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Influencing Factor Analysis on Initial Poor Graft Function after Liver Transplantation

Ran Tao, Bin Zhang

Department of Hepatobiliary surgery, the Affiliated Hospital of Qingdao University, Qingdao, 266072, China

Abstract: **To analyze the related influencing factors for initial poor graft function (IPGF) after liver transplantation (LT). 107 cases underwent liver transplantation from March in 2014 to November in 2015 were selected randomly. The group of IPGF is confirmed if ALT and/or AST are above 1500IU/L, while non-IPGF below 1500IU/L within 72h after LT. The donor related influencing factors includes age, source, warm ischemic time, cold preservation time, liver biopsy at the end of cold ischemia and if there is a supplementary perfusion at the end of cold ischemia. The recipient related influencing factors includes gender, age, primary liver diseases, Child-Pugh classification, MELD score and ECOG score. The postoperative related influencing factors include intubation time and ICU monitoring time. There are 31 cases (28.97%) in IPGF group and 67 cases (71.03%) in non-IPGF group. The result of ALT and/or AST are significantly higher in IPGF group than those in non-IPGF group (P<0.05). The recovery time of liver function is significantly longer in IPGF group (20.50±5.28d) than that in non-IPGF group (13.20±5.50d) (P<0.01). The donor warm ischemic time is significantly longer in IPGF group (4.34±2.25min) than that in non-IPGF group (2.18±1.90min) (P<0.05). The cold preservation time were significantly longer in IPGF group (9.73±1.19h) than that in non-IPGF group (9.24±0.99h) (P<0.05). There was significant difference between the 2 groups in spite of higher values in Child-Pugh C recipients' ratio. There were no significant differences between the 2 groups (P>0.05). The rest of related influencing factors had no significant differences between the 2 groups. Longer donor warm ischemic time, cold preservation time and Child-Pugh C recipients' ration are important risks factors for IPGF. Longer anhepatic time and rewarm ischemic time are the potential risk factors.**

Keywords: Liver transplantation; IPGF; Warm ischemia time; Cold preservation time; Risk factor

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*Corresponding Author: Bin Zhang, 18661808021@163.com

1. Introduction

In 1963, American professor Starzl carried out the first human orthotopic liver transplantation. Subsequently, the liver transplantation technique was progressing; and it is now known as the most reliable method to treat the end-stage liver disease. In China, liver transplantation in dogs was first executed in Wuhan Tongji Hospital in 1970s. However, the first human allogeneic orthotopic liver transplantation was done in Shanghai Ruijin Hospital in 1977. Since then, the liver transplant has on the booming in mainland China. But, soon afterwards, it stagnated in China due to high cost, lack of donor liver, poor prognosis and so on. It was not until 1990 that with introducing advanced foreign technology and new immuno-suppressive drugs. The liver transplantation has shown tremendous growth. In the 21st century, our clinical experience is gradually matured and the number of liver transplantation has multiplied for years and the post-operative survival rate approaches the advanced level. The liver transplantation starts the second high tide in China [1]. In recent years, the 1 year survival rate after transplantation has reached 70%～90% in China, even the 10-year overall survival has up to 60% [2]. At present, the survival duration for patients with liver transplant has met the advanced standards. However, how to reduce the post-transplantation complications has become the issue that needs to be addressed urgently. The causes for hepatic dysfunction are complex and diversify. Only clearing the inducement of abnormal liver tests as soon as possible, the targeted therapeutic measures can be taken.

The most severe complication at early stage after liver transplantation is primary graft non-function (PGNF). PGNF refers to the ALT and AST increase continually, serious coagulation dysfunction and heart, lung and renal failure occurs within 7 days after transplantation [3]. The inactive rate of graft, receptor complications and mortality become very high in case of PGNF. Whereas, the main reason for primary graft non-function (PGNF) is initial poor graft function (IPGF). IPGF is a borderline syndrome with about 20% of occurrence and its clinical manifestations include prominent elevation of early alanine aminotransferase (ALT) and/or aspartate aminotransferase (AST) after liver transplantation. The partial graft function after IPGF may be recovered slowly. However, there are still some patients continue to present PGNF and thus need re-transplantation. According to reports in literature, incidence rate of IPGF is related to source of liver graft, access of liver graft, warm ischemia time, cold preservation time and preserving method, and preoperative liver function of

receptors, operating time and approach, postoperative intubation time, and immuno-suppressive regimen [3]. This study analyzed affecting factors of IPGF among 107 patients undergoing liver transplantation.

