortality (15). Li et al. reported that multi-organ failure was the commonest cause of early mortality (12). El Amir et al. found that infectious complications, pneumonia and sepsis, were the commonest cause of early mortality after LDLT (14). In our study, we found that respiratory complications followed by vascular complications and sepsis were the commonest causes of early mortality after LDLT.

Identification of different predictive factors for early

Table 6 - Studies reporting early mortality (90 days mortality) after living-donor liver transplantation

Study	Total number of cases	Early postoperative mortality
Li et al (12)	218 patients	26 patients (11.9%)
Elkholy et al (13)	126 patients	29 patients (23%)
ElAmir et al (14)	86 patients	21 patients (24.42%)
Nafea et al (15)	122 patients	28 patients (22.8%)
Freise et al (32)	384 patients	34 patients (8.5%)
Akamatsu et al (33)	445 patients	23 patients (5%)
Li et al (34)	235 patients	31 patients (13.2%)
Alves et al (35)	78 patients	16 patients (20.5%)

postoperative mortality after liver transplantation is essential to optimize the selection of appropriate candidates, control of correctable causes, and achieve favorable outcomes (16).

Several predictive factors for early mortality had been identified. These include preoperative, operative, and postoperative factors. Preoperative factors include higher MELD score, small liver graft volume, poor quality liver grafts, and older donor age. Operative factors include larger amounts of blood loss and transfusion requirements, longer anhepatic phase duration, longer cold and warm ischemia times, and technical troubles. Postoperative factors include postoperative transfusion requirements, longer ICU and hospital stay and abnormal postoperative laboratory values (12,16). In the current study, we evaluated our experience of 780 consecutive cases of LDLT in a single center to determine different predictive factors for early postoperative mortality. To the best of our knowledge this is the largest series of LDLT from a single center in our locality. We found that preoperative MELD score, blood transfusion requirements, post-operative pulmonary complications, and postoperative vascular complications were significant predictors of early postoperative mortality on multivariate regression analysis.

MELD Score has been validated as a predictor of survival in patients with cirrhosis, alcoholic hepatitis, and in patients with acute hepatitis. Afterwards, it has been widely used to allocate patients under waiting list for liver transplantation and predict the early mortality (17). Kidney dysfunction is commonly seen in almost 10 – 20% of liver transplantation candidates. Previous studies had shown that kidney dysfunction is associated with prolonged hospital stay, higher incidence of infectious complications, and poor survival outcomes (18-20). In our study, preoperative MELD score was a significant predictor of early and mortality and was significantly higher in the early mortality patients. Similar finding has been addressed by previous studies. Vrochides et al addressed that preoperative MELD score together with preoperative serum bilirubin, INR, and creatinine were significant predictors of early mortality (7). Elkholy et al. addressed that preoperative MELD score higher than 20 was a significant predictor of early mortality (13). On the other hand, El Amir et al. found that preoperative MELD score failed to predict both early postoperative and 1-year mortality after LDLT (14). Similarly, Chok et al addressed that higher MELD score group had comparable early mortality in comparison to lower MELD score group (21).

Perioperative blood transfusion had been identified as a poor predictor of recipient outcomes after liver

transplantation (22,23). Several studies had addressed that excess perioperative transfusions were associated with prolonged hospital stay, higher incidence of infectious complications, and poor survival outcomes after liver transplantation (24,25). In the current study, we found that perioperative transfusion was a significant predictor for early postoperative mortality. Similar finding had been addressed by Li et al. who found that intraoperative allogeneic red blood cell transfusion was a significant predictor of early mortality (12). Elkholy et al. addressed that intraoperative transfusion of more than 8 units of packed red blood cells was a significant predictor of early mortality (13). Ye-Ben et al. reported that the amount of operative blood loss and transfusion requirements had a significant association with early mortality (26).

Postoperative morbidities following major abdominal surgeries are associated with reduced survival outcomes (27). LDLT is a very complex surgery that is associated with high risk for the development of several postoperative complications which can cause graft loss and early postoperative mortality (28,29). Recipients are at a very high risk for the development of a wide variety of postoperative complications including biliary, vascular, infectious, renal, neurological, and cardiac complications (29). In our study, we found that the development of postoperative pulmonary complications, and postoperative vascular complications were significant predictors of early postoperative mortality. Duffy et al addressed that the development of vascular complications, especially hepatic artery thrombosis and portal vein thrombosis, were significantly associated with reduced liver graft and recipient survival. They addressed that retransplantation provides the most superior short-term for patients with hepatic artery thrombosis (30). Such backup with cadaveric programs is still lacking in our locality. On the other hand, Bozbas et al. showed that pulmonary complications after liver transplantation, especially pleural effusion and pneumonia, were significantly associated with early mortality. Early and late survival rates were significantly lower in patients in whom a microorganism was isolated on deep tracheal aspirate culture (31). Other studies did not find any significant association between postoperative morbidities and early mortality after liver transplantation (12,13,15). Avoidance, early detection, and proper management of early postoperative vascular and pulmonary complications are essential to reduce early postoperative mortality.

