

## Case Report

# Logistics and Strategy of Multiorgan Procurement Involving Total Face Allograft

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M. J. Colominas changed to M. J. Colomina]

The face is the latest body structure to be added to the field of transplantation and the learning curve is ongoing. In the scenario of multiorgan recovery, the face is a nonvital 'organ' structure compared with other life-saving organs. To date, the face has been the first 'organ' to be procured in a multiorgan procurement. A technique for simultaneous recovery of the whole face, heart, lungs, liver, pancreas and kidneys is described. Thirty professionals participated in the procedure, of whom 13 were surgeons. No tracheotomy was performed. A mask of the donor's face was made from a mold impression. Duration of the procedure from skin incision to the end of surgery was 7.3 h. The face was perfused with Wisconsin solution through a cannula inserted into the aortic arch between the origin of the brachiocephalic arterial trunk and the left subclavian artery. Blood requirements consisted of 4 units of packed red blood cells. After the procedure, the mask was placed on the donor's face. All recovered grafts functioned immediately. In summary, simultaneous multiorgan procurement including the whole face is feasible, effective and saves time without jeopardizing life-saving organs and without the need for tracheotomy.

**Key words:** Face transplantation, multiorgan donor, procurement, surgical technique

**Abbreviations:** G, gauge; UW, Wisconsin solution; PRBC, blood red packed cells.

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## Introduction

The first successful face transplant was performed in France in November 2005. Before April 2010, a total of 11 face transplants, 1 combined with bilateral hand transplantation, had been performed worldwide, 6 of which were reported in the English literature (1–8). In the scenario of multiorgan procurement, the face is a nonvital 'organ' structure compared with other life-saving organs such as the heart, lungs and liver. Additionally, face recovery implies differences from an organizational and logistic point of view. Only two articles focused on procurement of the face allograft; however, there remain a paucity of information and unanswered questions regarding the donor procedure (7,9). The aim of this manuscript is to facilitate the dissemination of relevant details of our experience in an attempt to aid the surgical interaction among the different teams involved in simultaneous multiorgan procurement involving the whole face.

## Case Material

In August 2009, the University Hospital Valle de Hebron received approval to perform a facial allotransplant from the Hospital Ethics Committee, the Catalan and the Spanish Organizations for Transplantation. The multiorgan procurement was achieved on March 27, 2010. The transplant coordinator received informed consent from the deceased donor's family to recover and transplant the donor face, thoracic and abdominal organs. The donor was a brain-dead, 41-year-old Caucasian male with ABO blood type compatible with the recipient. The cause of brain death was cerebral hemorrhage. For the face transplant, donor selection was based on age, race, skin and anthropometric features. The recipient was a 30-year-old Caucasian male. HLA matching with the recipient was random. The donor was hemodynamically stable without the need for vasopressors, hematocrit 28%, normal blood sugar and serum lipase levels and liver function test. Other thoracic and abdominal organ-sharing centers were contacted at the time



of donor acceptance and notified of our need for a facial graft. In addition, the participating teams were committed to conforming to the surgical strategy herein described. The remaining organs retrieved were heart, lungs, liver, pancreas and kidneys.

#### **Donor preparation and surgical fields**

The patient was brought to the operating room orotracheally intubated, with the left radial artery, two peripheral veins in the feet and right and left femoral veins canalized to avoid manipulation of upper central veins. The donor was placed on the operating table in the supine decubitus position with his arms alongside his body. The endotracheal tube was anchored to the upper incisors with 2/0 silk sutures. The anesthetic team and i.v. fluids and ventilator were stationed near the donor's feet, with extension of the ventilator tube (Figure 1). No tracheotomy was performed to facilitate lung procurement.

