Donor Defect Coverage by Epidermis Transplantation after Radial Flap Removal - A Case Series Report

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Abstract

Background: In Oral and Maxillofacial Surgery, anatomical and functional defect coverage after tumor resections is often performed by microvascularly stemmed radial forearm transplants/ flaps. The defect is usually covered simultaneously by split or full skin transplants either from the proximal forearm or more distant donor sites (upper arm, thigh, lower abdomen, etc), which can also be associated with possible wound healing disorders and additional pain. The aim of this case series was therefore to describe a minimally invasive alternative for covering the removal defects and to investigate their effectiveness and clinical relevance.

Methods: Within the scope of the study 10 patients (n=6 m/4 w) were examined after plastic reconstruction with micro vascular anastomosed radial forearm flap. An epidermal skin graft (CelluTome System, KCI, Acelity, San Antonio, Texas, USA) was taken from the inside of the thigh to cover the site of removal using the suction blister procedure.

Results: The study shows good results regarding the functional rehabilitation of the former donor site. This includes tendon mobility and hand sensitivity. Within the framework of wound healing, however, significant scarring and pigmentation were observed. The first visible results were seen after an average of 11 days with pre-growing epithelial cell nests. The complete reepithelialization took place after an average of 72.4 days (minimum 21 days, maximum 101 days). The average healing time at the donor site of the epidermis transplants on the thigh was 23 days (minimum 7 days, maximum 28 days).

Conclusion: The low surgical effort and the lack of morbidity are the greatest advantages of SBV with simultaneous coverage after radial flap removal. The time and cost savings as well as the possibility of multiple sampling from the same sampling site are also positive. The main disadvantage of this procedure is the resulting aesthetics in this distinctive area, accompanied by a partially protracted healing process. This results in an increased compliance of the patient to be demanded.

Keywords: Radial forearm flap; Full skin graft; Split skin graft; Removal defect; Tissue harvesting; Suction blister epidermal graft

Introduction

In reconstructive surgery after tumor resections, the current main aspect is to close defects both functionally and aesthetically at the highest possible level. Due to the high aesthetic and functional demands in the form of articulation, mastication and deglutition in oral and maxillofacial surgery, the microsurgical revascularized forearm flap in the form of a radial graft for the coverage of orofacial soft tissue defects has established itself over time as one of the leading reconstructs.

The origin of this procedure lies in the Chinese working group around Yang et al. [1] from 1981 [2]. Today, this procedure has established itself as the standard procedure with a healing rate of over 90% of all cases for the coverage of primarily iatrogenic or pathologic surface defects as well as in orofacial tumor surgery [3,4].

The advantages of this transplant are easy surgical removal due to fewer anatomical border structures and fewer variations in the course of the stalk of the radial artery. Due to the large cross-section of the lumen of the vein and artery, a complication-reduced connection to the cervical vessels is possible with a simultaneously long stem [4].
The donor site is considered to be sparsely hairy, soft, with fine contours and a low degree of keratinization. The low proportion of subcutaneous fat tissue results in a high formability of the graft, which has a high functional and aesthetic advantage [5].

A disadvantage is the transposed donor site, which should provide an aesthetically pleasing and functionally resilient covering. All autologous extraction defects can lead to complications, wound dehiscence and pain.

The most frequent complications are tendon exposures, hyp- and paraesthesia in the radial hand area as well as scarred retractions and sliding obstacles [6,7].

The donor site is usually covered primarily, rarely secondarily (e.g., in the case of missing peritendineum after flap removal). The use of full or split skin is used for this purpose. Due to the additional development of a significant additional donor site, both procedures must be viewed critically, even if a full skin can be removed from the compensating incisions of the stalk access on the forearm. In a seven-year study involving 47 volunteers, a research group led by Davis et al. [8], showed no significant difference between full and split skin grafts in terms of tendon exposure, aftercare or healing time. In terms of esthetics, full-skin transplants were better accepted by patients [9].

In order to avoid the emergence of another significant donor site for skin removal, further possibilities or alternatives to the existing procedures are being sought intensively. One of the possibilities is epidermis transplants using the CelluTome System (KCI, Acelity, San Antonio, Texas, USA). The procedure is applied in the dermo-epidermal junction zone, the boundary between epidermis and dermis, and in the Suction Blister Procedure (SBP) it removes individual epidermis islands that are necessary to cover the defect.