Our study had some limitations. Firstly, it is a single center retrospective study. Secondly, we did not evaluate any of the postoperative laboratory

parameters in the regression model. Further studies on a large number of patients from multiple centers are needed to support our findings.

CONCLUSION

In conclusion, early postoperative mortality after LDLT is a disappointing event to the medical staff and patients' families. We found that preoperative MELD score, blood transfusion, postoperative pulmonary complications, and postoperative vascular complications were significant predictors of early postoperative mortality. Reduction of perioperative transfusions together with early detection and management of vascular and respiratory complications are essential to reduce early postoperative mortality. A DDLT program is essentially needed to back up ongoing LDLT programs in our locality.

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Conflicts of interest

All authors declare no conflicts of interest.

Ethical approval

The study was approved by the institutional review board and local ethical committee at Faculty of Medicine, Mansoura University.

REFERENCES

- Daw MA, El-Bouzedi AA, Ahmed MO, Dau AA, Agnan MM, Drah AM. Geographic integration of hepatitis C virus: a global threat. *World J Virol*. 2016;5(4):170-182.
- Galal HE, Azza HE. Liver transplantation in Egypt from West to East. *Transplant Research and Risk Management* 2010;2:41-46.
- Olthoff KM, Merion RM, Ghobrial RM, Abecassis MM, Fair JH, Fisher RA, et al. Outcomes of 385 adult-to-adult living donor liver transplant recipients: a report from the A2ALL consortium. *Ann Surg*. 2005;242(3):314-23, discussion 323-5.
- Wahab MA, Hamed H, Salah T, Elsarraf W, Elshobary M, Sultan AM et al. Problem of living liver donation in the absence of deceased liver transplantation program: Mansoura experience. *World J Gastroenterol*. 2014;20(37):13607-14.
- Wahab MA, Shehta A, Elshobary M, Yassen AM, Elmorshedi M, Salah T, et al. Living-donor liver transplantation in hepatitis C virus era: a report of 500 consecutive cases in a single center. *Transplant Proc*. 2018;50(5):1396-1406.
- Santori G, Andorno E, Antonucci A, Morelli N, Bottino G, Mondello R, et al. Potential predictive value of the MELD score for short-term mortality after liver transplantation. *Transplant Proc*. 2004;36(3):533-4.
- Vrochides D, Hassanain M, Barkun J, Tchervenkov J, Paraskevas S, Chaudhury P, et al. Association of preoperative parameters with postoperative mortality and long-term survival after liver transplantation. *Can J Surg*. 2011;54(2):101-6.
- Dawwas MF, Lewsey JD, Watson CJ, Gimson AE; UK, Ireland Liver Transplant Audit. The impact of serum potassium concentration on mortality after liver transplantation: a cohort multicenter study. *Transplantation* 2009;88(3):402-410.
- Wahab MA, Shehta A, Elshobary M, Salah T, Fathy O, Sultan A, et al. Outcomes of Living Donor Liver Transplantation for Patients with Preoperative Portal Vein Problems. *J Gastrointest Surg* 2018;22(12):2055-63.
- Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg* 2004;240(2):205.
- Pomfret EA, Fryer JP, Sima CS, Lake JR, Merion RM. Liver and intestine transplantation in the United States, 1996–2005. *Am J Transplant*. 2007;7(5 Pt 2):1376-89.
- Li C, Wen TF, Yan LN, Li B, Yang JY, Wang WT, et al. Factors associated with early mortality after living-donor liver transplant. *Experimental and clinical transplantation* 2014;13(1):62-7.
- Elkholy S, Mogawer S, Hosny A, El-Shazly M, Al-Jarhi UM, Abdel-Hamed S, et al. Predictors of mortality in living donor liver transplantation. *Transplant Proc* 2017;49(6):1376-1382.
- El Amir M, Eldeen HG, Mogawer S, Esmat G, El-Shazly M, El-Garem N, et al. Different score systems to predict mortality in living donor liver transplantation: which is the winner? The experience of an Egyptian center for living donor liver transplantation. *Transplant Proc* 2015;47(10):2897-901.
- Nafea MA, Alsebaey A, Abd El Aal Sultan A, Goda MH, Salman A, Rashed HS, et al. Predictors of early recipient mortality after living donor liver transplantation in a tertiary care center in Egypt. *Annals of Saudi Medicine* 2019;39(5):337-44.
- Olivari D, Mainardi V, Rando K, Rey G, Menendez J, Prieto J, et al. Risk factors of mortality after liver transplantation in Uruguay. *Transplant Proc* 2018;50(2):499-502.
- Kamath PS, Wiesner RH, Malinchoc M, Kremers W, Therneau TM, Kosberg CL, et al. A model to predict survival in patients with end-stage liver disease. *Hepatology* 2001;33(2):464-70.
- Park I, Moon E, Hwang JA, Yu S, Kim BW, Wang HJ, et al. Does hepatorenal syndrome affect the result of liver transplantation? Clinical observations. *Transplant Proc* 2010;42(7):2563-6.
- Kundakci A, Pirat A, Komurcu O, Torgay A, Karakayali H, Arslan G, et al. Rife criteria for acute kidney dysfunction following liver transplantation: incidence and risk factors. *Transplant Proc*. 2010;42(10):4171-4.
- Northup PG, Argo CK, Bakhru MR, Schmitt TM, Berg CL, Rosner MH. Pretransplant predictors of recovery of renal function after liver transplantation. *Liver Transpl*. 2010;16(4):440-446.
- Chok KSh, Chan SC, Fung JY, Cheung TT, Chan AC, Fan ST, et al. Survival outcomes of right-lobe living donor liver transplantation for patients with high Model for End-stage Liver Disease scores. *Hepatobiliary Pancreat Dis Int*. 2013;12(3):256-62.
- Dunn LK, Thiele RH, Ma JZ, Sawyer RG, Nemerut EC. Duration of red blood cell storage and outcomes following orthotopic liver transplantation. *Liver Transpl* 2012;18(4):475-481.
- Wiederkehr JC, Igreja MR, Nogara MS, Gonçalves NL, Wiederkehr BA, Nascimento VB, et al. Analysis of survival after primary liver transplantation: multivariate analysis of 155 cases in a single center. *Transplant Proc* 2010;42(2):511-2.
- Ramos E, Dalmau A, Sabate A, Lama C, Llado L, Figueras J, et al. 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.
- Benson AB, Burton JR Jr, Austin GL, Biggins SW, Zimmerman MA, Kam I, et al. Differential effects of plasma and red blood cell transfusions on acute lung injury and infection risk following liver transplantation. *Liver Transpl*. 2011;17(2):149-58.
- Qian YB, Cheng GH, Huang JF. Multivariate regression analysis on early mortality after orthotopic liver transplantation. *World J*

