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Impact of restrictive fluid balance focused to increase lung procurement on renal function after kidney transplantation

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Abstract

Background. Restrictive management of fluid status has been proposed to increase the rates of lung grafts available for transplant. However, no studies have supported the effect of this negative fluid balance in the kidney graft recipients.
Methods. We evaluated the effect of restrictive fluid balance in brain-dead donors and their impact in 404 kidney recipients using Kaplan–Meier curves and Cox regression for long-term effects, and logistic regression for short-term effects. Our primary interest was graft survival and the second was occurrence of delayed graft function (DGF).
Results. A negative or equalized fluid balance with a central venous pressure (CVP) <6 mm Hg affects neither graft survival in kidney recipients ($P = 0.983$) nor the development of DGF ($P = 0.573$). A positive fluid balance between brain death and organ retrieval does not reduce either the risk of graft survival or the risk of DGF.
Conclusion. We concluded that restrictive management of fluid balance in a multiorgan donor supports adequate perfusion to vital organ systems even with a CVP <6 mm Hg. A strict fluid balance could avoid volume overload and lung neurogenic oedema, increasing the rate of lung grafts available for transplant without impacting either kidney graft survival or DGF development.

Keywords: brain-dead donors; central venous pressure; delayed graft function; fluid management; graft survival

Introduction

In resuscitating brain-dead potential donors, the optimization of perfusion prior to donation is crucial. Guidelines for the critical care management of the potential organ donor suggest that after the declaration of brain death, treatment strategy previously aimed at cerebral protection should shift toward preserving solid organ perfusion and function [1]. Some principles of donor management apply generally, whereas others are targeted to a specific organ. Because as many organs as possible will be recovered from a given donor, the team in charge of the donor has to consider a treatment in the best interest of all organs.

In resuscitating brain-dead renal potential donors, consideration must be given to the optimization of kidney perfusion prior to donation. Maintenance of arterial pressure is a key factor and this will often require a balance between volume therapy and vasopressor use. Volume therapy is generally preferred to sustain blood pressure as a result of the concern that vasoconstriction agents may impair functioning of the transplanted kidney [2]. Hypovolaemia is known to cause organ hypoperfusion and failure, and it is generally accepted that patients undergoing renal transplantation should be well fluid loaded, although there is very little information on the effect of fluid therapy on renal transplantation, as in other transplantation areas.

Competing requirements for organ perfusion may produce antagonistic strategies for fluid replacement. A restrictive fluid balance is associated with higher rates of lung procurement, whereas aggressive volume repletion facilitates the maintenance of kidney function. Several strategies have been proposed for reducing the shortage of lung donors, such as ventilatory strategies, hormonal resuscitation and aggressive active medical management of potential lung donors. Aggressive management strategies such as restricting fluid administration or administering diuretics have increased lung procurement. In fact, several authors and consensus documents of different Scientific Societies have recommended the maintenance of central venous pressure (CVP) at a minimum or between 6 and 8 mm Hg in lung donors [1,3,4].

Aggressive management of fluid status has therefore increased the rate of lung grafts available for transplant. However, no studies have supported the effect of this aggressive management strategy (including specific fluid restriction) in kidney graft recipients. In fact, there is very little information on the effect of fluid therapy in donors

according to the effect after transplantation. Management of brain-dead multiorgan donors requires a standardized successful protocol to maximize the number and success of available organs. Although recommendations exist for certain donor management interventions and parameters, data to substantiate the impact of these interventions on recipient outcomes are limited. It is generally assumed that patients undergoing renal transplantation should be well fluid loaded. Thus, it is suggested that relatively high central filling pressures (CVP between 10 and 15 mm Hg) correlate with better early graft function but no large prospective study has been conducted [2,5]. Moreover, intravenous hydration has been recommended as the most important and cheapest therapeutic intervention of preoperative management [6].

No studies have supported the use of specific fluid status indicators in lung donors as they impact other recipient grafts, such as the kidney. Our aim was to evaluate the effect of restrictive fluid balance (evaluated by CVP < 6 mm Hg) in brain-dead renal donors. We analysed the impact of this fluid status in kidney graft survival and in the development of delayed graft function (DGF).

