JPRAS Open 18 (2018) 28–37

Contents lists available at ScienceDirect

JPRAS Open

journal homepage: www.elsevier.com/locate/jpra

Original Article

Normobaric oxygen therapy increases cartilage survival ratio in auricular composite grafting in rat models

Yusuke Hamamoto[a], Tomohisa Nagasao[a,*], Niyazi Aizezi[a], Motoki Tamai[a], Tetsukuni Kogure[a], Tadaaki Morotomi[b], Noriyuki Tagichi[a], Yoshio Tanaka[a]

[a] Department of Plastic and Reconstructive Surgery, Faculty of Medicine/Graduate School of Medicine, Kagawa University, Kida County, Miki-Cho Ikenobe 1750-1, Takamatsu, Kagawa, Japan
[b] Department of Plastic and Reconstructive Surgery, Faculty of Medicine/Graduate School of Medicine, Kindai University, Sayama City, Ono-higasi 377-2, Osaka, Japan

ARTICLE INFO

Article history:
Received 19 May 2018
Revised 3 July 2018
Accepted 18 July 2018
Available online 31 July 2018

Keywords:
Composite graft
Oxygen
Blood
Cartilage
Ear
Auricle

ABSTRACT

Purpose: This study aims to clarify whether normobaric oxygen therapy improves the survival of auricular composite grafts in rats.
Methods: For 10 male SD rats, 1.5 cm^2 composite grafts were harvested from bilateral ear regions including whole auricles. The harvested grafts were transferred caudally and sutured there. The 10 rats were randomly divided into two groups and kept for 21 days in two different circumstances. The first group (Control group: five rats carrying 10 grafts) was kept in room air (20% oxygen) throughout the 21 days, and the second group–named NBO (normobaric oxygen) group (five rats carrying 10 grafts)–was kept in normobaric 60% oxygen for 3 days and then in room air for 18 days. All the 10 rats were sacrificed on the 21st day. Surviving areas of the grafts and the height of the surviving auricular cartilage were examined for statistical comparison of the two groups. Furthermore, the conditions of chondrogenesis occurring around the perichondrium were compared between the two groups.
Results: Surviving areas did not present statistically significant differences between the two groups. The height of surviving cartilage

* Corresponding author.
E-mail address: nagasao@med.kagawa-u.ac.jp (T. Nagasao).

https://doi.org/10.1016/j.jpra.2018.07.003

was significantly greater for the NBO group (2610 ± 170 SD μm) than that for the Control group (1720 ± 190 SD μm). Chondrogenesis occurred at positions more distant from the recipient bed in the NBO group than that in the Control group.
Conclusion: Normobaric oxygen therapy increases the thickness of surviving cartilage in auricular composite grafting in rats, thus suggesting that NBO therapy may also be effective in composite grafting for humans.

Introduction

Free composite grafting is a surgical procedure in which different kinds of combined tissues are transplanted without vascular anastomosis. Plastic surgeons often use auricular composite grafting—consisting of cartilage, subcutaneous fat, and skin–in their clinical practices. The skin of the ear is similar to the skin of the face in texture and color. Furthermore, the inclusion of cartilage allows surgeons to form the graft into desired three-dimensional shapes to fit defects by using cartilage as a framework[1–4]. Because of these advantages, auricular composite grafting is a workhorse for the reconstruction of the eyelid, columella, and nostril rim (Figure 1).

On the other hand, graft survival is not necessarily reliable in auricular composite grafting. It takes 2–3 days for angiogenesis from the recipient bed into the graft to occur. Furthermore, the supply of oxygen to the graft depends solely on diffusion from the recipient bed to the graft. Hence, parts of the graft distant from the recipient bed cannot receive sufficient oxygen to survive, thus developing necrosis. Thus, oxygen supply regulates the size of the graft that can be safely transplanted.

Therefore, while performing the reconstruction of defects above certain sizes with auricular composite grafting, efforts should be made to maximize the part of the graft capable of survival. Specific examples of clinical trials to improve outcomes by increasing oxygen supply include hyperbaric oxygen (HBO) therapy for diabetic feet[5] or sudden sensorineural hearing loss.[6] In animal studies, HBO therapy was reported to increase survival areas of flaps and grafts.[7–10]

In the present study, we focus on normobaric oxygen (NBO) therapy. NBO therapy—putting patients under high-density oxygen at normal pressure—is conducted to improve metabolic effects by increased oxygen supply. NBO therapy is easier to apply clinically than HBO therapy.[11–12]

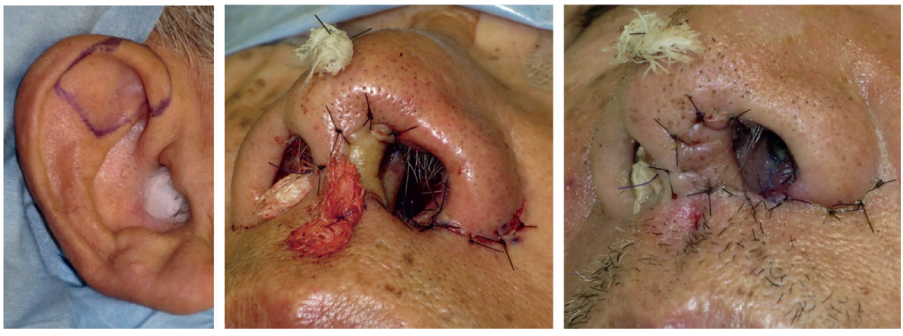

Figure 1. An instance of facial reconstruction with auricular composite graft. A composite graft harvested from the helical crus (Left) was transplanted to a defect of the columella (Center). (Right) The condition on the 7th postoperative day: the graft completely survived.