2. Materials and methods

2.1. Case selection

The patients were selected who was accepted the liver transplantation for the first time. And their routine inspections before operation were according to the surgical indications. Patients were not selected by the eliminated criteria: (1) the patients with operation failure, which is the patient, who dead during operation or the patient, whose operation stopped because of organ tissue adhering severely; (2) patients with living allograft transplantation; (2) the patients with incomplete donor liver data.

2.2. Clinical data of selected cases

From March, 2014 to November, 2015, 107 cases were subject to allograft transplantation in the department of liver transplantation, the Affiliated Hospital of Qingdao University. There were 85 males and 22 females with the gender ratio being of 3.86:1. The age of patients ranges from 21 and 68; except that, the median and average age were 51 and 51.25±9.72 respectively. The routine inspection before operation covers routine examination of blood, urine and stools; blood grouping, coagulation convention, complete biochemistry, tumor markers (such as Alphafetoprotein); full set of serum hepatitis, syphilis and HIV; serum toxoplasma, rubella virus, herpes simplex virus, cytomegalovirus antibodies and antigen detection; electrocardiogram, color Doppler echocardiography, craniocerebral CT scan, chest CT scan; the complete abdomen and pelvic cavity enhanced CT hepatic vascular and billiary tract reconstruction. The basis liver diseases: 46 cases were post chronic viral hepatitis cirrhosis with primary liver cancer; 36 cases were post chronic viral hepatic cirrhosis; 9 cases were cholestatic hepatic diseases; 5 cases were primary liver cancer with hepatic cirrhosis; and 5 other cases were alcoholic cirrhosis; besides, there were 4 cases of polycystic liver and kidney and 2 cases of hepatolenticular degeneration. All selected patients were computed MELD score, liver function Child-Pugh grading and ECOG score before operation.

2.3. Therapeutic method

2.3.1. Procurement of donor liver

The liver grafts were obtained from two ways: 75 cases came from donation after citizens' death, and 32 cases were gained through judicial channel. Before donation, all donors were confirmed no infectious disease like viral hepatitis, syphilis, and HIV by serological examination. Their ABO blood type and RH blood group were same as receptors. In order to access the liver graft, the donor was experienced exploratory laparotomy. Large cruciate incision was made in abdomen, inferior vena cava was exposed and bloodletting was done at renal veins through inferior vena cava. After exposing the aorta abdominalis, 3000ml of kidney preservation liquid with 0-4℃ and 1000ml of UW preservation liquid were perfused at renal artey via aorta abdominalis. And then superior mesenteric vein was exposed. 2000ml of kidney preservation liquid with 0-4℃ and 2000ml of UW preservation liquid were perfused at suspensory ligament of duodenum by intubating to portal vein through superior mesenteric vein. In the next step, common bile duct at the rear of pancreas was revealed, 500ml of normal saline with 0-4℃was infused via common bile duct and gall bladder was cut off. The gall bladder was washed till no obvious bile reserved. The crushed ice was put into liver and kidney for swiftly cooling. Here, warm ischemia time of liver graft means the liver duration from donor heart failure to the start of cold perfusion. This warm ischemia time was 2 to 5 minutes. The liver was stored in 0~4℃ of UW preservation liquid and the storage expiration was 3 to 12 hours with the average time being of 9.38±1.07h. Cold preservation time of liver graft refers to the duration from cold perfusion to portal vein opening and liver rewarm after transplantation. Graft biopsy: before liver transplantation, 0.5g of liver tissue was conventionally cut from the edge of graft right anterior lobe; and it was then fixed in 100g/L of formaldehyde solution to be sent for pathological examination and the score of pathological biopsy was calculated according to graft biopsy pathology scoring criteria [4,5]. Some liver grafts were subject to supplementary perfusion by 1000ml of UW preservation liquid.