The chest and abdomen were prepared with povidone and draped. Initially, these fields were separated from the head and neck for a layer of alginates to be placed over the face to form a mold (Figure 2). The mold was then removed and used to produce a resin mask to restore the donor's appearance after face graft procurement. For separation of the mold, the endotracheal tube was disconnected from the ventilator and reconnected once the mold had been removed. Following creation of the mold, the head and neck were scrubbed with povidone as well as the ventilation tube with its extension and sterilely packed. This permitted three fields to be created in continuity: head-neck, chest and abdomen, which permits simultaneous interventions.

The operating room measured 38 square meters and had two lamps, with a supplementary lamp for the plastic surgeons who also used xenon head lights. In addition, each field was assigned an electric scalpel and a sucker.

Thirteen surgeons were involved in the whole procedure: three plastic surgeons, three heart-lung surgeons, three liver surgeons, two pancreas surgeons and two urologists; four anesthetists, one medical coordinator, one nurse coordinator and seven nurses completed the team. Altogether, 30 professionals participated in the procedure.

#### **Donor surgical procedure**

The strategy for donor organ recovery was to perform a simultaneous multiorgan procurement including the face based on the standard guidelines for organ procurement in three successive phases: variable dissection with intact donor circulation of the organs to be used, cannulation and *in situ* cooling by aortic infusion of the different organs with simultaneous exsanguination, and organ removal. The order of the different surgical transplant teams from the beginning to the end of surgery is shown in Table 1. The plan agreed on by the different surgical teams was to provide two additional hours for the plastic surgeons following

pancreas dissection to allow them to move on with the *in situ* facial dissection as far as possible. For cannulation and cross-clamping, all the teams agreed with the technique described below. In addition, should hemodynamic donor instability occur, rapid cannulation would be performed.

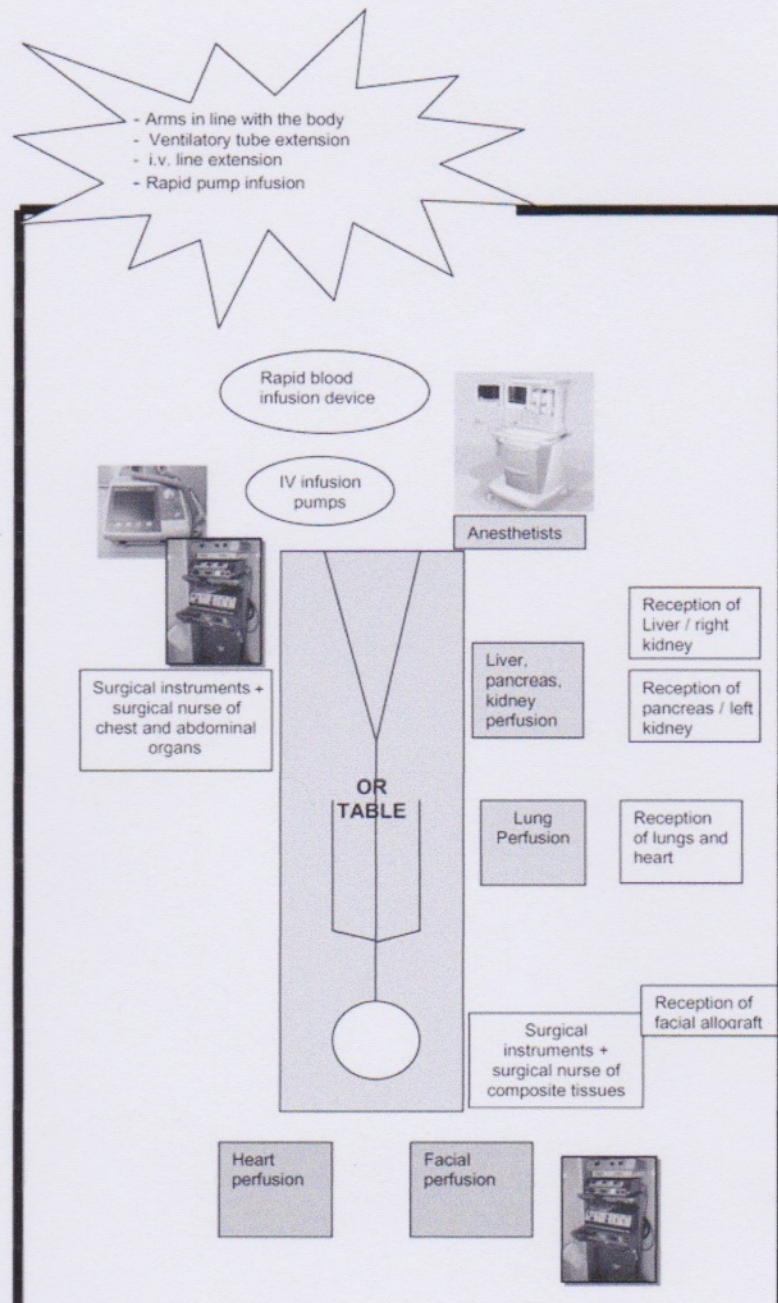
#### **Dissection with intact circulation**