The first study on this special method of epidermal transplantation was published by Osborne et al. [10] in 2015. He investigated the cellular properties and components of the epidermal grafts removed and showed that the existing cell types allow regimentation and reepithelialization [10]. In the same year, Serena et al. [11] published two further studies on the subject, describing the method of manufacture, harvesting technique and possible application spectra of the grafts. In the second study, a total of seven patients with longstanding chronic wounds were examined in Haiti. At the same time, the research group was concerned with the practicability of this CelluTome procedure in resource-poor countries. Six of the seven patients showed improved to complete wound healing after four weeks. Only one patient with a chronic wound for more than two years showed no improvement of the wound surface. At the same time, the group described the procedure as very useful due to the low time and cost involved [11,12].

Another patient study with 23 subjects was conducted by Fearmonti et al. [13] in 2016. They examined 23 chronic wounds in the lower extremities in patients with multiple comorbidities. The 16 of the 23 wounds were supported in the healing process by wound treatment, negative pressure therapy, hyperbaric O2 therapy and/or regenerative tissue matrix. After evaluation of the results, the research group came to an 88.1% average reepithelialization rate. After two weeks a complete healing at the donor site was observed [13].

Smith et al. [14] also focused on a different issue in his 2017 study, which compared the quality of split skin and epidermal transplants in terms of cost and patient-related outcome measure. With the help of a questionnaire, the aesthetics of the transplant, complications and the overall satisfaction of the patient were determined. The result showed that 100% of the Cellume volunteers had no complications. In 25% of the patients, complications occurred during the split skin graft, and overall satisfaction was only 50%. The operation and five clinical follow-ups were included to compare the costs of the procedure. In terms of costing, the group described a total of £ 431 for the epidermal graft as £ 1489 for split skin removal compared to £ 431 for the epidermal graft.

In 2016, the Osborne et al. [15] working group published another study on the quality of the skin grafts removed and on morbidity/pain at the site of removal. In summary, it can be said that the research group came to a similar conclusion of practicability as the group around Serena in Haiti [15]. In their study, Cai et al. [16] also dealt with the treatment of chronic and acute wounds. At the same time, however, you also focused on the comorbidities of the patients. The group of authors stated that there were no complications in the donor/receiver area [16].

Based on the latter encouraging studies, the present study will now evaluate to what extent epidermal transplants using the CelluTome method can be an alternative to full or split skin transplants to cover the donor defect after radial flap removal.

**Materials and Methods**

In the study 10 patients, six men and four women were examined after plastic reconstruction with a micro vascular anastomosed radial graft after resection of squamous cell carcinoma.

The multi-component Cellutome-System (KCI, Acelity, San Antonio, Texas, USA) produced a uniformly thick epidermal skin graft by means of a vacuum of -400 mmHg to -500 mmHg and a heat development of 37°C-41°C. The harvester was placed on the thigh, which had been disinfected with 70% isopropanol and shaved, in the form of a 5 cm × 5 cm structural template. This created epidermal microdromes by the physical conditions mentioned above, which contained the keratocytes and melanocytes. Together with the vacuum head, this formed the sampling unit. The procedure was evaluated by visual inspection through a window on the device. In the study, optimal microdromes were formed after an average of 30 min to 45 min.

After fixing the microdromes on a carrier film (3M Tegaderm- Film wound dressing; 3M Company, St. Paul, Minnesota, USA), they were removed using an integrated blade. Before application to the granulation bed, the carrier film was perforated between the microdromes to allow any wound exudates to escape. The resulting micro graft was applied to the prepared forearm. A pressure dressing was applied for at least five days, followed by weekly controls until complete granulation. The donor site on the thigh was covered with the same carrier foil. The wound was cleaned with NaCl until complete epithelialization of the wound surface.

Postoperative and weekly dressing changes were accompanied by clinical documentation using a questionnaire and photo documentation. The focus was on current wound healing, wound characteristics such as wound size, wound status and exudation, documentation of dressing material, abnormalities, complications, sensitivity disorders, aesthetic aspects such as degree of scarring and pigmentation of the wound area.