2.3.2. Management in liver transplantation

Among the 107 cases of liver transplantation, there were 103 cases of standard orthotopic liver transplantation (96%) and 4 cases of modified piggyback liver transplantation (4%). Extracorporeal veno-venous bypass technique was not applied in all transplants. No portal vein and inferior vena cava damage occurred during the operation; and before opening the portal vein, 1000 to 1500ml of human albumin normal saline was perfused for fully exhausting; basiliximab was used to avoid acute rejection after opening portal vein. Both hepatic artery and biliary tract were zero damage in the transplantation, all of which were performed end to end anastomosis. Relative warm ischemia time of patients with liver transplantation means the duration from portal vein opening and graft rewarming to the open of hepatic artery. There was 1 T-tube for 107 patients, which was placed at proximal biliary tract anastomosis of common bile duct; and 3 drainage

tubes were located in underpart of left liver, right inferior phrenic, and porta hepatis. During the liver transplantation, biapenem was routinely used for anti-infection, the injectable esomeprazole was utilized for acid suppression, and injectable methylprednisolone sodium succinate was employed for anti-rejection therapy. Except that, blood flow of hepatic arterio-vein, portal vein and inferior vena cava were inspected by color Doppler for all patients before and after transplantation. Intraoperative and postoperative monitoring index: operating time of receptors, time of anhepatic phase, relative warm ischemia time, and serum ALT and AST within 72h after liver transplantation.

2.3.3. Postoperative management

Triple immuno-suppressive regimen namely, tacrolimus, mycophenolate mofetil, methylprednisolone sodium succinate were applied after surgery. Besides, biapenem, cefoperazone-sulbactam sodium, ganciclovir were adopted for anti-infection treatment. The basiliximab was employed conventionally on the 3rd postoperative day to avoid acute rejection. Low molecular weight heparin was taken on the basis of patients' postoperative coagulation routine. Blood flow of hepatic arterio-vein, portal vein and inferior vena cava were routinely inspected by color Doppler per day within 14 days after surgery. The patients were transferred from ICU (intensive care unit) to general ward on the third or fourth postoperative day. Blood routine examination, coagulation convention, complete biochemistry, and arterial blood gas analysis were conducted at every 6a.m. for each patient in the care unit. The blood routine examination, coagulation convention, emergency liver function, emergency renal function, electrolyte and arterial blood gas analysis were also executed at 6a.m. during such period. In addition, blood routine, complete biochemistry, coagulation convention, concentration of anti-rejection drugs were detected at every 6a.m for all patients within 14 days after they were admitted to general unit.

Table 1. Pathological biopsy scoring criteria for donor liver.

Items of pathological observation	Scoring criteria			
	0 score	1score	2 score	3 score
Cellular edema(hydropic degeneration)	None	Limited to area of Ⅱ-Ⅲ	Area of Ⅰ-Ⅲ	Area of Ⅰ-Ⅲ with ballooning degeneration
macrovesicular steatosis (ratio of liver cell degeneration)	None	<30%	30%-60%	>60%
intrahepatic cholestasis	None	≤30%	≤30%，with cholangiole cholestasis	>30%, with cholangiole cholestasis
Eosinophilic change and apoptotic cells[a]	None	<1	2-10	>10
Hemorrhage and necrosis area	None	<10% hepatic lobule	10%～50% hepatic lobule	>50% hepatic lobule
Infiltrating numbers of Neutrophils[b]	<5	5～10	10-50	≥50

Notes: a: cell number under the vision of microscope with 10 times; b: average cell numbers within each hepatic lobule and hepatic sinus.

2.4. Grouping of selected patients

According to Nanashima standard [6], the patients with liver transplantation were divided into IPGF group and non-IPGF group. Specifically, the patients, whose ALT and/or AST peak value >1500IU/L within 72h after transplantation, were incorporated into initial poor graft function (IPGF) group. Whereas, whose ALT or AST peak value <1500IU/L were considered as non initial poor graft function (non-IPGF) group. The diagnostic criteria of PGNF include the ALT and AST increase continually, serious coagulation dysfunction and heart, lung and renal failure occurs within 7 days after transplantation and re-transplantation [7]. Liver function recovered time after the surgery is defined as: ALT, AST, alk aline phosphatase, and γ-glutamyl transpeptidase are all declined to the normal value after transplantation.

