

Ex Vivo Coronary Angiography of a Donor Heart in the Organ Care System

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ABSTRACT

The international demand for donor hearts for transplantation is steadily increasing. Thus, longer transportation distances and explantation from sites with limited abilities for preexplantation diagnostics have to be considered. The development of the Organ Care System® (OCS) (TransMedics, Andover, MA, USA) may extend the extracorporeal period, with the possibility to constantly evaluate and interact during organ transport. One of the potential advantages of the OCS® is the ability to even perform coronary angiography of the donor heart, if a preexplantation angiography evaluation is not possible at the donor hospital and if significant evidence for coronary artery disease in the donor heart becomes known, because of the donor's medical history or after palpation of sclerotic coronary ostia. In this report, we present the first ex vivo coronary angiography evaluation of a potential donor heart that was performed in the OCS®. Upon explantation of the donor heart, sclerosis of the left coronary artery was palpated. After reaching the implantation site, a coronary angiography was performed by placing the OCS® on a catheterization table and inserting a 6F sheath into the access site of the OCS®. A 6F guide catheter was used to intubate the left coronary ostium. Injection of contrast agent led to strong contrast for visualization of the left coronary system. This procedure allowed sufficient assessment of the coronary arteries, which showed a slight diffuse sclerosis without any significant stenosis. This report demonstrates the advantage of the OCS® in the complex assessment of donor hearts after explantation. While the donor heart is still in the OCS®, not only is it possible to measure metabolic parameters and pressures, but even coronary angiography is feasible. With the increasing international demand for donor organs, such ex vivo examinations might play a more important role, because longer transportation distances can be accepted and organs from suboptimal donors without preexplantation diagnostics may be considered at donor sites with limited diagnostic options.

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INTRODUCTION

Approximately 5 million Americans are estimated to currently live with heart failure, and an additional 500,000 patients receive such diagnoses each year [Hunt 2005]. Symptomatic heart failure has a worse prognosis than most types of cancer [Stewart 2001]. Heart transplantation remains the gold standard of all medical or surgical therapies for advanced and end-stage heart failure [Keck 2000]. Despite the epidemiologic and economic importance of heart failure in industrialized countries, however, the small number of donor organs is a major limitation. It is estimated that only 2000 organs are available annually for transplantation in the United States. In 2006, 377 heart transplantations were performed in Germany, but almost 900 organs were needed. These numbers demonstrate the importance of allocating all possible organs to appropriate patients, even if the transportation time and distance are long. The time between explantation and implantation for an optimal outcome for the patient should not exceed 5 hours. With the development of the Organ Care System® (OCS) (TransMedics, Andover, MA, USA), the extracorporeal period could be extended, with the capability for constant evaluation and the possibility to interact during organ transport. One of the potential advantages of the OCS® is the ability to even perform a coronary angiographic evaluation of the donor heart, if a preexplantation angiography evaluation is not possible at the donor hospital and if significant evidence for coronary artery disease in the donor heart becomes known, because of the donor's medical history or after palpation of sclerotic coronary ostia.

EX VIVO ANGIOGRAPHY OF DONOR HEART

In this report, we describe the first ex vivo coronary angiography evaluation of a potential donor heart that was performed in the OCS®. The donor was a 46-year-old male patient with a body mass index of 24 kg/m². The cause of death was spontaneous intracranial bleeding. The preoperative echocardiography evaluation showed an ejection fraction of 55%, and the donor appeared to be a smoker. The organ offer was rejected by 3 other centers because of the long transportation time and the suboptimal donor conditions. Upon explantation of the heart, sclerosis of the left coronary artery was palpated, and