Materials and methods

Patients who underwent kidney transplantation at the University Hospital 'Marqués de Valdecilla' in Santander, Spain between January 1994 and July 2007 were included in the study. We only considered those transplants in which donors were obtained in our intensive care unit (ICU) to avoid the 'centre effect'. We excluded kidney transplants from living donors. Data were retrospectively collected from the prospectively maintained database of all renal transplant patients and the prospectively maintained database of all organ donors in our hospital ICU. Both databases were matched anonymously by the hospital number of the donor. We included all kidney transplants (even retransplant recipients) except combined transplant recipients (kidney and other solid organ, mainly pancreatic transplant). Recipient follow-up was until graft loss, patient death or study conclusion in July 2007.

The University Hospital 'Marqués de Valdecilla' is an academic tertiary 1000-bed hospital located in Santander, northern Spain. In our centre kidney, liver, lung, heart and pancreas transplant programmes are available.

An expanded-criteria donor (ECD) was defined as donor older than 60 years or donor between 50 and 59 years with at least two of the following characteristics: donor history of cerebrovascular accident, donor history of arterial hypertension, or elevated serum creatinine (1.5 mg/dl) [7].

Brain death was diagnosed according to the clinical and legal criteria of the Spanish law [8]. We considered DGF when dialysis in the first week after kidney transplantation was needed [9]. However, there are several definitions proposed of DGF and we also considered the creatinine reduction ratio (CRR2) on post-transplant day 2 as an earlier parameter of renal allograft function [10,11]. The formula to define CRR2 was CRR2 (%) = ([Cr 1 − Cr2] × 100) / Cr1, where Cr1 and Cr2 are serum creatinine on post-transplant day 1 and day 2, respectively. We considered delayed graft function when CRR2 was <30%.

For the recipients, our primary interest was the graft survival and the second was either the appearance of DGF or the lack of immediate graft function.

Long-term graft survival was studied using Kaplan–Meier curves; functional grafts at the end of follow-up were considered as censored. Risk factors for graft failure were identified using Cox regression adjusting for donor age and recipient age; results are expressed as hazard ratios (HR) with 95% confidence intervals (CI). In order to identify factors related with DGF, we estimated odds ratios (OR) using logistic regression models, adjusting for donor age and recipient age. As survival or graft renal failure in both recipients from the same donor could be correlated, we used robust estimates of variance in both Cox and logistic regression, using the donor as cluster.

Table 1. Donor characteristics

Donor age (years)	44.4 ± 16.9
Male donor	127 (52.4%)
History of hypertension	54 (22.3%)
History of type I diabetes	13 (5.4%)
Cause of death (cerebrovascular accident)	112 (46.3%)
Use of inotropic drug	216 (89.2%)
ICU stay (days)	3.39 ± 3.14
Creatinaemia at retrieval time	1.08 ± 0.47
Uraemia at retrieval time	38.7 ± 21.9
Multiorgan donor (%)	209 (86.3%)
ECD criteria	61 (25.2%)

Results

A total of 404 kidney recipients were included in the study. A total of 242 brain-dead donors were included. Donor age was 44.4 ± 16.9 years. Diagnoses of brain death were intracerebral haemorrhage (39.7%), traumatic brain injury (36.7%) and a miscellaneous aetiology in the other 23.6%. Donor characteristics are presented in Table 1.

Recipient age was 48 ± 13.1 years. The initial disease for kidney transplant was glomerulopathy in 38.4% (n = 155), systemic disease in 15.4% (n = 62), vascular disease in 11.9% (n = 48) and hereditary disease in 11.9% (n = 48). Cold ischaemia time of grafts was >20 h in 40.3% of patients. Recipient data are presented in Table 2.

Graft survival was 85.24% (95% CI 81.2–88.5) in the first year, 66.24% (95% CI 60.7–71.2) at 5 years and 48.53% (95% CI 41.1–55.6) at 10 years. At the end of the follow-up (July 2007) graft was functional in 233 recipients (57.7%). The main causes of graft loss were the death of the recipient with functional graft (43 recipients), acute rejection (42 recipients) and chronic rejection (39 recipients).

