Controlled Donation After Circulatory Death Program: Analysis and Results at a Tertiary Care Hospital

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ABSTRACT

Background. The objective of the study was to evaluate the impact in organs obtained and transplanted from controlled donation after circulatory death (cDCD).

Methods. Transplants from cDCD donors performed at the Hospital Universitario Marqués de Valdecilla from the beginning of the program (December 2013) to December 2020 were evaluated. All procedures were performed with normothermic regional perfusion. Donors after brain death (DBDs) during the same period were used as a control group.

Results. A total of 95 donors after cardiac death and 152 DBDs were included. Age was similar in both groups (60 years [IQR, 53-68 years vs 62 years {IQR, 51-79 years]; $P = .390$). The number of organs recovered per donor was higher in the DBD group (4 [IQR, 3-5] vs 3 [IQR, 2-4], $P < .001$], as well as the number of transplanted organs (4 [IQR, 2-4] vs 2 [IQR, 2-4]; $P = .002$]. However, the number of noneffective donors was similar. DBDs presented a higher rate of liver donation (30.5% vs 46.7%; $P = .012$), lung donation (25.3% vs 38.2%; $P = .036$), and cardiac donation (1.1% vs 21.7%; $P < .001$) with respect to the donors after cardiac death group, but kidney and pancreatic donation were similar.

Conclusions. The cDCD with normothermic regional perfusion program is fully established in our center. The age of the cDCD donor has increased with experience and it is currently identical to the control group (DBD). After overcoming the learning curve, cDCD is a multiorgan donation that presents an excellent profitability in the number of organs extracted and transplanted.

BRAIN death is the common source of organs for transplant, but the imbalance between demand and supply has conditioned the development of strategies such as controlled donation after circulatory death (cDCD). The cDCD has been implemented heterogeneously because of ethical and legal conditions but also because it requires technical expertise and organizational capabilities [1]. The cDCD was initiated in our country in 2009 to 2010 and since then, cDCD has exponentially increased. There are specific requirements to initiate a cDCD program in a Spanish hospital. Among others, hospitals must have implemented an agreed on protocol on the withdrawal of life-sustaining therapy, the institution's ethics committee must have approved a cDCD protocol, and finally the regional authority must give authorization for the program. One of the critical steps is the ischemia related with the procedure. The Spanish experience shows that normothermic regional perfusion (nRP) relates to improved survival compared with other recovery approaches, and these findings explain the progressively greater application of nRP for donation after cardiac death donor maintenance [2]. We aim to evaluate the impact and results after the implementation of a cDCD program in our hospital.

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MATERIALS AND METHODS

A retrospective cohort study was carried out. All cDCD donors from 2014 to 2019 in the University Hospital Marqués de Valdecilla were included. Donors after brain death (DBD) from the same period were the control group. A cDCD program was implemented in our hospital in 2014. Our protocol uses extracorporeal membrane oxygenation as nRP and antemortem heparinization and cannulation. Outcome variables were the donation rate and the number of valid grafts for transplant. Short-term results in recipients (1-year survival rate) were also analyzed. These data were obtained through the transplant database in University Hospital Marqués de Valdecilla.

Statistical Analysis

Categorical variables are displayed as absolute value and percentage, using χ^2 or Pearson test for comparison. Quantitative variables are expressed as median and IQR. Mann-Whitney *U* test was used to compare quantitative variables.

RESULTS

There were 247 donors (97 cDCDs) (Fig 1). Age was similar in both groups (Table 1), and the length of intensive care unit stay was shorter in the DBD group (2 days [IQR, 1-4] vs 6 days [IQR, 5-11]; $P < .001$). The proportion of noneffective donors (no organ was finally transplanted) was similar in both cohorts (13 donors [13.7%] vs 18 donors [11.8%], $P = .671$). The median of grafts retrieved per DBD was higher (4 vs 3; $P = .001$) at the expense of thoracic and liver grafts. Kidney and pancreatic donation were identical in both groups (Table 1). The number of transplanted organs per donor in DBD group was higher (4 [IQR, 2-4] vs 2 [IQR, 2-3]; $P = 0.002$). One-year survival in liver recipients was similar between donor after cardiac death [DCD] (93.3%) and DBD (93.7%) groups ($P = .474$). No significant differences were observed in 1-year lung recipient survival (DCD 96.1% vs DBD 90.6%; $P = .240$). One-year kidney graft survival was similar in both cohorts (DCD 89.4% vs DBD 95.5%; $P = .640$).