2.5. Correlative affecting factors

Related factors of donor include age, gender, source of liver donor, warm ischemia time of liver graft, cold preservation time, pathological biopsy score for donor liver before transplantation, and supplementary perfusion or not before transplant (Table 1). Related factors of recipient include age, gender and primary liver diseases of patient with liver transplantation, Child-Pugh classification, MELD score and ECOG score (Table 2). Correlative factors of operation

include operative approach, operating time, amount of bleeding during operation, infusion amount during operation, time of anhepatic phase, relative warm ischemia time, ascitic volume, portal vein thrombosis or not, and splenic artery ligation or not. The postoperative related influencing factors are intubation time and ICU monitoring time.

2.6. Relevant scoring criteria

See Table 1.

2.7. Statistical method

SPSS 19.0 statistical software was used to treat and independent-sample T test was adopted for the data; and chi-square test was employed for count data. P<0.05 was considered as statistical difference.

Table 2. Liver function Child-Pugh classifying standard.

Clinical and detecting items	Liver function scoring		
	1	2	3
Hepatic encephalopathy (grading)	None	1 or 2	3 or 4
Abdominal dropsy	None	Mild	Moderate
Bilirubin（mg/dl）	1～2	2.1～3	≥3.1
Albumin （g/dl）	≥3.5	2.8～3.4	≤2.7
prothrombin time（lengthening, s）	1～4	4.1～6	≥6.1

Class A: 5-6 score; Class B: 7-9 score; class C: 10-15 score.

3. Results

3.1. Cases grouping

The 107 patients had no PGNF after transplantation. According to the results of ALT and AST peak value on the first three days postoperative day (Figure 1, 2.). There were 31 cases in IPGF group (28.97%) and 76 cases in non-IPGF group (71.03%); ALT and/or AST peak value for patients in IPGF group was obviously higher than that in non-IPGF group (P<0.05) with statistical significance. In terms of liver function recover time after transplantation: it was 20.50±5.28 days in IPGF group and 13.20±5.50 in non-IPGF group; the difference was statistically significant (P<0.01). The graft survival rate for patients in IPGF group was 90.32% and 93.42% in non-IPGF group without any statistical difference (P>0.05), see Table 3.

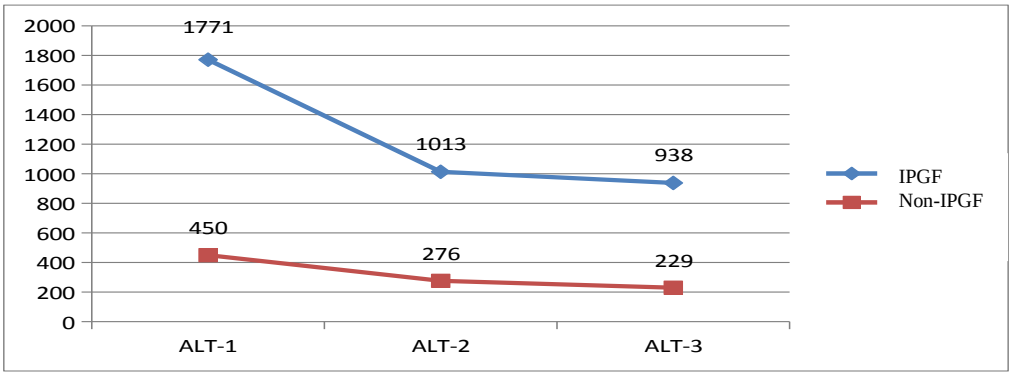

Figure 1. Average of ALT peak three days after liver transplantation (unit: IU/L).

