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Review

From partial to full-face transplantation: Total ablation and restoration, a change in the reconstructive paradigm

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ABSTRACT

The innovation of composite vascularized allotransplantation has provided plastic and reconstructive surgeons with the ultimate tool for those patients that present with facial deformities that cannot be reconstructed with classical or more traditional techniques. Transplanting normal tissues allows for a true restorative surgery. Initial experiences included the substitution of missing anatomy, whereas after the first world's full-face transplant performed in Barcelona in March 2010, a true ablative surgery with a total restoration proved to be effective. We review the world's experience and the performance of our restorative protocol to depict this change in the reconstructive paradigm of facial transplantation. Facial transplants should be performed after a careful analysis of the defect, with a comprehensive ablation plan following esthetic units with sacrifice of all required tissues with a focus of global restoration of anatomy, aesthetics and function, respecting normal functioning muscles. Nowadays, facial transplants following strict esthetic units should restore disfigurement extending to small central areas, whereas major defects may require a total ablation and restoration with full-face transplants.

1. Introduction

Face transplantation became a reality in November 2005, following the initial experience of the Amiens Team.[1] It broke boundaries and started a new frontier for reconstructive surgery and transplantation medicine. This was indeed the birth of restorative surgery in contrast to reconstructive surgery.

Few teams followed them in the exploration of this new path for the reconstruction of severe facial deformity.[2–7] These pioneering experiences proved the safety, efficacy and reproducibility of facial transplant outcomes. They also showed that a robust protocol and team approach warrant safe and excellent results in this complex experimental surgery. From 2005 to 2010, different amounts of facial tissues were transplanted in 11 facial transplantations, but a full-face transplant was still theoretical. The indication varied, but all facial transplants had in common the limitation of the resection to the area involved in the deformity and small amount of normal skin and soft tissues surrounding these destroyed tissues.

In 2010 we performed the world's first full-face transplantation,[5,8–10] which included all facial soft tissue structures, intraoral structures, and facial skeleton. This consisted in a type VB face transplant according to Lengele's classification.[11] The indication surpassed that of previous face transplants. Many facial units were involved, thus a reconstructive approach was implemented according to the facial unit criteria.[12] Herein we describe the reconstructive plan approach used to this unique facial transplant, and we analyze the change in the reconstructive paradigm in the following 14 facial transplants thereafter.

2. Material and methods

All facial transplants performed between November 2005 and July 2013 were analyzed. The information was retrieved from published literature; press releases, congress proceedings and direct information form the head surgeon of the transplant teams.

Facial transplants were studied concerning the amount of facial units transplanted, normal tissues sacrificed, and type of transplant.

The transplants were also divided in two groups of patients: facial transplants performed before march 2010 and after march 2010 (date of the first full-face transplantation) and compared in regards of the type of indication and tissues ablated.

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Table 1
Global list of facial transplants to date.

Number	Team	Date	Etiology	Type
1	Amiens	Nov 05	Dog bite	Partial
2	China	Apr 06	Bear bite	Partial + Bone
3	Paris	Jan 07	Neurofibromatosis	Partial
4	Cleveland	Dec 08	Gunshot	Partial + Bone
5	Paris	Mar 09	Gunshot	Partial + Bone
6	Paris	Apr 09	Burn	Partial + Hands
7	Boston	Apr 09	Burn	Partial + Bone
8	Valencia	Aug 09	Postoncological	Partial + Bone + Tongue
9	Paris	Sep 09	Gunshot	Partial
10	Amiens	2009	Burn	Partial + Bone
11	Seville	Jan 10	Neurofibromatosis	Partial + Bone
12	Barcelona	Mar 10	Gunshot	Full + Bone
13	Paris	Jun 10	Neurofibromatosis	Full
14	Paris	2010	Gunshot	Partial + Bone
15	Paris	2010	Neurofibromatosis	Partial
16	Boston	Mar 2011	Burn	Full
17	Boston	Apr 2011	Burn	Full
18	Boston	May 2011	Chimp Attack	Full + Hands
19	Gent	Dec 2011	Gunshot	Partial + Bone
20	Antalya	Jan 2012	Burn	Full
21	Ankara	Feb 2012	Burn	Full
22	Ankara	Mar 2012	Gunshot	Partial + Bone
23	Baltimore	Apr 2012	Gunshot	Full + Bone + Tongue
24	Amiens	Jun 2012	Arterio-venous malformation	Partial
25	Boston	Feb 2013	Burn	Full
26	Gliwice	May 2013	Trauma	Near-Total + Bone

