

ORIGINAL PAPER

# Aortic Perfusion only in Liver Sampling

Vasile LUNGU<sup>1</sup>, Irinel POPESCU<sup>2,3</sup>

## Abstract

In the 1990s a sampling team from the Surgery Department of Saint Luc Clinic in Louvain Brussels, published a study showing that single aortic infusion is as safe as classic, standard infusion (aortic and portal) but the attempt was not fully accepted. Also, some recent studies recommend the safe use of single aortic infusions in the case of multiple organ sampling from the brain-dead donor. In order to test the effectiveness of this method we made a retrospective study between 2017 and 2019 at the Center for General Surgery and Liver Transplantation of the Fundeni Clinical Institute, Bucharest, Romania. First of all, we performed a comparative analysis between the single aortic sampling group and the group in which we used the standard sampling. We also analyzed the impact of singular aortic sampling on cases with anatomical arterial variants.

**Keywords:** aortic infusion, liver transplantation, multiple organ sampling.

## Rezumat

În anii 1990, o echipă de prelevare de la Departamentul de Chirurgie al Clinicii Saint Luc din cadrul Universității Louvain Bruxelles, a publicat un studiu prin care a arătat că perfuzia aortică singulară este la fel de sigură ca perfuzia clasică, standard (aortică și portală), însă încercarea modificării de paradigmă nu a fost pe deplin acceptată. Studiile recente au recomandat folosirea sigură a perfuziei singular aortice în cazul prelevării multiple de la donator aflat în moarte cerebrală. Studiul de față este un studiu retrospectiv realizat în Centrul de Chirurgie Generală și Transplant Hepatic „Dan Setlacec” a Institutului Clinic Fundeni, București, România, între anii 2017 și 2019. Studiul a urmărit în principal analiza comparativă a lotului de prelevări singular aortice cu lotul în care s-a folosit prelevarea standard. De asemenea, s-a analizat și impactul prelevării singular aortice asupra cazurilor cu variante anatomice arteriale.

**Cuvinte cheie:** perfuzie aortică, transplant hepatic, prelevare multiplă.

<sup>1</sup>Department of General Surgery CF2 Hospital, Bucharest, Romania

<sup>2</sup>“Carol Davila” University of Medicine and Pharmacy, Bucharest, Romania

<sup>3</sup>Digestive Diseases and Liver Transplantation Center, Fundeni Clinical Institute, Bucharest, Romania

### Corresponding author:

Vasile Lungu, Department of General Surgery CF2 Hospital, Bucharest, Romania.

E-mail: v\_lungu84@yahoo.com

## INTRODUCTION

The principles of the multi-organ sampling technique for the brain-dead patient were first described by Starzl in the 1980s and have remained the same to this day<sup>1,2</sup>.

Most sampling teams consider portal perfusion in the in situ cooling stage mandatory. In the 1990s a sampling team from the Department of Surgery at the Saint Luc Clinic at the University of Louvain Brussels published a study showing that single aortic infusion is as safe as classic, standard infusion (aortic and portal), but the attempt to change the paradigm has not been fully accepted<sup>2,3,5</sup>.

Relatively recently, the sampling team in the surgery department of the Thomas E. Starzl Institute at the University of Pittsburgh, Pennsylvania admits that portal infusion is not mandatory and the choice of infusion type (single-aortic or standard) remains at the discretion of the sampling team. Also, recent outcomes about sampling recommend the safe use of single aortic infusions in the case of multiple sampling from the brain-dead donor<sup>5,6,7,8</sup>.

The present study is a retrospective study and was conducted in the Center for General Surgery and Liver Transplant Dan Setlacec of the Fundeni Clinical Institute (led by Prof. Irinel Popescu) by the same sampling team (Dr. Vasile Lungu), between 2017-2019.

We performed a comparative analysis between the single aortic sampling group and the group in which we used the standard sampling. We also analyzed the impact of singular aortic sampling on cases with anatomical arterial variants.