3.2. Analysis results of correlative affecting factors

3.2.1. Related factors of donor

Related factors about liver donor: liver grafts being from donation after citizen death was used by 25 patients (80.64%) in IPGF group and 50 patients (65.79%) in non-IPGF group. The comparison between the two groups had no statistical meaning (P>0.05). Warm ischemia time of liver graft was 4.34±2.25 minutes in IPGF group and 2.18±1.90 minutes in non-IPGF group. There has statistically significant (P<0.05). Whereas, cold preservation time was 9.73±1.19 hours in IPGF group and 9.24±0.99 hours was in non-IPGF group (P<0.05). There were 5 cases in IPGF group made supplementary perfusion before transplantation (16.1%) and 26 other cases (83.9%) without doing it. By contrast, 15 cases (19.7%) in non-IPGF group made supplementary perfusion but the remaining cases (80.3%) did not. There had no statistical significance between two groups (P≥0.05). The grafts in two groups were computed according to pathological biopsy scoring standard and their differences were not significant, see Table 4.

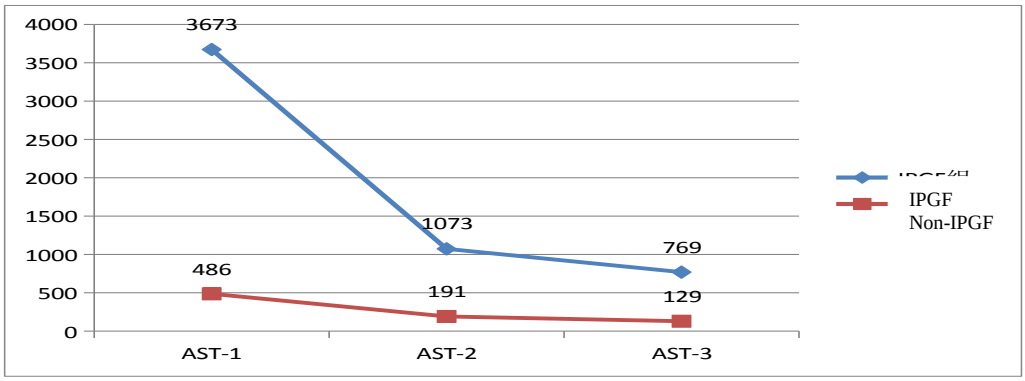

Figure 2. Average of AST peak three days after liver transplantation (unit: IU/L).

3.2.2. Related factors of recipient

There were 26 males and 5 females in IPGF group with the gender ratio being of 5.2:1; while, in non-IPGF group, 59 cases were males and 17 cases were females with the gender ratio being of 3.47:1; and the comparison had no statistical meaning (P>0.05). Regarding the average age, it was 49.29±6.93 years old in IPGF group and 51.76±9.94 in non-IPGF group (P>0.05). In IPGF group, there were 9 cases (29%), whose primary liver diseases was post hepatic cirrhosis, 3 cases (10%) were primary hepatic carcinoma, 14 cases (45%) were post hepatic cirrhosis with liver cancer and 5 other cases (16%) were end-stage liver disease due to other causes. By contrast, there were 27 cases in non-IPGF group whose primary liver diseases (36%) were post hepatic cirrhosis, 2 cases (3%) were primary hepatic carcinoma, 32 cases (42%) were post hepatic cirrhosis with liver cancer and 15 (20%) other cases were end-stage liver disease due to other causes and their comparison had no statistical difference (P>0.05). In the respect of Child-Pugh classifications, class A, B and C were 5 cases (16%), 3 cases (10%) and 23 cases (74%) in IPGF group; while, in non-IPGF group, the proportion of class A, B and C were 15 cases (20%), 27 cases (36%) and 34 cases (45%); and there were different statistically (P>0.05). What's more, when comparing among class A, B and C. The difference between class A and C, class B and C, and between A+B and class C were remarkable. But the comparison of MELD score and ECOG score both in IPGF group and non-IPGF group has no statistical significance, in Table 4.

Table 3. Grouping of selected cases, liver function recover time and graft survival rate.

Comparative items	IPGF (n=31)	Non-IPGF (n=76)	P
ALT-1	1771.10	449.54	P<0.01
AST-1	3673.35	486.29	
ALT-2	1013.26	275.93	P<0.01
AST-2	1072.87	191.05	
ALT-3	937.81	229.38	P<0.01
AST-3	769.39	128.95	
Liver function recover time (days)	20.50±5.28	13.20±5.50	P<0.01
Graft survival rate	90.32%	93.42%	P>0.05

Notes: -1, -2 and -3 indicated the peak value on the 1st, 2nd and 3rd day respectively with the unit being of (IU/L).

