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Analysis of the microcirculation after soft tissue reconstruction of the outer ear with burns in patients with severe burn injuries

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Summary Reconstruction of soft tissue defects of the ear with burns remains one of the most difficult tasks for the reconstructive surgeon. Although numerous reconstructive options are available, the results are often unpredictable and worse than expected. Besides full and split skin grafting, local random pattern flaps and pedicled flaps are frequently utilized to cover soft tissue defects of the outer auricle. Because of the difficulty and unpredictable nature of outer ear reconstruction after burn injury, a case–control study was conducted to determine the best reconstructive approach. The microcirculatory properties of different types of soft tissue reconstruction of the outer ear with burns in six severely burned Caucasian patients (three men and three women; mean age, 46 years (range, 22–70)) were compared to those in the healthy tissue of the outer ear using the O2C device (Oxygen to See; LEA Medizintechnik, Gießen, Germany). The results of this study revealed that the investigated microcirculation parameters such as the median values of blood flow (control group: 126 AU), relative amount of hemoglobin (control group: 59.5 AU), and tissue oxygen saturation (control group: 73%) are most similar to those of normal ear tissue when pedicled flaps based on the superficial temporal artery were used. These findings suggest that this type of reconstruction is superior for soft tissue reconstruction of the outer ear with burns in contrast to random pattern flaps and full

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skin grafts regarding the microcirculatory aspects. These findings may improve the knowledge on soft tissue viability and facilitate the exceptional and delicate process of planning the reconstruction of the auricle with burns.

Introduction

In the United States, nearly 450,000 people suffer from burn injuries per year.[1] Burn injuries of the face and scalp region are often associated with burns of the outer ear because of its exposed position.[2] The surgical reconstruction of the ear with burns remains one of the most difficult areas of plastic surgery, and despite surgeons' persistent efforts, the end result often bears no resemblance to the ear.[3,4] Moreover, the systemic critical care of the patient and priority of survival stand above the local care and is the reason for the frequent inappropriate treatment for ear burns.[5] In addition to careful planning of the reconstructive process, an experienced eye for the aesthetic unit of the face and scalp is obligatory in the management of outer ear soft tissue reconstruction after severe burn injuries.[6,7] Burn depth plays a crucial role in successful reconstruction surgeries. In general, stable soft tissue coverage of the reconstructed ear and the underlying framework is necessary for providing optimized healing conditions. Numerous options for soft tissue reconstruction of the outer ear were published in the past. In deep partial-thickness burns without exposed cartilage, autologous skin grafting with full- or split-thickness skin grafts is a possible reconstructive option, whereas in full-thickness burns with exposed cartilage, local flaps facilitate the coverage of the reconstructed outer ear.[8] Particularly, retroauricular random pattern or pedicled flaps, based on the superficial temporal artery, are reliable, offer fair cosmetic results, and have low donor-site morbidities.[9] Nevertheless, the exposed position of the outer ear and the nature of the burn injury cause multiple problems, including extensive scar tissue and a poor blood supply.[10]

Hence, this study was conducted to determine the best reconstructive approach for treatment of outer ear burn injuries in patients with severe burns by comparing the microcirculation properties of various soft tissue reconstructions such as pedicled flaps, random pattern flaps, and full-thickness skin grafts, and with those of normal ear tissue in healthy individuals. The reconstructive approach having microcirculation properties most similar to that of the normal ear tissue was considered the best approach.

Methods

Study design and patients

The present case—control study included six randomly selected healthy Caucasian participants (three men, three women; mean age, 41 years (range, 26—61)) as controls, and six Caucasian patients (three men, three women; mean age, 46 years (range, 22—70)) who sustained severe burn injuries in both outer ears between 2009 and 2014. In all six patients, burn injuries were caused by flames and involved mainly deep partial-thickness injuries of the outer ear. The mean total burn surface area (TBSA) was 50% (degree of the burn, IIb°/III°). Reconstructive surgeries were performed in 12 ears using pedicled flaps supplied by the superficial temporal artery covered with 0.3-mm-thin split skin graft (three auricles), random pattern flaps (four auricles), and full-thickness skin grafts (five auricles; Figure 1). All operations and treatments were carried out at the Department of Plastic, Reconstructive, Hand and Burn Surgery at the BG Trauma Center in Tuebingen, Germany. The mean duration between burn injury and reconstructive operative procedure was 14 days.

Inclusion criteria were severe burn injuries caused by flames with a minimum TBSA of 30% and partial-thickness or full-thickness outer ears with burns with an intact cartilage frame. Participants and patients with a history of damage or operations of the outer ear and the lateral head region and those with any severe comorbidities such as cancer and/or immunodeficiency diseases were excluded from study.

All reconstructive procedures of the outer ear were carried out by the same two skilled burn surgeons with >10-year experience in burn surgery. Except for full skin grafting that was not performed in cases with an exposed cartilage, the other reconstructive procedures were selected based on surgeons' experience. The mean follow-up period was 26 months (range, 7—62 months). The postoperative course was uneventful without complications or revisions in all cases. All flaps healed by first intention, and the skin grafts were successfully integrated in all patients (For detailed patient information, see Table 1).

The present study was approved by the Institutional review board of the University of Tuebingen, Tuebingen, Germany. All the study subjects were informed of the study purpose and provided informed consent.

Devices

In order to investigate the microcirculation properties, the O2C (Oxygen to See; LEA Medizintechnik, Gießen, Germany) device was used.[11] The O2C transmits continuous-wave laser light (830 nm and 30 mW) and white light (20 W, 500—800 nm, and 1-nm resolution) to the tissue; the scattered light is then collected on the skin surface by the fibers of the probe. The movement of erythrocytes causes a Doppler shift, which is detected by the laser light and analyzed by the O2C device. This is then computed and