Initially, the chest and liver surgeons worked simultaneously while the face mask was forming. Following a complete mid-line incision from the supra-sternal notch to the pubis, evaluation of thoracic and abdominal organs and confirmation of their viability, the plastic surgeons initiated the dissection of facial tissues. The thoracic team performed thymectomy and dissection of the ascending aorta, pulmonary artery, inferior and superior vena cava. Simultaneously, the liver team encircled the infrarenal aorta with umbilical tape for the eventual insertion of an infusion cannula and the inferior mesenteric vein for portal venous preservation solution infusion. The abdominal aorta was also encircled above the celiac axis for later cross-clamping when chilled fluid was infused through the distal aortic cannula. Once the liver and pancreatic teams had completed their dissection, the plastic surgeons moved on with the facial dissection. However, the donor suffered three episodes of atrial fibrillation, each of which required electrical cardioversion to achieve sinus rhythm. Finally, the donor developed hemodynamic instability requiring immediate cannulation and *in situ* cooling.

#### **Cannulation and in situ cooling**

Following full heparinization of the donor with 350 units/kg of i.v. low sodium heparin, the distal aortic and inferior mesenteric vein cannula was inserted. Simultaneously, the chest surgeons created a purse string with 4.0 polypropylene suture at the origin of the aorta to secure it after puncture with a 12 gauge (G) cardioplegia cannula, taking care to insert the cannula before the origin of the brachiocephalic trunk. Similarly, a 14G cannula was inserted into the aortic arch between the origin of the brachiocephalic arterial trunk and the left subclavian artery. An additional 16G cannula was placed in a similar fashion in the trunk of the pulmonary artery for pulmoplegia. Prostaglandin E1 was administered. Each cannula was connected to its clamped perfusion line. The clamping and perfusion sequence was initiated by the cardiac/pulmonary team. Cannulation and cross-clamping sites are shown in Figure 3. The aorta was cross-clamped twice: the first clamp was placed beyond the cardioplegia cannula, before the origin of the brachiocephalic trunk, and the second crossed the aortic arch beyond the origin of the left subclavian artery, with special care taken to avoid injury to the left pulmonary artery and trachea. Immediate cardioplegic, pulmoplegic and chilled Wisconsin solution (UVW) were perfused through the cannulas for heart, lung and face, respectively. The face was covered with a gauze moistened with a crushed ice crystalloid solution. The superior vena cava was then transected, allowing for facial venous bed drainage, followed by





**Figure 1: Diagram of the operating room organization to permit simultaneous multiorgan procurement combined with the face.**

venting of the inferior vena cava at the junction with the donor right atrium to permit drainage of the abdominal organs. The donor heart and lungs were immersed in cold solution. Simultaneously, the encircled supraceliac aorta was cross-clamped, abdominal organs perfused with UW through the cannula inserted in the infrarenal aorta and inferior mesenteric vein, and immersed in crushed ice solution.