3.2.3. Correlative factors of operation

Analysis of operation related factors: relative warm ischemia time for patients in IPGF group was 74.48±17.76 minutes and 68.24±26.36 minutes in non-IPGF group with no statistical meaning (P>0.05). Time of anhepatic phase was 80.56±20.85 minutes in IPGF group and 75.31±21.95 minutes in non-IPGF group; between two groups was no significant difference (P<0.05) (Table 4). While the comparison between two groups in other respects such as operative approach, total operative time, bleeding during the operation and infusion amount, anhepatic time, rewarm ischemic time, ascites volume and complication, portal vein thrombosis or not, and splenic artery ligation or not had no clear difference.

3.2.4. Affecting factors after operation

Analysis of affecting factors after operation: regarding intubation time and ICU monitoring time, the comparison between IPGF group and non-IPGF group had no statistical significance (P>0.05) (Table 4).

Table 4. Related factors comparison between IPGF group and non-IPGF group.

Related factors	IPGF group （n=31） Num（%）	non-IPGF group （n=76） Num（%）	P
Graft source			
Donation after citizen death	25(81%）	50(66%)	0.128
Access through judicial channel	6(19%)	26(34)	
Warm ischemia time (min)	4.34±2.25	2.18±1.90	0.035
Cold preservation time (h)	9.73±1.19	9.24±0.99	0.033
Supplementary perfusion or not			0.664
Supplementary perfusion	5(16.1%）	15(19.7%)	
No supplementary perfusion	26(83.9%)	61(80.3%)	
Receptor gender			
Male	26(84%)	59(78%)	0.469
Female	5(16%)	17(22%)	
Rceptor age	49.29±6.93	51.76±9.94	0.147
Primary liver diseases			
post hepatic cirrhosis	9(29%)	27(36%)	0.421
primary liver cancer	3(10%)	2(3%)	
Post hepatic cirrhosis with primary liver cancer	14(45%)	32(42%)	
others	5(16%)	15(20%)	
Child’s classification			
Class A	5(16%)	15(20%)	0.011
Class B	3(10%)	27(36%)	
Class C	23(74%)	34(45%)	
Relative Warm Ischemia Time(RWIT) (min)	74.48±17.76	68.24±26.36	0.229
Time of anhepatic phase (min)	80.56±20.85	75.31±21.96	0.258

4. Discussion

IPGF is a borderline syndrome. The induced PGNF may rise up the inactive rate of graft, rate of re-transplantation, and death rate after surgery. However, there is no unified standard for IPGF. The reason about selection of Nanashima standard (Table 5) in the study is that the criteria can be able to completely reflect postoperative poor liver function. The incidence rate of IPGF is 28.97% in this study, which is slightly higher than literature report without any PGNF.

In terms of donor related factors, it is reported that source of donor liver, access method, perfusion method, donor age, warm ischemia time, cold preservation time, and donor liver quality have something to do with IPGF. In this study, access method of donor livers for 107 selected patients is that aorta abdominals and portal vein are incubated for lavage in situ, and combined liver-kidney procurement. There is no clear difference between IPGF group and non-IPGF group regarding to donor liver source. Rull [11] pointed out that among 228 selected patients with orthotopic liver transplantation, 25% receptors use the liver with donor age are >65. Moreover, all these donors have vasoacitve agent application history, with 29% of IPGF incidence rate, which has significant difference. Most of donors in this study are young and without statistical meaning. Canelo [12] demonstrated that macrovesicular steatosis >30% may lead to IPGF. While Urena [13] suggested critical standard for donor liver usage is moderate macrovesicular steatosis (30%-60%). The relative safe range is macrovesicular steatosis <30%; while its severity (>60%) may obviously increase occurrence of PGNF. The donor liver quality in this study is better and there is no significant difference in pathological score of donor liver biopsy. In theory, graft ischemia-reperfusion injury is the fetal risk factors causing IPGF [14]. According to D'Alessandro [15] report, 19 cases of liver grafts were from transplantation of donors with cardiac arrest with the average warm ischemia time and being of 16.4min and PGNF occurrence being of 10.5%. In Gomez [16] research, 8 cases of liver grafts were derived from transplantation of donors with cardiac arrest, 6 cases take on IPGF. Two of them presented PGNF, subsequently. Piratvisuth [17] retrospectively analyzed 230 cases of liver transplantation, and confirmed that the incidence rate of IPGF increase clearly if the cold preservation time of liver graft ranges from 12h to 18h. In this study, warm ischemia and cold preservation time for patients in IPGF group are also longer than in non-IPGF group. Two of them presented PGNF, subsequently.

