Vascular Anatomy of Facial Units for Vascularized Composite Tissue Transplantation Design in a Large Animal Model: An in-Vivo and Radiological Study

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INTRODUCTION: A large animal model for composite face transplantation is necessary to better understand the immunologic processes and nerve regeneration. Current porcine models of facial transplantation fail to include all major branches of the facial nerve, and have not demonstrated long-term survival.1,2 A better understanding and detailed evaluation of vascular anatomy and microvascular territories in facial subunits and bone can help effectively develop a reliable porcine composite tissue flap model for experimental reconstructive or transplantation studies.

METHODS: Eleven 10kg domestic pigs were used for in-vivo studies. Vascular anatomy was assessed by Intra-operative anatomical dissections of 11 hemi-facial composite tissue flaps including the auricle. In addition Computed Tomographic Angiography (CTA) and Laser-assisted Indocyanine Green Fluorescence Angiography (LA-ICGFA) were used to assess vascular architecture preoperatively and flap perfusion. In addition, 8 cadaveric pigs were used for selective angiography of branches of the external carotid artery using a barium sulfate and latex mixture to provide detailed qualitative and quantitative analysis of the vascular territories using ultra-high resolution 3D CTA followed by a detailed anatomical dissection. Perforator distributions in facial subunits and the relationship of vascular territories to the facial nerve branches were documented.

RESULTS: A composite tissue flap of the hemi-face including the auricle was elevated and auto-transplanted in eleven 2 months old domestic pigs. Three pigs underwent preoperative CTA. We demonstrated two principal vessels supplying the hemifacial tissues: Internal maxillary artery (IMA) and superficial temporal artery (STA), with less significant contribution from the facial artery. Use of 3D volume rendering of the CTAs and the anatomical dissections demonstrated the vasculature and potential angiosomes of dominant and minor branches from the external carotid artery. We have been able to categorize facial subunit vascularity to delineate safe vascular territories for flap design in facial transplantation or reconstructive surgery.

CONCLUSION: We describe a new swine facial transplantation model with successful outcomes and reliable vascularity confirmed with anatomic, in-vivo CTA studies. Novel detailed vascular injection studies provide understanding of 3D vascular territories paramount to flap design, therefore enabling successful long-term modeling of hemi-facial composite tissue transplantation.

Reference Citations:

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