The presence of oliguria after transplantation (HR 2.01, 95% CI 1.20–3.34, P = 0.007), having suffered DGF (HR 1.89, 95% CI 1.3–2.74, P = 0.001) and the peak anti-human leukocyte antigen (HLA) antibodies > 10% (HR 1.54, 95% CI 1.07–2.21, P = 0.019) were the variables in the multivariate analysis associated with a lower likelihood of graft survival.

Renal graft survival was 88% (95% CI 79–93%), 68% (95% CI 55–77%) and 52% (95% CI 37–65%) per annum, 5 and 10 years after renal transplantation in patients whose donor had a CVP < 6 mm Hg, whereas it was 85% (95% CI 80–89%), 67% (95% CI 60–73%) and 48% (95% CI 39–57%) in patients whose donor had a CVP ≥ 6 mm Hg.

A fluid balance with a CVP < 6 mm Hg did not affect the risk of graft loss on a CVP ≥ 6 mm Hg either in

Table 2. Recipient characteristics

Age (years)	48 ± 13.1
Male recipient	278 (69.1%)
HLA A-B-DR incompatibilities > 3	218 (53.9%)
Delayed graft function (need of dialysis)	116 (28.7%)
peak anti-HLA antibodies > 10%	110 (27.2%)
Cold ischaemia time (hours)	18.9 ± 5.9
Retransplant	114 (28.2%)
Need of blood transfusion before transplant	213 (52.7%)

Table 3. Differences in donor management with regard to the CVP value

	CVP < 6 mm Hg (n = 88)	CVP ≥ 6 mm Hg (n = 154)	P-value
Use of vasopressor drugs	91%	89.6%	0.84
Hypotension in ICU	38.6%	34.4%	0.45
Fluid balance from BD to OR (ml)	482 ± 1223	840 ± 1575	0.05
Urine output from BD to OR (ml)	308 ± 154	288 ± 154	0.32

BD to OR, brain death to organ retrieval. Values are presented as % or mean ± SD.

the univariate analysis (HR 1.02, 95% CI 0.65–1.59, P = 0.922) or multivariate analysis (HR 1.00, 95% CI 0.64–1.56, P = 0.983).

We also analysed graft survival according to the fluid balance of donors grouped by quartiles (from brain death to organ retrieval). We did not observe any differences between grafts from donors who received the more negative fluid balance (Quartile 1, reference) and those who received a more positive fluid balance (Quartile 2: HR 0.95, 95% CI 0.58–1.56, P = 0.85; Quartile 3: HR 0.94, 95% CI 0.58–1.53, P = 0.81; Quartile 4: HR 0.89, 95% CI 0.53–1.51, P = 0.68).

There were no differences with regard to the CVP value in the use of vasopressors, the presence of hypotension or urine output. By contrast, we observed a significant difference in fluid balance between groups. The group of donors with a CVP ≥ 6 mm Hg showed a significant increased fluid balance from brain death to organ retrieval (see Table 3).

In assessing the risk for the development of DGF, a CVP < 6 mm Hg did not increase the risk of DGF in either univariate analysis (OR 0.82, 95% CI 0.45–1.49, P = 0.499) or in multivariate analysis (OR 0.85, 95% CI 0.46–1.54, P = 0.573). The results were similar when we examined the risk of DGF by the formula CRR2 (<30%), both in the univariate analysis (OR 0.66, 95% CI 0.35–1.27, P = 0.211) and in multivariate analysis (OR 0.65, 95% CI 0.33–1.28, P = 0.212).

We also analysed the risk for the development of DGF according to the fluid balance of donors. No differences were observed between grafts from donors who received the more negative fluid balance from brain death to organ retrieval (Quartile 1, reference) and those who received a more positive fluid balance (Quartile 2: OR 1.21, 95% CI 0.60–2.46, P = 0.60; Quartile 3: OR 0.93, 95% CI 0.48–1.81, P = 0.83; Quartile 4: OR 1.51, 95% CI 0.76–3.01, P = 0.24).

Our lung donor rate was 21.1% (51 of 242 donors). However, no differences in lung donor rate (P = 0.41) were observed according to the fluid balance of donors grouped by quartiles (from brain death to organ retrieval).