## MATERIAL AND METHOD

This retrospective study was conducted between February 2017 and December 2019 on a group of 33 brain-dead donors. The multiorgan sampling method was according to the classical method described by Starzl, whose main times are: incision, exploration of the abdominal cavity and inspection of the liver, dissection and widening of the infrarenal and subdiaphragmatic aorta, cholecystectomy and distal sectioning of the choledochus, dissection and sectioning, cannulation, cross-clamping, infusion and refrigeration, total hepatectomy with aortic patch and back-table, with the particularity that the infusion and cannulation were performed only at the level of the aorta (unlike the classic variant in which the infusion and cannulation

is performed at the level of the aorta and the inferior portal / mesenteric vein).

We used Custodiol 5 liters as preservative solution.

The following donor parameters were analyzed: age, weight, sex, cause of death, cardiac arrest (yes or no), use of vasopressors, other organs taken.

The parameters analyzed from the recipient were: age, sex, diagnosis, amount of blood lost, number of transfused blood units, number of platelet masses transfused, IR ultrasound index.

Liver graft parameters were analyzed by: macroscopic appearance, dimensions, weight, duration of sampling, weight of the liver, anatomical variants of the hepatic artery, hepatic ischemia time (from cross clamping to arterial decampation), method of dissecting the hepatic pedicle.

Data processing and statistical analysis were performed using Microsoft Office Excel/Word 2013 and R program, version 3.5.3 (2019-03-11) Copyright (C) 2019 The R Foundation for Statistical Computing, R Core Team (2019). Quantitative variables were expressed as averages with standard deviations, and categorical variables were expressed as absolute or percentage. Independent quantitative variables with parametric distribution were tested using the Welch t and ANOVA tests. The qualitative variables were tested using the Pearson Chi-Square test, and any correlation will be proved using the Pearson correlation coefficient. The Dunn-Bonferroni test was the post-hoc test, performed to detail the results obtained in testing independent quantitative variables.

## RESULTS AND DISCUSSIONS

Since the first description made by Starzl of a standardized technique for multiple organ sampling, modifications have been suggested in order to simplify the operative methods and minimise the risk of damage to the graft.

**Table 1.** Significant data on donors

Variable	Lot of patients
Age – Mean ± S.D	46.33 ± 17.27
Sex W – No (%)	30 (34.88)
M – No (%)	56 (65.12)
Blood type	
O(+) – No (%)	21 (24.41)
O(-) – No (%)	5 (5.81)
A(+) – No (%)	36 (41.86)
A(-) – No (%)	2 (2.33)
B(+) – No (%)	11 (12.79)
B(-) – No (%)	3 (3.49)
AB(+) – No (%)	7 (8.14)
AB(-) – No (%)	1 (1.16)
Surgery duration – Mean ± S.D	190.79 ± 45.52
Liver weight – Mean ± S.D	1533.90 ± 357.93
Portal Vein Cannulation – No (%)	38 (44.19)
VMI – No (%)	48 (55.81)
Dissection In Vivo Yes – No (%)	38 (44.19)
No – No. (%)	48 (55.81)
Anatomical variant – No (%)	64 (74.42)
RHA of SMA – No (%)	12 (13.95)
LHA of SGA – No (%)	10 (11.63)
Timp Ischemie – Mean ± S.D	387.07 ± 142.45
Cause of death - Medical – No (%)	40 (46.51)
Nonmedical – No (%)	46 (53.49)

**Table 2.** General data recipients

Variable	Lot of patients
Age – Mean ± S.D	48.71 ± 13.51
Sex W – No (%)	29 (34.94)
M – No (%)	57 (65.06)
Blood type	
O(+) – No (%)	13 (15.47)
O(-) – No (%)	6 (7.14)
A(+) – No (%)	36 (42.86)
A(-) – No (%)	4 (4.76)
B(+) – No (%)	15 (17.86)
B(-) – No (%)	2 (2.38)
AB(+) – No (%)	7 (8.33)
AB(-) – No (%)	1 (1.19)

The distribution of donors according to age was close to normal, with a slight negative skewness (Table 1). The most common age group was 40-60.