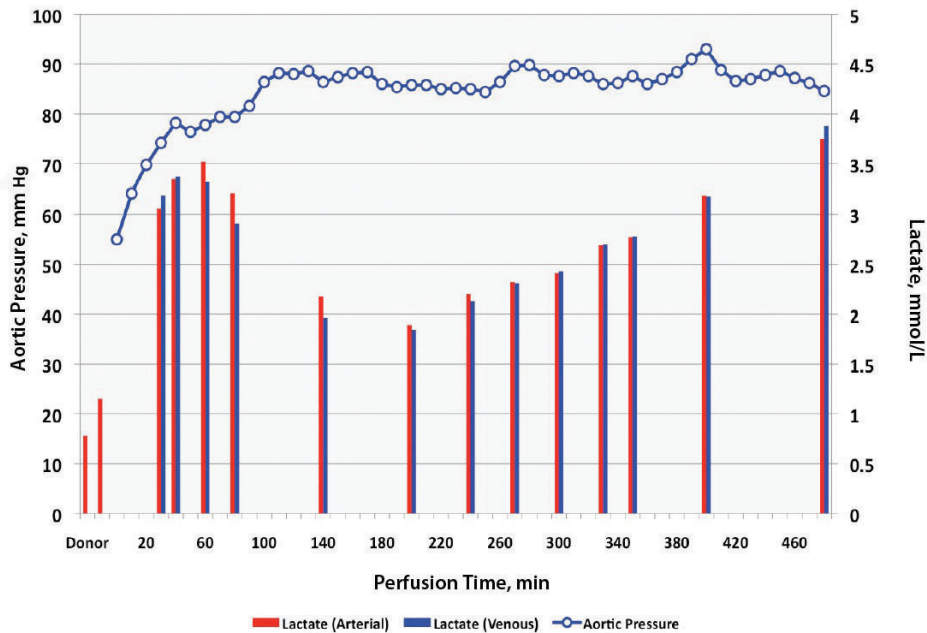


Figure 1. The perfusion parameters measured by the TransMedics Organ Care System for the donor heart. The aortic pressure and the venous/arterial differences in lactate concentration are shown.

1000 mL of Bretschneider cardioplegia solution was administered for cardiac arrest. Thirty-seven minutes were required to start perfusion in the OCS®. The transportation time to our hospital in Heidelberg was 5 hours and 35 minutes. The total perfusion time using the OCS® was 9 h 30 min. At the beginning, the parameters of the heart were not stable, which led to a delayed departure time. The rate of epinephrine

administration was first raised to 15 mL/h at 7 minutes and then to 20 mL/h at 9 minutes. Moreover, defibrillation was required twice, first at 5 J and then at 10 J. A pacemaker was implanted, and it paced at a rate of 80 beats/min (Figures 1 and 2). After 2 negative balanced lactate results with the I-Stat System portable blood analyzer (Abbott Laboratories, Abbott Park, IL, USA), transportation to the airport was initiated.

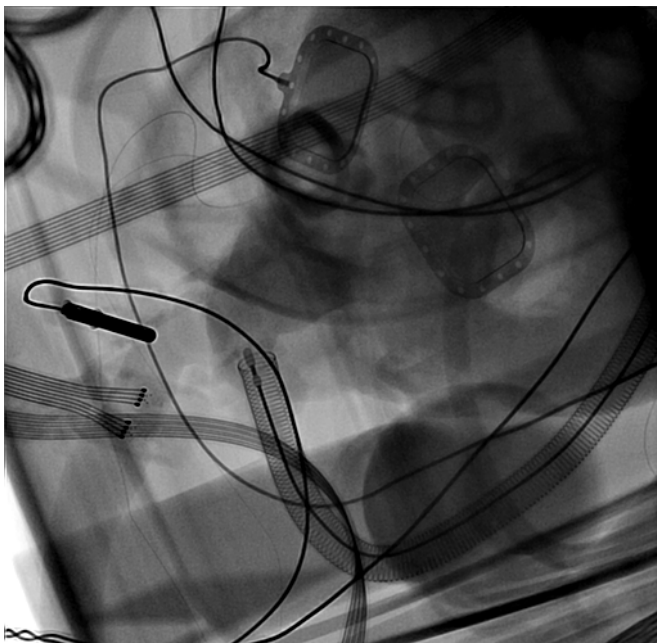


Figure 2. Fluoroscopy image of the donor heart in the OCS.