- Gastroenterol 2002;8(1):128-30
27. Khuri SF, Henderson WG, DePalma RG, Mosca C, Healey NA, Kumbhani DJ. Determinants of long-term survival after major surgery and the adverse effect of postoperative complications. *Ann Surg* 2005;242:326-341.
28. Gad EH, Alsebaey A, Lotfy M, Eltabbakh M, Sherif AA. Complications and mortality after adult to adult living donor liver transplantation: a retrospective cohort study. *Ann Med Surg (Lond)* 2015;4:162-171.
29. Parikh A, Washburn KW, Matsuoka L, Pandit U, Kim JE, Almeda J, et al. A multicenter study of 30 days complications after deceased donor liver transplantation in the model for end-stage liver disease score era. *Liver Transpl*. 2015;21(9):1160-8.
30. Duffy JP, Hong JC, Farmer DG, Ghobrial RM, Yersiz H, Hiatt JR, et al. Vascular complications of orthotopic liver transplantation: experience in more than 4,200 patients. *J Am Coll Surg* 2009; 208(5):896-903.
31. Bozbas SS, Eyuboglu FO, Ergur FO, Arslan NG, Sevmis S, Karakayali H, et al. Pulmonary complications and mortality after liver transplant. *Exp Clin Transplant*. 2008;6(4):264-70.
32. Freise CE, Gillespie BW, Koffron AJ, Lok ASF, Pruett TL, Emond JC, et al. Recipient morbidity after living and deceased donor liver transplantation: findings from the A2ALL retrospective cohort study. *Am J Transplant*. 2008;8(12):2569-79.
33. Akamatsu N, Sugawara Y, Kanako J, Junichi Arita, Sakamoto Y, Hasegawa K, et al. Low platelet counts and prolonged prothrombin time early after operation predict the 90 days morbidity and mortality in living-donor liver transplantation. *Ann Surg* 2017; 265(1):166-72.
34. Li L, Wang H, Yang J, Jiang L, Yang J, Wang W, et al. Immediate postoperative low platelet counts after living donor liver transplantation predict early allograft dysfunction. *Medicine* 2015;94(34): e1373.
35. Alves RC, Fonseca EA, Mattos CA, Abdalla S, Gonçalves JE, Waisberg J. Predictive factors of early graft loss in living donor liver transplantation. *Arquivos de gastroenterologia* 2012;49(2):157-61.