POLSKI
PRZEGLĄD CHIRURGICZNY
2015, 87, 5, 221–230

10.1515/pjs-2015-0046

DE GRUYTER
OPEN

ORIGINAL PAPERS

EVOLUTION OF THE RESULTS OF 1500 LIVER TRANSPLANTATIONS PERFORMED IN THE DEPARTMENT OF GENERAL, TRANSPLANT AND LIVER SURGERY MEDICAL UNIVERSITY OF WARSAW

MAREK KRAWCZYK[1], MICHAŁ GRĄT[1], KAROLINA GRĄT[2], KAROLINA WRONKA[1], MACIEJ KRASNODĘBSKI[1], JAN STYPUŁKOWSKI[1], ŁUKASZ MASIOR[1], WACŁAW HOŁÓWKO[1], JOANNA LIGOCKA[1], PAWEŁ NYCKOWSKI[1], TADEUSZ WRÓBLEWSKI[1], RAFAŁ PALUSZKIEWICZ[1], WALDEMAR PATKOWSKI[1], KRZYSZTOF ZIENIEWICZ[1], LESZEK PĄCZEK[3], PIOTR MILKIEWICZ[1], URSZULA OŁDAKOWSKA-JEDYNAK[1], BOGUSŁAW NAJNIGIER[1], KRZYSZTOF DUDEK[1], PIOTR REMISZEWSKI[1], IRENEUSZ GRZELAK[1], OSKAR KORNASIEWICZ[1], MARCIN KOTULSKI[1], PIOTR SMOTER[1], MARIUSZ GRODZICKI[1], MICHAŁ KORBA[1], PIOTR KALINOWSKI[1], MICHAŁ SKALSKI[1], KRZYSZTOF ZAJĄC[1], RAFAŁ STANKIEWICZ[1], MARTA PRZYBYSZ[1], BARTOSZ CIEŚLAK[1], ŁUKASZ NAZAREWSKI[1], MAŁGORZATA NOWOSAD[1], KONRAD KOBRYŃ[1], MICHAŁ WASILEWICZ[1], JOANNA RASZEJA-WYSZOMIRSKA[1], JOLANTA PIWOWARSKA[4], DOROTA GIERCUSZKIEWICZ[4], JOANNA SAŃKO-RESMER[3], SŁAWOMIR REJOWSKI[1], MONIKA SZYDŁOWSKA-JAKIMIUK[1], BARBARA GÓRNICKA[5], BOGNA WRÓBLEWSKA-ZIARKIEWICZ[5], MICHAŁ MAZURKIEWICZ[5], GRZEGORZ NIEWIŃSKI[4], JACEK PAWLAK[1], RYSZARD PACHO[2]

Department of General, Transplant and Liver Surgery, Medical University of Warsaw[1]
Kierownik: prof. dr hab. *M. Krawczyk*
2nd Department of Clinical Radiology, Medical University of Warsaw[2]
Kierownik: prof. dr hab. *O. Rowiński*
Department of Immunology, Transplantology and Internal Medicine, Transplantation Institute, Medical University of Warsaw[3]
Kierownik: prof. dr hab. *L. Pączek*
2nd Department of Anaesthesiology and Intensive Therapy, Medical University of Warsaw[4]
Kierownik: prof. dr hab. *A. Kański*
Department of Pathology, Medical University of Warsaw[5]
Kierownik: prof. dr hab. *B. Górnicka*

Liver transplantation is a well-established treatment of patients with end-stage liver disease and selected liver tumors. Remarkable progress has been made over the last years concerning nearly all of its aspects.

The aim of this study was to evaluate the evolution of long-term outcomes after liver transplantations performed in the Department of General, Transplant and Liver Surgery (Medical University of Warsaw).

Material and methods. Data of 1500 liver transplantations performed between 1989 and 2014 were retrospectively analyzed. Transplantations were divided into 3 groups: group 1 including first 500 operations, group 2 including subsequent 500, and group 3 comprising the most recent 500. Five year overall and graft survival were set as outcome measures.

Results. Increased number of transplantations performed at the site was associated with increased age of the recipients ($p<0.001$) and donors ($p<0.001$), increased rate of male recipients ($p<0.001$), and

increased rate of piggyback operations (p<0.001), and decreased MELD (p<0.001), as well as decreased blood (p=0.006) and plasma (p<0.001) transfusions. Overall survival was 71.6% at 5 years in group 1, 74.5% at 5 years in group 2, and 85% at 2.9 years in group 3 (p=0.008). Improvement of overall survival was particularly observed for primary transplantations (p=0.004). Increased graft survival rates did not reach the level of significance (p=0.136).
Conclusions. Long-term outcomes after liver transplantations performed in the Department of General, Transplant and Liver Surgery are comparable to those achieved in the largest transplant centers worldwide and are continuously improving despite increasing recipient age and wider utilization of organs procured from older donors.
Key words: liver transplantation, survival, outcomes, donors, center experience, center volume

Liver transplantation remains the only available method of treatment of patients with end-stage insufficiency of this organ. Furthermore, transplantation is gaining more and more importance in the treatment of patients with selected liver malignancies. Data published by the European Liver Transplant Registry, (ELTR: http://www.eltr.org/) indicate that between 1968 and 2013 more than 118,000 transplantations were performed in Europe alone. The situation in the USA is similar, since the number of transplantations performed there between 1988 and 2014, included in the OPTN database (Organ Procurement and Transplantation Network, http://optn.transplant.hrsa.gov/), exceeded 130,000.