The total amount of UW infused was guided by blanching of the organs. The face required 2 L of UW. The organs remained *in situ* until the cold infusion was completed.

#### **Organ removal**

The heart and lungs were procured first. Just before the end of the lung procurement, the face perfusion was put



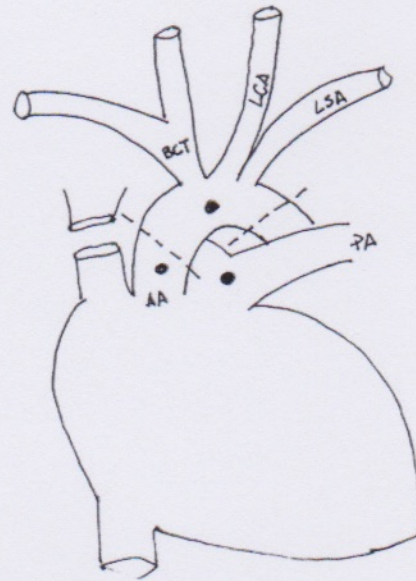


**Figure 2:** Mold of the donor's face with the orotracheal tube.

on hold since the aortic arch required transection (at the level of the aortic clamps) for the chest surgeon to be able to approach the pulmonary artery and staple the trachea (Figure 3). To avoid the endotracheal tube being in the GIA stapler section, it was moved upward up from the staple site. Following moderate inflation of the lungs with end-tidal normal volume prior to their recovery, the trachea was transected with the stapler and the endotracheal tube removed. The aortic arch was then repaired with 4/0 polypropylene running sutures and the UW re-infused with a continuous slow drip until the end of the face procurement to avoid rewarming. At the same time, the abdominal organs were retrieved: first the liver, then the pancreas and finally the kidneys. When the facial al-

**Table 1:** Sequence of organ dissection and multiorgan procurement by the different surgical teams. The preplanned step 3A was obviated due to donor hemodynamic instability

(1) Mask impression/heart-lung-liver-pancreas: approval of organs
(2) Plastic-liver
(3) Plastic-pancreatic team
(3A) Plastic team (2 h)
(4) Cannulation by heart-lung-liver team
(5) Heart-lung
(6) Liver/plastic team
(7) Pancreas/plastic team
(8) Kidney/plastic team
(9) Plastic team
(10) Mask fitting



**Figure 3:** Cannulation and cross-clamping sites. Bold dots: cannulation for heart, lungs and face. Broken lines: sites of cross-clamping (AA, aortic arch; PA, pulmonary artery; BCT, brachiocephalic trunk; LCA, left carotid artery; LSA, left subclavian artery).

lograft had been procured, it was stored in a cold UW solution.

The total facial allograft procured en bloc included all skin and soft tissues of the face (from the frontal hairline to the mid part of the neck and from the right to the left preauricular creases), facial muscles, lachrymal ducts and cysts, eyelids, floor of the mouth, lips, upper and lower teeth, hard palate, all cheek mucosa up to the anterior pharyngeal pillar, mandible from the right coronoid to left coronoid process, maxilla, 2/3 of both zygomatic bones, nose (including cartilage, nasal bones and septum), turbinates, vomer, ethmoid bone and the maxillary sinuses. The vascular pedicles consisted of both external carotid arteries, both external jugular veins, the right anterior jugular vein and the left retromandibular vein. Nerves included sensory branches of the trigeminal (supraorbital, infraorbital and mandibular nerves) and the buccal, zygomatic, orbicularis oculi and frontal branches of the facial nerve. The osteotomies and separation of the floor of the mouth, anterior pillar of the pharynx and nasopharynx were performed after the heart and lungs had been retrieved. Among the surgical instruments used included a Joseph periosteotome, pterygoid chisel and a dentist electrical saw for osteotomies. As soon as the face was procured, the mask was placed on the donor's face and anchored to the skin and scalp with 2/0 silk sutures. The deceased donor was returned to the necropsy room and his family.