Discussion

One of the most relevant results of this study is the evidence that a more restrictive, CVP-guided fluid balance in a multiorgan donor supports adequate perfusion to vital organ systems, including kidney perfusion. Kidney graft survival was comparable to the observations reported by other authors [12,13]. A strict fluid balance could avoid volume overload and lung neurogenic oedema, increasing the lung function and the rate of lung grafts available for transplant without negatively impacting the kidney graft recipient. We established a cut-off of 6 mm Hg in CVP, this being the lower limit recommended by the Crystal City Conference [1] and the Spanish consensus document on lung donor management [4]. We observed that fluid balance restriction (CVP < 6 mm Hg or non-positive fluid balance) does not decrease graft survival or increase the risk of DGF (assessed as need for dialysis or CRR2 < 30%).

The survival rate of lung recipients has greatly increased in the last decade [14–16]. However, few patients benefit from lung transplantation because of the scarcity of lung donors. The lack of organ donors is most serious for patients awaiting lung transplantation, in part because lungs are procured from only 10 to 20% of organ donors [17,18]. Lung acceptance rate in our donors (21.1%) was higher than reported [17,18]. We did not observe differences in the number of lungs retrieved according to the fluid balance of donors. The criteria used to select lung donors in the early 1990s were quite conservative and stringent. Acceptability criteria for lung donation were recently reviewed in an extensive consensus report from the Pulmonary Council of the International Society for Heart and Lung Transplantation (ISHLT) [19]. We believe that criteria used in the last decade, the absence of extended criteria donors and the low number of lung donors in our study may explain the absence of statistic difference in lungs retrieved. Several strategies have been proposed for reducing the shortage of lung donors. Aggressive management strategies such as restricting fluid administration or administering diuretics have increased lung procurement. Angel *et al.* stated that management strategies in marginal lung donors including restricting fluid administration and administering diuretics were associated with a significant increase in the number of lung donors and transplant procedures without compromising pulmonary function, length of stay or survival of the lung recipients [20]. Other authors focusing on aggressive management with severe negative fluid balance in brain-death donors have shown similar results [3]. Recently, Abdelnour and Rieke demonstrated that the standardization of hormonal resuscitation therapy, in combination with a CVP <10 mm Hg, significantly increased the use of hearts and lungs for transplantation [21]. In fact, the Crystal City Conference recommended maintaining CVP at a minimum or between 6 and 8 mm Hg in potential lung donors [1]. In Spain, with an organ donor rate of 34.2 pmp, a consensus meeting to develop guidelines to improve the recovery and transplantation of lungs from cadaveric

donors was held in 2007 and the maintenance of a CVP value of 6–8 mm Hg was recommended [4].

Aggressive management strategies thus increase lung oxygenation, reduce pulmonary oedema and finally increase the number of lungs available for transplants. Nevertheless, this restrictive fluid management could negatively affect kidney graft survival. However, no studies have supported the use of specific fluid status indicators as they impact other recipient grafts, such as kidney. Giral *et al.* observed that the infusion of large volume expanders (> 1250 ml) in donors was associated with a shorter DGF in recipients who underwent kidney transplant [22]. Other authors agree that a CVP of at least ~10 mm Hg in kidney donors is ideal to maintain an adequate renal perfusion [5,23]. By contrast, we have observed that adequate multiorgan donor management with CVP limit <6 mm Hg does not have negative effects in kidney graft function. Moreover, we observed that positive fluid balance after brain death does not reduce DGF (evaluated as a need for dialysis or CRR2 < 30%) or increase kidney graft survival. Moreover, graft survival was comparable to the observations reported by other authors [12,13]. To our knowledge, no studies have supported the effect of these aggressive management strategies (including specific fluid restriction) in kidney graft recipients. Our results demonstrated, for the first time, that aggressive management strategy in potential lung donors focused on strict fluid balance (with a CVP < 6 mm Hg) is safe for kidney recipients. We believe that in experienced ICUs a very negative fluid balance (with a CVP goal < 6 mm Hg) could be applied in closed monitored multiorgan donors to increase lung procurement with no adverse effects for kidney recipients.