The most common indications for liver transplantation include currently cirrhosis caused by infection with hepatotropic viruses [hepatitis B/C virus, HBV (fig. 1) and HCV (fig. 2)] and alcoholic liver disease (fig. 3) as well as focal lesions of hepatocellular carcinoma (HCC) (fig. 4). The best long-term results have been achieved for liver transplantation in autoimmune diseases, such as primary sclerosing cholangitis (PSC), primary biliary cirrhosis (PBC) (fig. 5) and cirrhosis caused by autoimmune hepatitis (AIH) (1, 2). On the other hand, the lowest rates of long-term, 5-year survival were achieved in patients undergoing liver transplantation due to cirrhosis caused by HCV infection and HCC (2). In the first case this is related to low effectiveness of treatment of common recurrences of viral infection, while in the other case – recurrences of the malig-

Fig. 1. Liver cirrhosis caused by hepatitis B virus (HBV) infection

Fig. 2. Liver cirrhosis caused by hepatitis C virus (HCV) infection

Fig. 3. Alcoholic liver cirrhosis

Fig. 4. Liver cirrhosis with hepatocellular carcinoma (HCC)

Fig. 5. Primary biliary cirrhosis (PBC)

nancy resulting in death. Negative results in patients infected with HCV can substantially improve after launching of new, significantly more effective antiviral drugs (Direct Acting Antivirals, DAA) (3). Limitation of risk of HCC recurrence after the transplantation may be achieved through improvement of current qualification criteria to transplantation. Milan criteria involving 1 tumor up to 5 cm or 2-3 lesions up to 3 cm, without extrahepatic lesions and macroscopic infiltration of blood vessels, are commonly accepted as the basis of the qualification process and guarantee HCC recurrence rate that does not exceed several per cent over the 5-years of follow-up. However, the analysis of the material from the Department of General, Transplant and Liver Surgery, Medical University of Warsaw demonstrated that this risk can be effectively limited by adding a biological criterion (concentration of α-fetoprotein before the transplantation) to the morphological criteria (4, 5).

The first successful liver transplantation in an adult patient in Poland was performed in this Department of General, Transplant and Liver Surgery, Medical University of Warsaw in 1994 (6). It was preceded by 2 attempts undertaken at the Department in 1989 and 1993 as well as other attempts undertaken at the sites in Szczecin, Katowice, Warsaw and Wrocław. According to data published by Poltransplant, the number of all performed liver transplantations in Poland by the end of 2013 exceeded 3,000, while more than 2,500 procedures were performed in adults (7).

Analysis of the first one thousand liver transplantations performed at the Department of General, Transplant and Liver Surgery, Medical University of Warsaw demonstrated the structure of indications and achieved long-term results that were compatible with data published by the largest transplantation centers worldwide. What is more important, increased experience of the transplantation team resulted in almost complete elimination of intraoperative mortality and marked limitation of perioperative mortality, which was reduced more than 4-fold over the 18 years (8).

The aim of this study was to perform further analysis of evolution of outcomes of liver transplantations at the Department of General, Transplant and Liver Surgery, Medical University of Warsaw based on the material obtained after performance of 1,500 procedures.

MATERIAL AND METHODS

This study was a retrospective analysis. The material included data from 1,500 liver transplantation performed at the Department of General, Transplant and Liver Surgery, Medical University of Warsaw between December 1989 and October 2014. The annual number of transplantation rose from 6 in 1996 to 50 in 2001 and 103 in 2005, to 165 in 2013, corresponding to almost 30-fold increase over 18 years (fig. 6). Among all 1,500 transplantations, 1496 (99.7%) were performed using organs harvested from deceased donors and 4 (0.3%) from alive donors.

The primary endpoint of the study was patient's death over 5 years of follow-up. The secondary endpoint of the study was retransplantation within 5 years of the previous transplantation. An overall survival after the transplantation was defined as the time until

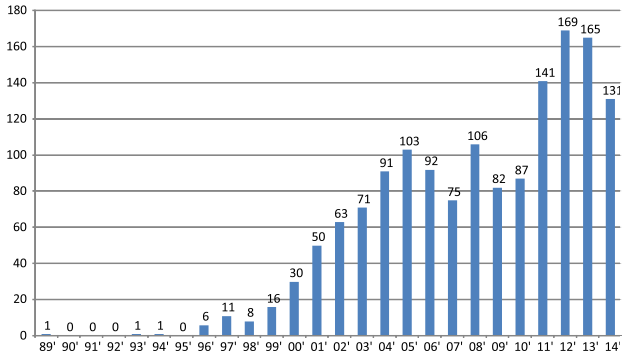

Fig. 6. Number of transplantations performer in the Department of General, Transplant and Liver Surgery, Medical University of Warsaw in individual years

death or the last follow-up visit. The graft survival was defined as the time from the procedure until the retransplantation, death or the last follow-up visit. The material of 1,500 liver transplantations was divided into 3 groups: group 1 included the first 500 procedures, group 2 included the next 500 procedures, and group 3 included the last 500 transplantations. To analyze evolution of long-term outcomes of transplantations, the above mentioned 3 groups were compared with regard to basic characteristics and 5-year overall survival and graft survival.