## Results

Overall duration of the procedure from skin incision to the end of surgery was 7.3 h. Cross-clamping and cooling of the organs was performed after 4 h of surgery. The plastic team invested 1 h in performing the mold and preparing their field, nearly to 3 h for *in situ* dissection prior to organ perfusion and 2 h after under cardiac arrest in which the osteotomies and separation of the floor of the mouth, anterior pillar of the pharynx and coarctation were performed. Blood requirements consisted of four units of packed red blood cells (PRBC), two owing to the initial low hematocrit count, and two to blood loss during surgery. The heart, liver, pancreas, one lung and both kidneys were transplanted at different centers. Cold ischemia time for the facial allograft was 220 min. The face recipient required transfusion of 20 units of PRBC during transplantation, 4 of which were transfused during the first hour following facial reperfusion. All recovered grafts functioned immediately. The recipient of the face has now been followed up for 9 months.

## Discussion

The face is the latest body structure to be added to the field of transplantation and the learning curve is ongoing. Unfortunately, information regarding donor organ procurement is scant. Relevant details available in the English literature on donor organ procurement involving facial allografts are summarized in Table 2.

Each new kind of 'organ' transplant raises concerns about adding a further organ to the procurement list for a given donor. These questions have been posed first from an ethical and technical viewpoint. The ethical concern of transplant surgeons involved in this procedure was whether the removal of composite tissues combined with multiple organs would cause damage to vital allografts, resulting in graft and patient loss. However, to date, the face has been the first 'organ' to be procured in cases of multiorgan recovery. The pioneers in face transplantation advocated recovery of the face *in situ* from a brain-dead donor prior to other organs including the heart, liver and kidneys with perfusion of the composite tissue *ex situ* (7). In a similar sequence, Siemionow et al. procured a near total face allograft (1). In those two cases, facial procurement lasted 11 and 9 h, respectively, not including the following procurement of the remaining organs, which in our experience ranged between 5 and 6 h. Therefore, the procedure following the previous strategy lasted at least 15 h. Thus, a key issue is that donor operative time needs to be shortened, not only because life-saving organs which have priority over the face might be jeopardized, but also because it causes professional fatigue, particularly if surgeons hail from different centers outside the city. In addition, the French authors stated that the face graft procurement arrangement rendered it impossible to remove other organs simultaneously since the head and neck region was in the surgical

field and the anesthetists had access only to the lower part of the donor body (9). We showed that simultaneous organ recovery is possible, with an overall surgical time for the whole procedure of 7.3 h. The described positions of the donor, surgical fields and anesthetists and their devices in the caudal region of the donor permit surgical teams to work without interference. Nevertheless, in the scenario of multiorgan procurement, facial recovery requires an increased effort in logistics coordination with interaction and communication among 30 professionals in a single operating room. Further, if we had maintained our original plan of providing two additional hours following pancreas dissection for *in situ* face dissection, the duration of the whole procedure would then have been close to 9 h, a reasonable time.

Our shorter operative time if compared with the previously reported experiences was also influenced by the donor becoming hemodynamically unstable and requiring immediate cannulation and *in situ* cooling to minimize tissue ischemic injury and save the vital organs. In all the described cases, cooling and perfusion of the facial allograft were performed *ex situ*. We used a straightforward technique that permits optimal flushing of the face by insertion of a single cannula in the aortic arch above the cardioplegic cannula and cross-clamping after the origin of the left subclavian artery. In our case, functionality of all organs was successfully preserved.