The prospective clinical examination received a positive vote from the Ethics Committee of the University of Düsseldorf (number 5093R).
Results

The average wound area at the forearm extraction site was 5.76 cm × 3.17 cm (minimum 4.0 cm × 2.5 cm and maximum 9.50 cm × 2.40 cm). After 11 days, all volunteers showed signs of wound healing through epidermal cell nests. Complete epithelialization occurred after an average of 72.4 days (Figure 1). The fastest complete healing was after 21 days of therapy and the longest with 101 days.

Functionally good results were obtained for the parameters tendon gliding movement and sensitivity. In terms of esthetics, the therapy showed acceptable results with a pronounced degree of scarring and pigmentation.

In terms of time expenditure, which included wound bed preparation, shaving, disinfection of the donor site, transplantation and compression dressing, the mean complete time was 59 min. The average removal time of the skin graft was 35.1 min, the shortest 21 min and the longest 56 min. The donor site on the thigh healed painlessly and without irritation in all subjects in seven to a maximum of 28 days. There was no visible scarring or dyspigmentation on the thigh after removal (Figure 2).

Discussion

Based on the above-mentioned results, it can be said that epidermal skin transplantation using the CelluTome system does not seem to be an absolute replacement, but under certain conditions it appears to be a good alternative to conventional methods such as split skin or full skin transplantation for covering radialis donor defects.

One of the reasons why epidermal transplantation is an alternative is the problem of the significant secondary wound that occurs after full or split skin transplantation. This is associated with additional pain, risk of wound infection and protracted wound healing. The second problem is the so-called "limited donor site skin". This describes in particular the condition after an inadequate or unsuccessful full-skin transplant or even an occasional split skin transplant, which, however, makes it almost impossible to remove the skin again at this donor site [17].

Until now, epidermal transplantation has not been considered the method of choice for covering defects due to the non-reproducible, time-consuming and non-standardisable removal of grafts. With the help of the system currently used in this study, however, uniform epidermal cell nests at the dermoeipidermal junction zone can be detached from the donor site and transplanted without any manual post-processing. Another advantage of the procedure is the high level of patient satisfaction, since an excellent donor site optic can be guaranteed, as Smith et al. [14], have also already stated.

A further advantage of the epidermis removal presented here is the high donor site availability, which is reproduced after 7 to a maximum of 28 days, so that the process can be repeated from the same site if required in contrast to full and split skin transplantation. This could then be done without anesthesia due to the low pain during removal and necessary repetition and could represent an additional reserve option in the case of failed full and split skin transplants with minimal surgical effort [14,16].

The acceptor site optics on the ventral forearm in our study can be described as acceptable, but according to our results is not equivalent to the esthetic result after a successful full-skin or split skin transplant. In contrast, other authors such as Smith et al. [14] describe similarly good esthetic results in comparison with different methods of wound coverage, which we cannot confirm in this way. However, since the acceptor site on the forearm is an exposed body site with high aesthetic and functional demands, it can be said that, despite the numerous positive characteristics and areas of application (multimorbid patients, possible outpatient, inexpensive, fast, low-risk and organizationally low-cost use), based on the results of this study, it is a compromise solution that should be regarded as subordinate to full and split skin transplantation. An additional disadvantage of the applied procedure is an extended wound healing process at the acceptor site and thus increased patient compliance, care, and follow-up and treatment appointments [17].

The esthetic and functional result at the recipient site (forearm) after full skin transplantation (over lock bandage for fixation) is classified as the best in the literature and the esthetic result at the donor site (thigh) after the epidermis transplantation is described as particularly desirable. Nevertheless, many surgeons prefer to use split skin transplantation, since the dermatome allows an even and simplified removal, enlargement in the sense of a mesh graft is used for large defect coverage, and the donor site, with an aesthetically acceptable result both at the donor and at the aceto site, generally no longer requires any additional coverage as with full skin transplants [18-20].

Conclusion

In summary, it can be stated that the CelluTome method is an effective alternative to conventional methods with regard to covering removal defects after radialis removal for special indications. Although it does not replace the gold standard in the form of split or full skin transplants, it is a practical and practicable solution in the case of severely compromised patients, limited skin supply and failed full and split skin transplants.
Due to the superficial removal of the graft, there is no need for additional donor site coverage with aesthetic value. Due to the rapid tissue regeneration, the donor site is not limited by the patient’s own body, which means that multiple donations can be made from the same area with a time difference. Together, the above points lead to a great saving of time and money. Functionally, there were only minor differences to the standard procedures of full and split skin transplantation.

References