The use of CVP as a single indicator of fluid status can be misleading. There are many factors that can influence CVP, such as underlying heart failure, expansion of the right atrium in response to increased volume in healthy hearts, and intracellular and extracellular fluid shifts that occur with traumatic injury and illness, and resuscitative efforts prior to brain death. Nevertheless, measurement of CVP is currently the most readily obtainable target for fluid management in ICUs. Although the use of pulmonary artery catheters can provide valuable data to guide donor management, most organ procurement organizations and most ICU physicians rely heavily on the measurement of CVP as an indirect indicator of fluid status [24]. Thus, the Surviving Sepsis Campaign clinical management guidelines considered the use of CVP as an end point in the management of septic patients [25]. Some authors have considered CVP value as the ideal indicator of fluid status in brain-dead organ donors [21]. In the near future the use of the other parameters for monitoring extravascular lung water (EVLW) might be a valid dynamic measure of lung oedema at the bedside, supporting therapeutical decisions on brain-dead donors with compromised cardiopulmonary function. A value of EVLW < 10 ml/kg has been recommended in lung donors [4,26].

The main limitation of our study is its retrospective nature. However, we believe that the high number of patients included increases the value of the conclusions. The low rate of lung donors increases the difficulty in obtaining sufficient numbers of lung donors in a single centre. Thus, comparing series from different institutions (including both lung donors and their impact on kidney recipients) would be meaningless because series can differ in a number of factors associated with donor management, graft survival of DGF development.

Conclusion

In summary, the management of fluid status should be a focus of any lung donor management protocol. Aggressive management of fluid balance in a multiorgan donor supports adequate perfusion to vital organ systems (even with a CVP < 6 mm Hg). A strict fluid balance could avoid volume overload and lung neurogenic oedema, increasing the lung function and the rate of lung grafts available for transplant negatively impacting neither kidney graft survival nor DGF development.

Conflict of interest statement. None declared.

References

1. Rosengard BR, Feng S, Alfrey EJ *et al*. Report of the Crystal City meeting to maximize the use of organs recovered from the cadaver donor. *Am J Transplant* 2002; 2: 701–711
2. Roche AM, James M. Fluid therapy in organ transplantation. *Curr Opin Organ Transplant* 2007; 12: 281–286
3. Straznicka M, Follette DM, Eisner MD *et al*. Aggressive management of lung donors classified as unacceptable: excellent recipient survival one year after transplantation. *J Thorac Cardiovasc Surg* 2002; 124: 250–258
4. Available at: http://www.ont.es/infesp/Paginas/DocumentosdeConsenso.aspx
5. Peeters P, Vanholder R. Therapeutic interventions favorably influencing delayed and slow graft function in kidney transplantation: mission impossible? *Transplantation* 2008; 85: S31–S37
6. Carlier M, Squifflet JP, Pirson Y *et al*. Confirmation of the crucial role of the recipient's maximal hydration on early diuresis of the human cadaver renal allograft. *Transplantation* 1983; 36: 455–456
7. Port FK, Bragg-Gresham JL, Metzger RA *et al*. Donor characteristics associated with reduced graft survival: an approach to expanding the pool of kidney donors. *Transplantation* 2002; 74: 1281–1286
8. Real Decreto 2070/1999, de 30 de diciembre, por el que se regulan las actividades de obtención y utilización clínica de órganos humanos y la coordinación territorial en materia de donación y trasplante de órganos y tejidos. BOE 3/2000 de 4-1-2000, p. 179-90
9. Halloran PF, Hunsicker LG. Delayed graft function: state of the art, November 10-11, 2000. Summit meeting, Scottsdale, Arizona, USA. *Am J Transplant* 2001; 1: 115–120
10. Govani MV, Kwon O, Batiuk TD *et al*. Creatinine reduction ratio and 24-hour creatinine excretion on posttransplant day two: simple and objective tools to define graft function. *J Am Soc Nephrol* 2002; 13: 1645–1649
11. Rodrigo E, Ruiz JC, Piñera C *et al*. Creatinine reduction ratio on post-transplant day two as criterion in defining delayed graft function. *Am J Transplant* 2004; 4: 1163–1169
12. Cecka JM. The OPTN/UNOS Renal Transplant Registry. *Clin Transpl* 2005; 1–16
13. Hariharan S, Johnson CP, Bresnahan BA *et al*. Improved graft survival after renal transplantation in the United States, 1988 to 1996. *N Engl J Med* 2000; 342: 605–612
14. Christie JD, Edwards LB, Aurora P *et al*. Registry of the International Society for Heart and Lung Transplantation: twenty-fifth official adult lung and heart/lung transplantation report—2008. *J Heart Lung Transplant* 2008; 27: 957–969