Table 5. Definition and occurrence rate of IPGF in literature.

Presenter	Definition	Occurrence rate(%)
Nanashima, et al[6]	ALT and/or AST >1500IU/L within 72h after OLT	18
Ploeg, et al.[8]	AST >2000IU/L, PT >16 seconds 2～7d after OLT	22
Chui, et al.[9]	ALT and/or AST >2000IU/L within 24h after OLT	29.5
Ardite, et al.[10]	ALT >2500IU/L on the 3rd after OLT	19

Notes: OLT denotes orthotopic liver transplantation.

Piratvisuth [17] retrospectively analyzed 230 cases of liver transplantation, and confirmed that the incidence rate of IPGF increase clearly if the cold preservation time of liver graft ranges from 12h to 18h. In this study, warm ischemia and cold preservation time for patients in IPGF group are also longer than in non-IPGF group. There is significant difference between two groups, which proves that the extension of warm ischemia and cold preservation time is related to IPGF. For some liver grafts with longer cold preservation time, 1000ml of UW liquid is infused additionally before transplantation. However, there is no statistical meaning between the two groups due to small number of cases. When concerning to receptor related factors, some researchers suggested that the occurrence of IPGF is also associate with gender, age, primary liver diseases of recipient, and preoperative Child-Pugh classification. In this study, there was no clear difference between IPGF group and non-IPGF group regarding receptors' gender, age and primary liver diseases. While, in the respect of preoperative Child-Pugh classification, class C patients in IPGF group were greatly different from in non-IPGF group. Avolio [18] pointed out that patients' preoperative hyper-bilirubinemia has something to do with the occurrence of PGNF. Total bilirubin and direct bilirubin are not considered as reference index in assessing liver function recovery. However, the two groups have obvious difference in Child-Pugh classification; meanwhile, in the Child-Pugh classification. Three classes were mutual compared, and the result indicated that there is distinct difference between class A and C, class B and C, class A+B and class C, which also proved aforementioned views indirectly. While in considering operative related effecting factors, Strasberg [19] thoughts that the important risk factor resulting in the incidence of IPGF is time expansion in anhepatic phase. However, it has yet unified standard for the critic time of anhepatic phase for liver transplantation. In Nanashim [6] research, time of anhepatic phase for all selected patients exceeded 110min. Platz [20] showed that if the time of anhepatic phase is over 90min, serum ALT and AST will increase obviously. In this study, as the improvement of surgery technique, there is no distinct difference between IPGF group and non-IPGF group in terms of anhepatic phase and relative warm ischemia time.

Hepatic protective support and anti-infection treatment were given for selected patients after transplantation in this study. Even IPGF appeared, most of patients could be recovered within short time. The liver function recover time for patients in IPGF group is 20.50±5.28 days and 13.20±5.50 days in non-IPGF group. And the comparison has statistical difference ($P<0.01$).

5. Conclusion

In conclusion, warm ischemia time of liver graft, extension of cold preservation time and class C in preoperative Child-Pugh classification for patients undergoing liver transplantation are related to IPGF. Nanashima standard is the reliable basis to evaluate initial poor graft function after transplantation. In clinical, ALT and AST should be monitored as early as possible after liver transplantation. Moreover, IPGF should be given sufficient attention and great efforts should be made to shorten warm ischemia time of liver graft, and cold preservation time. If possible, hard work should be done to improve patient's preoperative liver function status.

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