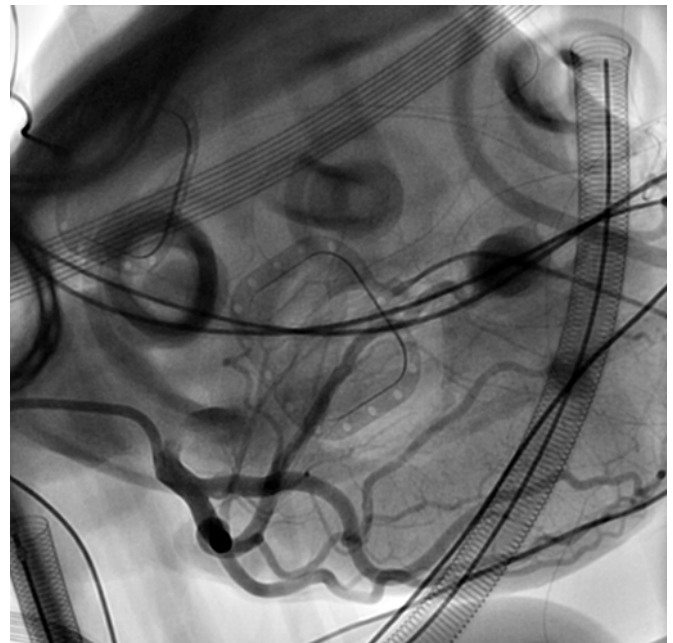


Figure 3. Selective imaging of coronary arteries of the beating donor heart in the OCS.



Figure 4. Selective imaging of coronary arteries of the beating donor heart in the OCS.

The suboptimal parameters and the palpatory evidence of coronary sclerosis led to the decision to examine the coronary arteries in our heart catheterization laboratory. The OCS® was placed on a catheterization table, and a 6F sheath was inserted under sterile conditions into the access site of the OCS®. A 6F 3.5 Judkins left guide catheter was then inserted through the sheath, and the left coronary ostium was successfully intubated. Injection of approximately 6 to 8 mL of contrast agent led to strong contrast for visualizing the left coronary system. This procedure allowed sufficient assessment of the coronary arteries, which showed a slight diffuse sclerosis without any significant stenosis (Figures 3-5, Videos 1-4 online). Owing to various negative parameters of the donor heart—such as a high left atrial pressure (20 mm Hg), catecholamine use before explantation (0.16 µg/kg per min), a low pH (7.25), and a *Pseudomonas* infection of the lung—the final decision was to reject this heart for transplantation. Nevertheless, the ability to perform a coronary angiography examination had been a valuable tool in the evaluation of this donor heart.

DISCUSSION

This report demonstrates the advantage of the OCS® in the complex assessment of donor hearts after explantation. While the donor heart is still in the OCS®, not only is it possible to

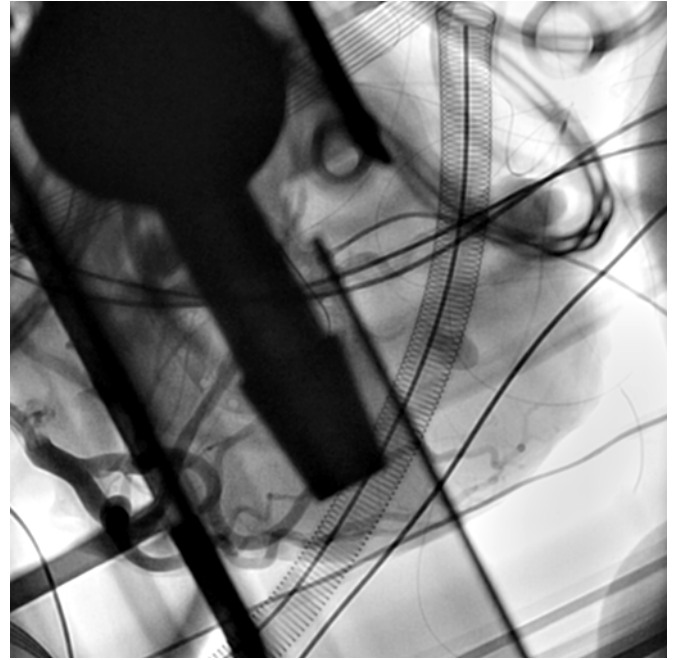


Figure 5. Selective imaging of coronary arteries of the beating donor heart in the OCS.

measure metabolic parameters and pressures, but even coronary angiography is feasible. With the increasing international demand for donor organs, such ex vivo examinations may come to play a more important role, because longer transportation distances can be accepted and organs from suboptimal donors without preexplantation diagnostics may be considered at donor sites with limited diagnostic options.

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