The current literature has described *in situ* face dissection in a brain-dead donor as well as face procurement in a donor after cardiac death with perfusion *ex situ* (2,7). Because we needed to change our initial strategy, approximately half of the dissection was performed *in situ* and the remainder under cardiac arrest. *In situ* face dissection reduces cold ischemia time, simplifies identification of nerves and vascular structures, eliminates unintentional graft rewarming during *ex vivo* manipulation and reduces hemorrhage. In contrast, facial procurement in a donor after cardiac death can cause severe blood loss after vessel unclamping in the recipient (2). Data on recipient blood transfusion requirements have been reported only in three cases (two *in situ*; one ACD) and ranged between 1 and 35 units of PRBC (1–3,9). In our case, 30 units of PRBC were required. This high amount of surgical blood loss can be explained not only by the fact of the donor facial dissection was performed under cardiac arrest, but also because of the great complexity of the recipient surgery, as described in the third case in the world which required 35 PRBC (3,4). In addition, the increased blood loss and volume replacement during organ recovery could prompt concerns that the quality of thoracic organs may be affected, as has occurred in other types of transplant (10). In our case, despite this there was a significant amount of blood requirement that did not affect the outcome of the other organs.

Questions arise regarding performing tracheotomy as recommended by others (7,9). Although this is also a



**Table 2:** Details relevant for facial donors and procurement characteristics found in the literature, including the present case

Patient/date reference	D/rage (years)	D/R ABO compati- bility	Facial graft	Multiorgan procure- ment	Recovery of organs sequence	D tra- cheotomy	Procurement					D/R blood transfusion
							Facial dis- section	Facial allograft perfusion	Facial preser- vation solution	CIT (minute)	R surgical time (hours)	
1. France November 05 (8)	46/38	Identical	Myocutaneous partial			Yes	<i>In situ</i>	<i>Ex situ</i>	IGL	230	15	
2. China April 06 (2)	25/30	Identical	Osteomyocutaneous partial			No	ACD	<i>Ex situ</i>	UW		18	/5 L + 6.2 L (plasma + PRBC)
3. France January 07 (3,9)	/29	Identical	Myocutaneous partial	Yes	Sequential (face first)	Yes	<i>In situ</i>	<i>Ex situ</i>	SCOT		15	/35 PRBC
4. USA December 08 (1)	44/45	Compatible	Osteomyocutaneous partial	Yes	Sequential (face first)	Yes	<i>In situ</i>	<i>Ex situ</i>	UW		22	/1 PRBC
5. France March 09 (4)	/28		Osteomyocutaneous partial				<i>In situ</i>				15	
6. France April 09 (7)	/37		Osteomyocutaneous partial + both hands	Yes	Sequential (face first)	Yes	<i>In situ</i>	<i>Ex situ</i>	Saline + heparin (stored in Celsior)		30 (facial + hands)	
7. USA April 09 (6)	60/59		Osteomyocutaneous partial	Yes	Sequential (face first)	No	<i>In situ</i>	<i>Ex situ</i>	UW	75	17	
8. Spain March 10	41/30	Compatible	Osteomyocutaneous total	Yes	Simultaneous	No	<i>In situ</i> /ACD	<i>In situ</i>	UW	150	22	4/30 PRBC

Blank: Data not available.

D, donor; R, recipient; CIT, cold ischemia time; IGL, Institut Georges Lopez; ACD, after cardiac death; SCOT, Solution de Conservation des Organes et des Tissus; PRBC, packed red blood cells.



time-consuming procedure, it does facilitate optimal mask impression and face recovery. However, if lung procurement is to be performed, as in our case, the thoracic team raised the concern that tracheotomy could contaminate the field with tracheal spillage and jeopardize lung viability. We demonstrated that both mask formation and face procurement can be performed with orotracheal intubation without the need for tracheotomy. Furthermore, after this first experience, we believe that the mask impression should be made in the intensive care unit prior to donor procurement to save additional surgical time.

In summary, with the strategy described, simultaneous multiorgan procurement including the whole face is a feasible, effective and less time-consuming procedure than that in cases described to date, even in cases of hemodynamic instability, without life-saving organs being jeopardized and without the need for tracheotomy.

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### Disclosure

The authors of this manuscript have no conflicts of interest to disclose as described by the *American Journal of Transplantation*.

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