The patients were qualified to the transplantation during sessions of a multidisciplinary team. The transplantations were performed using one of 2 surgical techniques, i.e. piggyback with sparing of retrohepatic segment of the inferior vena cava and conventional that involved its resection and use of a temporary veno-venous extracorporeal circulation using so called biopump. The utilized surgical techniques were described in detail in the previous publication (8). Immunosuppression involved most often induction using anti-CD25 and utilization of various combinations of glycocorticosteroids, calcineurin inhibitors and mycophenolate mofetil. mTOR (mammalian Target Of Rapamycin) inhibitors were also used in patients with hepatocellular cancer.

Quantitative variables were demonstrated as medians with interquartile ranges, and qualitative variables as numbers with percentages. Kruskall-Wallis and Chi^2 tests were used to compare quantitative and qualitative variables, respectively. Survival was calculated using Kaplan-Meier method. Survival curves were compared using a log-rank test. Median follow-up period after the transplantation was presented based on inverted Kaplan-Meier method. Statistical significance was declared at the 0.05 level. All calculations were performed using STATISTICA software version 10 (StatSoft. Inc., Tulsa, Oklahoma, USA).

RESULTS

Table 1 presents basic characteristics of 1,500 transplantations. This group included 1404 primary transplantations and 96 retransplantations. Marked majority of transplanta-

Table 1. Characteristics of 1,500 liver transplantations performed at the Department of General, Transplant and Liver Surgery, Medical University of Warsaw

	Mediana lub n / Median or n	Zakres międzykwartylowy lub % / Interquartile range or %
Age of the recipient (years)	48	35-55
Sex of the recipient:		
male	824	54,9%
female	676	45,1%
MELD (points)	13	10-20
HCV infection	424	30,2%*
HBV infection	286	20,4%*
ALD	261	18,6%*
PSC	157	11,2%*
PBC	120	8,5%*
AIH	90	6,4%*
HCC	215	15,3%*
Primary transplantations	1404	93,6%
Retransplantations	96	6,4%
PRBC transfusion (units)	4	2-7
FFP transfusions (units)	8	5-10
Duration of cold ischemia (hours)	9,0	7,8-10,3
Technique of transplantation:		
piggyback	1111	74,1%
conventional	388	25,9%
Age of the donor (years)	44	31-53

* primary transplantation rate. MELD – Model for End-stage Liver Disease; HCV – Hepatitis C virus; HBV – Hepatitis B virus; ALD – Alcoholic Liver Disease; PSC – Primary Sclerosing Cholangitis; PBC – Primary Biliary Cirrhosis; AIH – Autoimmune Hepatitis; HCC –Hepatocellular Cancer, conventional; PRBC – packed red blood cells; FFP – Fresh Frozen Plasma

tions was performed using piggyback technique (74.1%). Median age of the recipients was 48 years and males were slightly more likely to receive the transplant (54.9%). The most common cause of liver disease was HCV infection (30.2% of recipients of the primary transplant).

Other common etiologies included, in the order of frequency, HBV infection (20.4%), Alcoholic Liver Disease (ALD, 18.6%), PSC (11.2%), PBC (8.5%) and AIH (6.4%).

A total of 215 transplantations were performed in patients with conventional HCC, constituting 15.3% of recipients of the primary transplants. Median score in the MELD (Model for End-stage Liver Disease) system was 13. Median intraoperative tranfusions of packer red blood cells (PRBC) and fresh frozen plasma (FFP) was 4 and 8 units, respectively, and median time of cold ischemia was 9 hours.

Median follow-up period was 4 years. Postoperative mortality (up to 30 days after the transplantation) was 7.3% for primary transplantations and 29.2% for retransplantations (fig. 7) (p<0.001). The overall survival and graft survival 1, 3 and 5 years after the transplantation in the whole analyzed group was 84.8%, 78.5%, 74.7% and 81.5%, 74.8%, 70.6%. As compared to first transplantations, retransplantations were associated with lower 5-year overall survival rates (54.2% *vs* 76.1%, p<0.001) as well as 5-year graft survival rates (50.7% *vs* 71.9%, p<0.001), (fig. 8).