15. Miñambres E, Llorca J, Suberviola B *et al*. Early outcome after single vs bilateral lung transplantation in older recipients. *Transplant Proc* 2008; 40: 3088–3089
16. Miñambres E, Zurbano F, Naranjo S *et al*. Mortality analysis of patients undergoing lung transplantation for emphysema. *Arch Bronconeumol* 2009; 45: 335–340
17. Mulligan MS, Shearon TH, Weill D *et al*. Heart and lung transplantation in the United States, 1997-2006. *Am J Transplant* 2008; 8: 977–987
18. Sung RS, Galloway J, Tuttle-Newhall JE *et al*. Organ donation and utilization in the United States, 1997-2006. *Am J Transplant* 2008; 8: 922–934
19. Orens JB, Boehler A, de Perrot M *et al*. Pulmonary Council, International Society for Heart and Lung Transplantation. A review of lung transplant donor acceptability criteria. *J Heart Lung Transplant* 2003; 22: 1183–1200
20. Angel LF, Levine DJ, Restrepo MI *et al*. Impact of a lung transplantation donor-management protocol on lung donation and recipient outcomes. *Am J Respir Crit Care Med* 2006; 174: 710–716
21. Abdelnour T, Rieke S. Relationship of hormonal resuscitation therapy and central venous pressure on increasing organs for transplant. *J Heart Lung Transplant* 2009; 28: 480–485
22. Giral M, Bertola JP, Foucher Y *et al*. Effect of brain-dead donor resuscitation on delayed graft function: results of a monocentric analysis. *Transplantation* 2007; 83: 1174–1181
23. Zukowski M, Bohatyrewicz R, Krawczyk AA. Influence of selected factors on occurrence of delayed kidney graft function: a multivariate analysis. *Transplant Proc* 2007; 39: 2704–2706
24. Pinsky MR. Hemodynamic monitoring over the past 10 years. *Crit Care* 2006; 10: 117
25. Dellinger RP, Levy MM, Carlet J *et al*. Surviving Sepsis Campaign: international guidelines for management of severe sepsis and septic shock: 2008. *Intensive Care Med* 2008; 34: 17–60
26. Del Río F, Escudero D, De La Calle B *et al*. Evaluation and maintenance of the lung donor. *Med Intensiva* 2009; 33: 40–49

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Combined liver–kidney transplantation in patients with cirrhosis and chronic kidney disease

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Abstract
The outcome of patients with cirrhosis and chronic kidney disease treated with combined liver–kidney transplantation (CLKT) is not well known because most series of patients treated with CLKT include not only patients with cirrhosis but also patients with inherited diseases without cirrhosis. To evaluate to what extent the combined kidney transplantation impairs posttransplantation outcome compared to liver transplantation (LT) alone, the outcome of patients with cirrhosis and chronic kidney disease treated with CLKT (n = 20) was compared to that of a group of patients with cirrhosis without chronic kidney disease treated with LT alone matched by age, sex, year of transplantation and severity of cirrhosis (n = 60). The primary end point of the study was survival, and secondary end points were outcome of renal function and complications within 6 months of transplantation. Patients with CLKT had a higher incidence of bacterial infections and transfusion requirements compared to LT patients. The incidence of acute renal failure during the first 6 months was similar, yet the severity of renal failure was greater in patients with CLKT. Hospital and intensive care unit (ICU) stays were longer in the CLKT group. One- and three-year survival probabilities in patients treated with CLKT were 80 and 75% compared to 97 and 88%, respectively, in patients treated with LT. In conclusion, CLKT for patients with cirrhosis and chronic kidney disease is associated with a relatively high frequency of postoperative complications that moderately impairs short-term survival. However, 3-year survival of patients with cirrhosis treated with CLKT is excellent.

Keywords: cirrhosis; liver transplantation; renal transplantation