The mean age of the recipients was 48.71 ± 13.51 years, with a minimum of 12 and a maximum of 67 years (Table 2).

There was a mean, positive, statistically significant correlation ( $p < 0.01$ ) between the age of the donor and the age of the recipient.

A Welch t test is used to compare men's age versus women's age, but the difference is statistically insignificant ( $p > 0.05$ ).

An ANOVA procedure is used to compare age by region, but the differences are without statistical significance ( $p > 0.05$ ).

It was also investigated whether there was an age difference between the 2 years of study (the averages of the ages are compared, using a Welch test) but the difference is without statistical significance ( $p > 0.05$ ).

A Welch t test is used to compare the age of the donor according to the cause of death (medical vs. non-medical). A statistically significant difference was observed ( $p < 0.01$ ), so that younger donors (39.23 years) died due to trauma (craniocerebral trauma) compared to older donors (54.50 years) who died due to medical (hemorrhagic or ischemic stroke, subarachnoid hemorrhage).

The distribution of the number of donors according to the sampling center over the 2 years of study was homogeneous. The Transylvania region predominates in the 2 years of study (over 60%).

From the processing of data extracted from the surgical protocols, it was observed that the kidneys were most often taken simultaneously with the liver (in 98.93% of cases).

The mean liver weight was 1533.90 g ± 357.93, with a minimum of 300 g and a maximum of 2500 g.

The modal anatomy of hepatic arterial vascularization predominated in the group of donors included in the study (74.42%). The other anatomical variants of vascularization were also present, but in a smaller number:

- Right hepatic artery (RHA) from superior mesenteric artery (SMA): 12 (13.95%);
- Left hepatic artery (LHA) from left gastric artery (LGA): 10 (11.63%).

It was observed that the duration of the operating time was close to the normal distribution, but with a slight positive skewness (deviation to the right from the symmetry of the distribution). The mean duration of surgery was 190.79 minutes ± 45.52, with a minimum of 100 minutes and a maximum of 350 minutes.

No correlations were detected between age and duration of operation with statistical significance ( $p > 0.05$ ).

To see if there are correlations between the type of venous cannulation and the duration of the operation, a bidirectional Welch t test was used for 2 independent samples and the difference was statistically significant ( $p < 0.01$ ).

It was observed that there was a correlation with statistical significance ( $p < 0.01$ ) between the type of venous cannulation and the duration of surgery, so that the duration of surgery was significantly shorter in the case of portal vein cannulation compared to inferior mesenteric vein cannulation (difference=47.72 minutes).

It was observed that there is a correlation with statistical significance ( $p < 0.01$ ) between the duration of surgery and the mode of dissection of the hepatic pedicle (in vivo or not), so that the duration of surgery was significantly shorter in the case of in vivo dissection of the hepatic pedicle compared with its ex vivo dissection (difference=47.72 minutes).

To see if there are correlations between the anatomical variants of hepatic vascularization and the duration of the operation, an ANOVA test is used, but the difference was without statistical significance ( $p > 0.05$ ).

Analyzing the data, it was observed that the time distribution of hepatic ischemia followed the model of the Gaussian curve. The mean duration of hepatic ischemia was  $387.07 \pm 142.45$  minutes, with a minimum of 115 minutes and a maximum of 660 minutes.

An ANOVA procedure was used to compare the duration of hepatic ischemia by region. The differences are statistically significant ( $p < 0.01$ ). A corrected post-hoc procedure using the Bonferroni approximation is used to see the source of the differences. Differences with statistical significance ( $p < 0.01$ ) were between Bucharest and Moldova, and Bucharest and Transylvania.

The liver graft taken in Bucharest had the shortest duration of ischemia (266.38 minutes) compared to the other two regions, where the ischemia time was significantly increased, in Moldova - 505 minutes and in Transylvania - 432.92 minutes.