Multiple significant differences were observed between the liver transplantations in patients from groups 1, 2 and 3 (tab. 2). As the number of transplantations in our center increased, so did the recipient age (p<0.001) and percentage of male recipients (p<0.001) increase. The organs were also harvested from progressively older donors (p<0.001). Median of intraoperative blood and plasma transfusions was reduced by 20% (p=0.006) and 40% (p<0.001), respectively. The percentage of conventional procedures involving excision of the extrahepatic segment of the inferior vena cava and utilization of temporary venovenous extracorporeal circulation was reduced from 38.9% in group 1 to 19.6% in group 2 and 19.2% in group 3 (p<0.001). Furthermore, gradual reduction of median MELD score in the recipients (p<0.001) was found. However, no significant differences with regard to duration of cold ischemia were found between the 3 transplantation groups (p=0.359).

Fig. 7. Liver retransplantation caused by hepatic artery thrombosis

Table 2. Differences in basic characteristics between 3 groups of patients qualified to the transplantation in various years

	Group 1 (1-500)	Group 2 (501-1000)	Group 3 (1001-1500)	p
Age of the recipients	44 (33-51)	49 (35-55)	53 (39-59)	<0,001
Sex of the recipients				<0,001
male	245 (49%)	272 (54,4%)	307 (61,4%)	
female	255 (51%)	228 (45,6%)	193 (38,6%)	
MELD of the recipients	15 (11-21)	14 (9-22)	12 (9-18)	<0,001
PRBC transfusion	5 (3-8)	4 (2-7)	4 (2-7)	0,006
FFP transfusion	10 (7-13)	8 (6-10)	6 (4-9,5)	<0,001
Duration of cold ischemia	9,0 (7,7-10,3)	8,8 (7,8-10)	9 (7,8-10,4)	0,359
Technique of the transplantation				<0,001
piggyback	305 (61,1%)	402 (80,4%)	404 (80,8%)	
conventional	194 (38,9%)	98 (19,6%)	96 (19,2%)	
Age of the donor	40 (26-48)	45 (31-54)	49 (37-58)	<0,001

Qualitative and quantitative variables were presented as n (5) and median (interquartile range). MELD – Model for End-stage Liver Disease; PRBC – Packed Red Blood Cells; FFP –Fresh Frozen Plasma

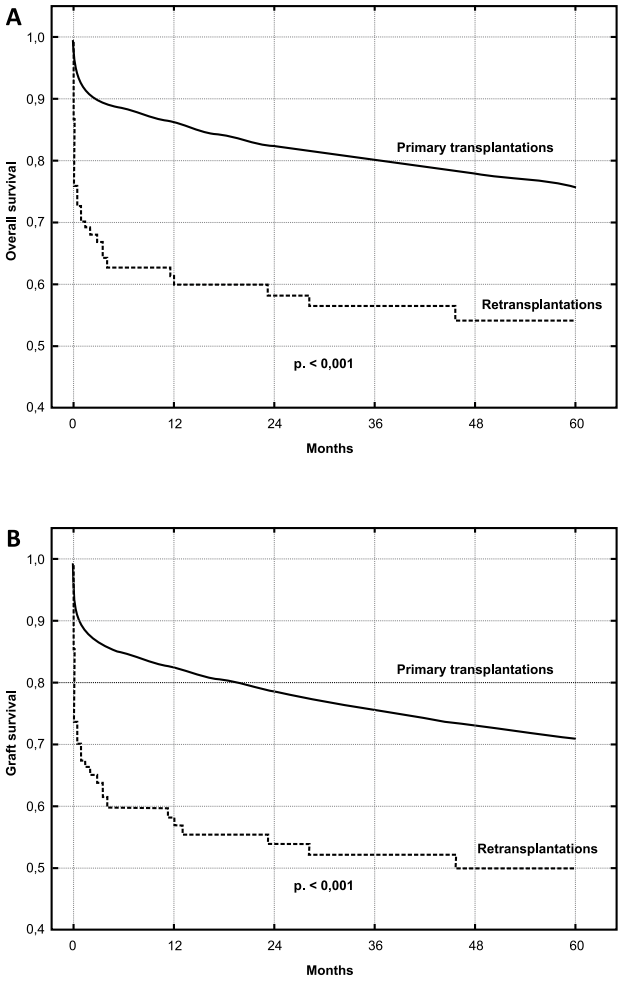

Fig. 8. An overall survival (A) and graft survival (B) after primary transplantation and retransplantation