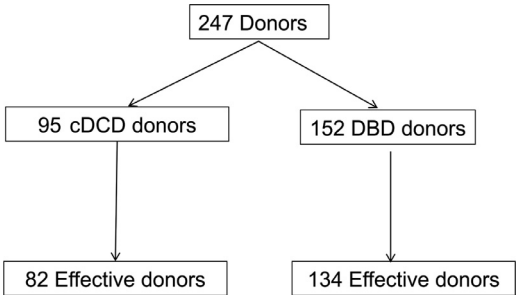

Fig 1. Donors included. cDCD, controlled donation after cardiac death; DBD, donation after brain death.

DISCUSSION

cDCD implies organizational and technical aspects that have limited its extension [2]. In our hospital, the cDCD program with nRP has been fully implemented and undoubtedly contributes to our donor pool because 1 in 4 donors are of this type. Our donation rate was 89.7 donors per million habitants (in Spain 49 per million population) in 2019 and our cDCD rate was 41.4 per million population [3]. During the last decades, the organ recovery rate from cDCD was considered inferior to those obtained with DBDs. However, almost 90% of the cDCD donors in our series are kidney donors, similar to the DBD group, and lung donation from cDCD has been fully incorporated in our series (25% of cDCD are lung donors). Liver donation was lower in the cDCD group, similar to international series [4], because of the risk of ischemic damage to the bile duct. In cDCD, the effects of warm ischemia during the hypotensive phase after the withdrawal of life−sustaining therapy and after circulatory arrest are further increased during the later period of cold ischemia. This ischemic damage is associated with the incidence of ischemic−type biliary lesions and graft loss in liver transplant recipients. The prolonged ischemia of cDCD organs is better understood, and a higher level of competence in preservation and assessment techniques are being implemented. Spanish teams were the first proposing the use of extracorporeal membrane oxygenation devices for the preservation of abdominal organs with oxygenated blood as the ideal approach for the practice of donation after cardiac death. This technique allows restoration of cellular energy substrates and turns an urgent into an elective organ recovery surgery. In this context, it is possible to evaluate macroscopic appearance and assess the viability of abdominal grafts prior to transplant. These advances have allowed liver recipients to have equivalent outcomes to those who undergo transplant through DBD [3,5] by increasing age of donors [2] and including thoracic donation in cDCD [6,7]. Lung transplant using cDCD grafts has been initiated, with outcomes similar to grafts from DBDs [6]. The

Table 1. Donation Baseline Characteristics

Characteristic	Controlled Donation After Circulatory Death (n = 95)	Donation After Brain Death (n = 152)	*P* Value
Age, y (IQR)	60 (53-68)	62 (51-79)	.390
Intensive care unit stay, d (IQR)	6 (5-11)	2 (1-4)	< .001
Organs retrieved per donor (IQR)	3 (2-4)	4 (3-5)	.001
Organs transplanted per donor (IQR)	2 (2-3)	4 (2-4)	.002
No effective donor (no organ transplanted), n (%)	13 (13.7)	18 (11.8)	.671
Kidney donation, n (%)	74 (77.9)	123 (80.9)	.565
Liver donation, n (%)	29 (30.5)	71 (46.7)	.012
Lung donation, n (%)	24 (25.3)	58 (38.2)	.036
Heart donation, n (%)	1 (1.1)	33 (21.7)	< .001

recovery of lung grafts in cDCD is performed using a rapid recovery technique decreasing the lung temperature with topical cooling as quickly as possible. This method, combined with the use of abdominal nRP for liver and kidney recovery, is safe for grafts. The cDCD lung transplant has become part of standard practice of care. Thus, although the heart was traditionally discarded, there are already worldwide experiences [8], including cases from our series, in which the heart has been successfully extracted and transplanted. In our center, the cDCD is a multiorgan donation, comparable with donation after brain death in terms of effectiveness and results. We consider that donation after cardiac death has an excellent profitability in the number of organs extracted and transplanted, and that although it implies a complexity of techniques, collaborations between centers have to be established to facilitate this type of donation, which is undoubtedly contributing to increase the pool of valid grafts for transplant.

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