To see if there were correlations between the type of venous cannulation and the duration of hepatic ischemia, a bidirectional Welch t test was used for 2 independent samples but the difference was at the limit of statistical significance ( $p = 0.05$ ).

The same result at the limit of statistical significance was obtained by analyzing the duration of hepatic ischemia and the mode of dissection of the hepatic

pedicle (in vivo or not). For this purpose a bidirectional Welch t test was used for 2 independent samples.

## CONCLUSIONS

Correlating the results obtained from the study performed with those presented in the literature we can conclude that the single aortic infusion compared to the dual (aortic and portal venous) has no detrimental affect on the liver function<sup>8,9</sup>.

The advantage of the single aortic infusion technique is that it avoids the need to perform additional dissection and cannulation of the vessels required for a technique that involves infusion of the portal vein. The surgical procedure is considerably simplified because it involves washing only through an aortic cannula, instead of having the two cannulas and infusion sets needed for the portal vein infusion technique. In critically unstable donors, these methods have been beneficial.

The liver infusion procedure allows the other abdominal organs, including the intestine, pancreas and kidneys, to be infused with a perfusion solution at the same time. Multiorgan sampling can be performed in a single donor.

In conclusion, we consider that the accuracy and speed of the sampling technique (especially "in vivo" compared to the preparation of the graft on the "back table") associated with an exact pre-, but especially intraoperative knowledge of hepatic arterial vascularization ensures a quality liver graft. appropriate even in conditions of difficulties (hemodynamic instability, rare arterial abnormalities, the presence of particular intraoperative situations).

**Compliance with ethics requirements:** The authors declare no conflict of interest regarding this article. The authors declare that all the procedures and experiments of this study respect the ethical standards in the Helsinki Declaration of 1975, as revised in 2008(5), as well as the national law. Informed consent was obtained from all the patients included in the study.

## References

1. Lin QY, Chui KK, Rao AN. Rapid donor liver procurement with only aortic perfusion. *World J Gastroenterol*. 2001 Dec;7(6):884-6.
2. Miller C, Mazzaferro V, Mackowka L. Rapid Flush Technique for Donor Hepatectomy: Safety and Efficacy of an Improved Method of Liver Recovery for Transplantation. *Transplant Proc*. 1988;20:948-950.
3. Ferla G, Colledan M, Doglia M, Fassati LR, Gridelli B, Rossi G, Caccamo L, Gatti S, Galmarini D. Back-table surgery for liver grafts. *Transplant Proc*. 1988;20:1003-1004.
4. Marcos À, Ham IM, Fisher RA, et al. Managementul chirurgical a variațiilor anatomice ale lobului drept în cazul donatorilor vii transplant. *Ann Surg* 2000,231:424-31.
5. Starzl TE, Hakala TR, Shaw BW, Hardesty RL, Rosenthal TJ, Griffith BP, Iwatsuki S, Bahnson HT. A flexible procedure for multiple cadaveric organ procurement. *Surg Gynecol Obstet*. 1984;158:223-230.
6. Starzl TE, Miller C, Broznick B, Makowka L. An improved technique for multiple organ harvesting. *Surg Gynecol Obstet*. 1987;165:343-348.
7. Sheil AG, Thompson JF, Stephen MS, Graham JC, Evers AA, Bookallil M, Kalpokas M, McCaughan GW, Dorney SF, Ekberg HB. Liver graft revascularization by donor portal vein arterialization following „no touch” donor hepatectomy. *HPB Surg*. 1988;1:57-66.
8. Lerut J, Reding R, de Ville de Goyet J, Baranski A, Barker A, Otte JB. Technical problems in shipped hepatic allografts: the UCL experience. *Transpl Int*. 1994;7:297-301.
9. Ville de Goyet J, Hausleithner V, Malaise J, Reding R, Lerut J, Jamart J, Barker A, Otte JB. Liver procurement without in situ portal perfusion. A safe procedure for more flexible multiple organ harvesting. *Transplantation*. 1994;57:1328-1332.