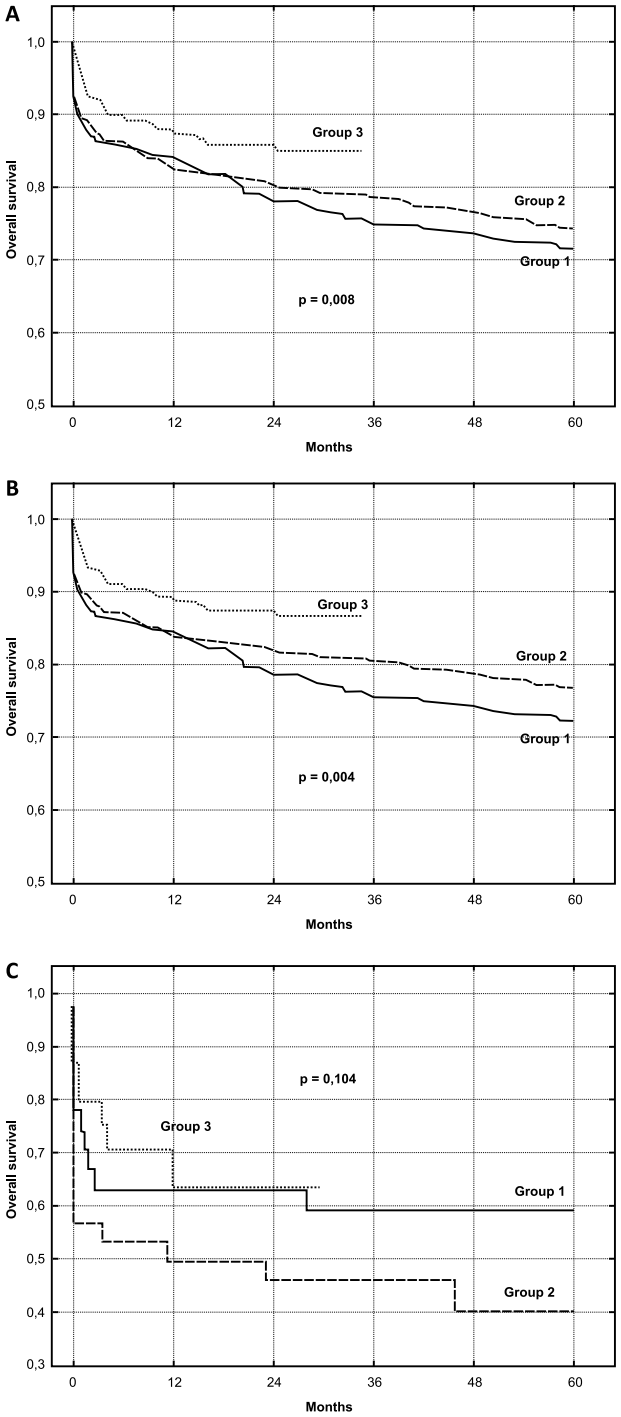

Fig. 9. Differences in overall survival after transplantations performer in different time periods in the whole analyzed group (A) and in subgroups of primary transplantation (B) and retransplantation (C). Group 1 – the first 500 transplantations; group 2 – middle 500 transplantations; group 3 – the last 500 transplantations

Overall survival rates 1, 3, and 5 years after the liver transplantation were 84.1%, 75%, 71.6% in group 1, 82.6%, 78.7%, and 74.5% in group 2 and 87.7% (1 year) and 85% (2.9 years) in group 3 (p = 0.008, fig. 9a). Improvement of overall survival rates was observed in particular with regard to primary transplantation (p=0.004, fig. 9b). However, no significant differences were found between these 3 groups with regard to overall survival after retransplantation (p=0.104, fig. 9c).

Graft survival rates 1, 3, and 5 years after the transplantation were 81%, 71.7%, 68.3% in group 1, 80.2%, 76.1%, 70.7% in group 2 and 82.7% (1 year) and 78.8% (2.9 years) in group 3 (p=0.136, fig. 10a). Differences in graft survival between these 3 groups were slightly below the level of significance for the primary transplantation (p=0.078, fig. 10b). Graft survival after retransplantation did not significantly differ between these 3 groups (p=0.200, fig. 10c).

DISCUSSION

The presented results reflect evolution of the liver transplantation program at the Department of General, Transplant and Liver