2.1. The Barcelona restorative protocol

Patients considered for facial transplantation are evaluated in a reconstructive facial clinic. The deformity is analyzed by clinical inspection, rehabilitation services and X-ray examination including Angio-CT-Scan and MRI and all reconstructive plans are considered. Patients with an indication for facial transplantation are included in the transplant team program and a complete medical, psychological, and analytical work-up is carried out which finalizes with the submission on a case-by-case basis to the Ethics Committee. The patient is then submitted to the regional and national transplant bodies for final administrative approval. During the whole work-up, an individual reconstructive plan, which includes areas to be extirpated, expected defect, and desired functional/anatomical outcome, is delineated.

3. Results

3.1. Analysis of global results

A total of 26 facial transplants have been performed in the world in 8 years.[2–6,13–22] The etiology of the deformity includes 8 gunshot injuries, 8 burn deformities, 4 neurofibromatosis, 1 high flow arterio-venous malformation, 1 postoncological deformity, 1 dog bite, 1 bear bite, 1 chimp attack, 1 traumatic injury. Out of 26 facial transplantations, 17 facial transplants are partial (66%), and 9 are full-face transplants (Table 1).

Before face transplant number 12 (the first full-face transplant) all transplant were partial and included different amounts of soft tissues and bone. Among them, 6 followed esthetic units with few or no normal tissue excised during the transplantation, and 5 did not followed any esthetic unit and resolved the deformity by replacing the missing anatomy by transplanted parts.

After the first full-face transplant, a change in the reconstructive paradigm occurred. The classical concepts of esthetic facial reconstruction were applied to facial transplantation. Out of the next 14 facial transplants, 8 were full-face transplants (with extirpation of deformed and normal tissues to achieve a complete functional and esthetic restoration), and 6 were partial transplants that followed strict esthetic units.

3.2. Analysis of Barcelona experience

The deformity of Patient 1 in the Barcelona facial transplant protocol included the central portion of the face, absence of the nose, subtotal destruction of the lips, scarred tissue on eyelids, cheeks, neck and forehead. The bony skeleton had destruction of maxilla and zygomatic bones, nasal bones, and partial destruction of mandible. There were areas of normal tissue, which included parts of the forehead and eyebrows, parts of the eyelids and cheeks. Fig. 1a shows disfigured and non-disfigured areas. A complete analysis of the deformity was undertaken (Fig. 1b and c), coupled with functional deficits and expected outcomes. The concepts of ablative surgery and functional reconstruction were applied, and a total resection of the face and destroyed facial bones and restoration of the missing anatomy with a full-face transplant with facial bones, intraoral structures and teeth was undertaken (Fig. 1d). The former was considered the best treatment plan to restore function and aesthetics and to reintegrate him into society. Total follow up is 42 months.

4. Discussion

Remarkable advances in research, technology, and clinical experience in medicine over the past few decades have resulted in a strong surge of development in reconstructive surgery. The innovation of composite vascularized allotransplantation has provided plastic and reconstructive surgeons with the ultimate tool for those patients that present with deformities that cannot be reconstructed with classical or more traditional techniques. However, few question arise when considering composite allotransplantation in the reconstructive ladder[23]:

- Is it ever indicated and, if so, how should it be accomplished?
- Is it a question of plain restorative surgery of missing parts?, or
- a true reconstructive master plan that includes a complex ablative surgery coupled with a nature–fashion composite Allo-microvascular flap?
- Given the risks and side effects of mandatory immunosuppression, will the expected outcomes and improvement in quality of life be worth enough to sustain the risks?

Thus, a decision making process has to be implemented in any facial transplantation protocol.

When we started our program in 2007, we introduced the philosophy of reconstructive surgery into the facial transplantation model. It was no longer a program of exchanging missing anatomy parts but creating a new face for a human being. Proper reconstructive and restorative surgery has to start with the analysis of the deformity, delineation of the extension of the ablative surgery extending to all esthetic units involved (with the sacrifice of normal tissues if necessary), and the reconstruction of the deformity with a facial transplantation. However, a word of caution is also mandatory when considering the resection of the periorbital structures. Replacing the eyelids is a new revolution in the reconstruction of this complex structure. There are not available reconstructive options to restore eyelid function with classical techniques. Should the transplant fail or function is inappropriate, vision would be at risk. Therefore, it should be advocated to preserve as much as normal structures as possible (conjunctiva, muscles, etc) to protect the eyes in these