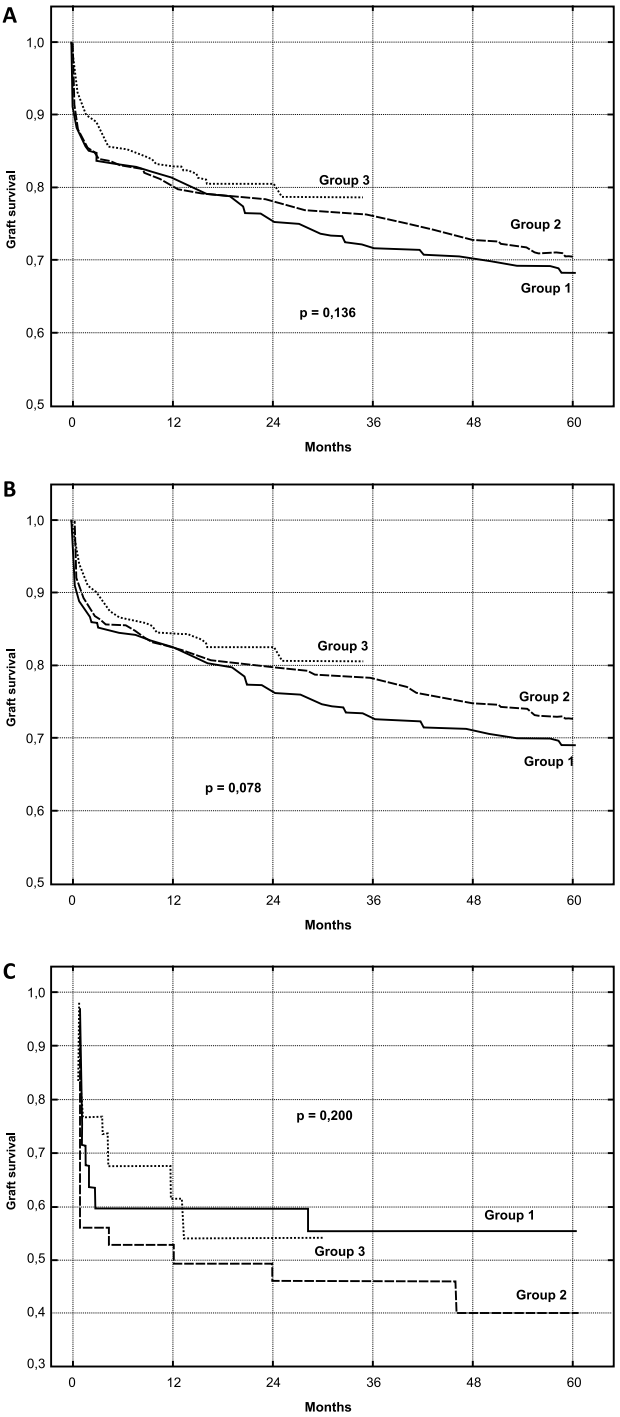

Fig. 10. Differences in graft survival after transplantations performer in different time periods in the whole analyzed group (A) and in subgroups of primary transplantation (B) and retransplantation (C). Group 1 – the first 500 transplantations; group 2 – middle 500 transplantations; group 3 – the last 500 transplantations

Surgery, Medical University of Warsaw that remains the largest liver transplantation center in Poland. According to the data published by the Organizational and Coordination Center for transplantation "Poltransplant", 165 transplantations that were performed at the Department in 2013, constituted over 50% of all liver transplantations utilizing organs harvested during this time from deceased donors in Poland. Furthermore, such number of procedures performed annually is compatible with values reported by the largest transplantation centers worldwide (9, 10, 11).

As compared to the previous collective analysis of outcomes of the liver transplantation at the Department of General, Transplant and Liver Surgery, Medical University of Warsaw, further reduction of an early (30-day) postoperative mortality from 8.9% to 7.3% after primary transplantation and from 34.5% to 29.2% after retransplantation must be emphasized (8). This report also present detailed evolution of long-term outcomes of transplantation, expressed as an overall 5-year survival rates and 5-year graft survival rates. Marked improvement of an overall survival after the primary transplantation was observed both between the first and middle 500 procedures as well as between the middle and the last 500 transplantations. While the difference between the 3 study groups with regard to the graft survival did not reach the statistical significance, the general tendency towards improvement of results was maintained. Gradual increase of survival rates probably results from increased experience of individual operators as well as continuous development of the liver transplantation program at the Department.

This is compatible with data reported by other authors, indicating that outcomes of transplantations performed at high volume centers are better than those from lower activity centers. Macomber et al. analyzed data concerning more than 5,000 liver transplantations and demonstrated that procedures performed at the highest volume centers (>76 transplantations annually) are associated with lower mortality, shorter total hospitalization duration, shorter stay at the intensive care unit and lower procedure costs (12). Furthermore, previous paper by Edwards et al. demonstrated increased mortality rate at centers performing less than 20 transplantations annually (13).

This improvement of patient survival after transplantations occurred despite the fact that the organs were harvested from progressively older donors. This observation is compatible with data available in the literature, indicating that the highest volume centers significantly

more commonly utilize organs harvested from higher risk donors, including the older ones (10, 14). Improved outcomes of transplantations performed at the highest volume centers is also particularly evident for the highest risk procedures, as indicated by the donor risk index (DRI) (10).

Reduction of frequency of intraoperative transfusions of the blood products was a significant factor potentially associated with improved long-term outcomes. This was clearly related to improved perioperative management, and in particular to increased experience of the surgical team. Volume of intraoperative blood transfusion is one of the known risk factors of worse survival after the transplantation (15, 16). Furthermore, achievement of better results could have been related to more common use of a surgical technique involving sparing of an extrahepatic segment of the inferior vena cava (piggyback). Data obtained in our Department regarding transplantations due to HCC demonstrated benefits of this technique (17).

Increased median age of the transplant recipients in the analyzed period also must be emphasized. Recently published analysis of outcomes of the liver transplantation at our Department in recipients over 60 years of age demonstrated that despite highest incidence of cardiovascular disease in this population, long term transplantation outcomes were similar to those obtained in younger recipients (18). Qualification of older patients to the liver transplantation is supported by reports by other transplantation centers (19). A study by Wilson et al. demonstrated also that transplantations in older patients were more common in higher volume centers (20).

We must emphasize that improved outcomes did not accompany increased number of retransplantations. However, retransplantations have markedly worse prognosis as compared to primary transplantations, which is supported by the presented survival curves. Retransplantation outcomes are much more dependent on the patient's condition and comorbidities and seem to be less dependent on increased experience of the transplantation center. This is supported by the analysis of almost 4,000 of retransplantations by Reese et al. who did not observe any significant differences in annual risk of failure of the transplanted organ after retransplantations performed at low, moderate and high volume centers (21).

The demonstrated structure of indications to 1,500 liver transplantation does not differ from this presented in the previous publication (8). Infections with hepatotropic viruses, HCV and HBV, were the most common. According to reports by other authors, liver cirrhosis caused by chronic HCV infection is associated with relatively poorer long-term transplantation outcomes (2, 22). Analysis of the material of our Department does not support such association (23). However, high percentage of HCV infected recipients is important in the context of increasing age of the donors, and this parameter adversely affects survival of patients with HCV-induced cirrhosis (24). Alcoholic liver disease was the third most common (after HCV and HBV infections) cause of liver cirrhosis in the group of patients undergoing primary transplantation. Qualification of patients with a history of alcohol abuse to liver transplantation is controversial is some medical communities due to the risk of recurrence of this addiction that could ultimately induce failure of the transplanted organ and death. Depending on adopted criteria and time frame, recurrence of alcoholic disease following liver transplantation occurs in up to 40% of transplant recipients (25).

Evaluation of the material of the Department indicated that the alcoholic disease recurred in 33.5% patients during 10 years of follow-up after the liver transplantation due to ALD, while its risk was markedly higher in the younger patients (26). Despite the fact that recurrence of ALD was associated with worse patient survival up to 5 years after the transplantation, no significant differences were found during this time with regard to long-term transplantation outcomes due to ALD and other indications. However survival of patients with ALD was markedly worse within 5 to 10 years after the transplantation.

HCC was another common indication to liver transplantation in the analyzed material. Previously published analyzes of the transplantation outcomes in this group demonstrated that combination of morphological criteria with a biological criterion (i.e. α-fetoprotein concentration) may result in marked reduction of the risk of malignancy recurrence (4, 5). The best candidates for transplantation were patients meeting one of the extended qualification criteria, with α-fetoprotein concentration not higher than 100 ng/ml (5). Good results

achieved in the last group of the most common disorders, i.e. autoimmune diseases, were confirmed by numerous reports, also on the basis of material of our Department (1, 2, 27).

Irrespective of improvement of long-term transplantation outcomes, evolution of the liver transplantation program affects results of other surgical procedures involving hepatobiliary surgery. Nguyen et al. demonstrated that mortality and complication rate after resection of HCC tumors at high volume liver transplantation centers were markedly lower than in other centers (28). Analysis of the outcomes of the liver resection due to HCC at our Department demonstrated low postoperative mortality (1.6%) (29). Analysis of more than one thousand liver resections performed between 2004 and 2009 demonstrated that perioeprative mortality was lower than 1.5% (30).

SUMMARY

The Department of General, Transplant and Liver Surgery, Medical University of Warsaw is the largest liver transplantation center in Poland that annually performs more than 50% of all liver transplantations in adults in Poland. Annual number of transplantations performed at our Department is compatible with the number of procedures performed at the largest transplantation centers worldwide. Increased number of transplantations over the past years was accompanied by marked improvement of long term results, in particular expressed as 5-year overall survival rates, reaching 80%. This improvement of outcomes was achieved despite requirement for organ harvesting from high risk donors and increasing age of the recipients.

REFERENCES

1. *Krawczyk M, Grąt M, Barski K* et al.: Analysis of long-term outcomes after liver transplantation in the Department of General, Transplant and Liver Surgery at the Medical University of Warsaw. *Gastroenterol Pol* 2012; 19: 43-50.
2. *Singal AK, Guturu P, Hmoud B* et al.: Evolving frequency and outcomes of liver transplantation based on etiology of liver disease. *Transplantation* 2013; 95: 755-60.
3. *Curry MP, Forns X, Chung RT* et al.: Sofosbuvir and ribavirin prevent recurrence of HCV infection after liver transplantation: an open-label study. *Gastroenterology* 2015; 148: 100-07.
4. *Grąt M, Kornasiewicz O, Hołówko W* et al.: Evaluation of total tumor volume and pretransplantationα-fetoprotein level as selection criteria for liver transplantation in patients with hepatocellular cancer. *Transplant Proc* 2013; 45: 1899-1903.
5. *Grąt M, Kornasiewicz O, Lewandowski Z* et al.: Combination of morphologic criteria and α-fetoprotein in selection of patients with hepatocellular carcinoma for liver transplantation minimizes the problem of posttransplant tumor recurrence. *World J Surg* 2014; 38: 2698-2707.
6. *Krawczyk M, Grzelak I, Zieniewicz K* et al.: The impact of experience of a transplantation center on the outcomes of orthotopic liver transplantation. *Transplant Proc* 2003; 35: 2268-70.
7. Dane Centrum Organizacyjno-Koordynacyjnego do spraw transplantacji „Poltransplant", http: // www.poltransplant.org.pl/(stan na 31.01.2015)
8. *Krawczyk M, Grąt M, Barski K* et al.: 1000 liver transplantations at the Department of General, Transplant and Liver Surgery, Medical University of Warsaw – analysis of indications and results. *Pol Przegl Chir* 2012; 84: 304-12.
9. *Nijboer A, Ulrich F, Bechstein WO* et al.: Volume and outcome relation in German liver transplant centers: what lessons can be learned?*Transplant Res* 2014; 3: 5.
10. *Ozhathil DK, Li YF, Smith JK* et al.: Impact of center volume on outcomes of increased-risk liver transplants. *Liver Transpl* 2011; 17: 1191-99.
11. *Washburn WK, Meo NA, Halff GA* et al.: Factors influencing liver transplant length of stay at two large-volume transplant centers. *Liver Transpl* 2009; 15: 1570-78.
12. *Macomber CW, Shaw JJ, Santry H* et al.: Centre volume and resource consumption in liver transplantation. *HPB (Oxford)* 2012; 14: 554-59.
13. *Edwards EB, Roberts JP, McBride MA* et al.: The effect of the volume of procedures at transplantation centers on mortality after liver transplantation. *N Engl J Med* 1999; 341: 2049-53.
14. *Ozhathil DK, Li Y, Smith JK* et al.: Effect of centre volume and high donor risk index on liver allograft survival. *HPB (Oxford)* 2011; 13: 447-53.
15. *Reichert B, Kaltenborn A, Becker T* et al.: Massive blood transfusion after the first cut in liver transplantation predicts renal outcome and survival. *Langenbecks Arch Surg* 2014; 399: 429-40.
16. *Rana A, Petrowsky H, Hong JC* et al.: Blood transfusion requirement during liver transplantation is an important risk factor for mortality. *J Am Coll Surg* 2013; 216: 902-07.
17. *Grąt M, Kornasiewicz O, Lewandowski Z* et al.: The impact of surgical technique on the results of liver transplantation in patients with hepato-

cellular carcinoma. *Ann Transplant* 2013; 18: 448-59.
18. *Grąt M, Kornasiewicz O, Grąt K* et al.: Short and long-term outcomes after primary liver transplantation in elderly patients. *Pol Przegl Chir* 2013; 85: 581-88.
19. *Yi SH, Yi HM, Fu BS* et al.: Long-term results of liver transplantation for over 60 years old patients with hepatitis B virus-related end-stage liver disease. *Hepatobiliary Pancreat Dis Int* 2014; 13: 501-07.
20. *Wilson GC, Quillin RC 3rd, Wima K* et al.: Is liver transplantation safe and effective in elderly (≥70 years) recipients? A case-controlled analysis. *HPB (Oxford)* 2014; 16: 1088-94.
21. *Reese PP, Yeh H, Thomasson AM* et al.: Transplant center volume and outcomes after liver retransplantation. *Am J Transplant* 2009; 9: 309-17.
22. *Wong RJ, Chou C, Bonham CA* et al.: Improved survival outcomes in patients with non-alcoholic steatohepatitis and alcoholic liver disease following liver transplantation: an analysis of 2002-2012 United Network for Organ Sharing data. *Clin Transplant* 2014; 28: 713-21.
23. *Krawczyk M, Grąt M, Kornasiewicz O* et al.: Results of liver transplantation in the Department of General, Transplant and Liver Surgery at the Medical University of Warsaw in patients with chronic hepatitis B and C viruses infection. *Przegl Epidemiol* 2013; 67: 5-10, 93-07.
24. *Grąt M, Kornasiewicz O, Lewandowski Z* et al.: Post-transplant outcomes of patients with and without hepatitis C virus infection according to donor age and gender matching. *Ann Transplant* 2013; 18: 705-15.
25. *Koljonen V, Fredrik A, Aki R* et al.: Self-Reported Alcohol Use and Depressive Symptoms After Liver Transplantation.*Transplantation* 2014 (w druku).
26. *Grąt M, Lewandowski Z, Grąt K* et al.: Negative outcomes after liver transplantation in patients with alcoholic liver disease beyond the fifth post-transplant year. *Clin Transplant* 2014; 28: 1112-20.
27. *Nyckowski P, Dudek K, Skwarek A* et al.: Results of liver transplantation according to indications for orthotopic liver transplantation. *Transplant Proc* 2003; 35: 2265-07.
28. *Nguyen GC, Thuluvath NP, Segev DL* et al.: Volumes of liver transplant and partial hepatectomy procedures are independently associated with lower postoperative mortality following resection for hepatocellular carcinoma. *Liver Transpl* 2009; 15: 776-81.
29. *Grąt M, Hołówko W, Grzegorczyk K* et al.: Long-term results of liver resection in the treatment of patients with hepatocellular carcinoma. *Pol Przegl Chir* 2011; 83: 319-24.
30. *Grąt M, Grzegorczyk K, Lewandowski Z* et al.: Intraoperative injuries during liver resection: analysis of 1,005 procedures. *Hepatol Int* 2012; 6: 498-504.

Received: 17.02.2015 r.
Adress correspondence: 02-097 Warszawa, ul. Banacha 1a
e-mail: michal.grat@gmail.com