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Research Article

Full-thickness skin grafts (FTSG) with a new technique

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Abstract

Introduction: Full-thickness skin grafts (FTSG) have long been an indispensable and frequently practiced standard procedure in plastic surgery. The defatting and thinning of the grafts with scissors or scalpel to a thickness of 0,8 – 1,2 mm is very time-consuming even for experienced surgeons in the case of large transplants. Devices for full-thickness skin graft defatting are not available on the market. For this reason, we developed a relatively simple device that enables complete and safe degreasing and thinning of the graft in the shortest possible time.

Materials and Methods: The machine has a dimension of 38cm width, 24cm length, and 23cm height. The cutting thickness can be set to 0.6mm, 0.8mm, and 1.0mm. The central part is a crimper run manually with a crank to guide the specimen through a cutting blade. The machine is made of stainless steel, can be completely disassembled, and is easy to sterilize.

Results: With this device small and very large skin grafts up to 15 cm in width can get completely defatted within a few seconds.

Discussion: The time for defatting is reduced by many times. Precious operating time is spared. It can be assumed that the healing of the graft is improved due to a more complete defatting, a much shorter manipulating time of the skin and a more even cut surface compared to the manual procedure. The risk of defects in the graft and of injury of the surgeon is minimized compared to manual preparation.

Keywords: technical innovations; surgical procedure; full thickness skin grafts; reconstruction; burn

Introduction

Full-thickness skin grafts (FTSG) have long been an indispensable and frequently practiced standard procedure in plastic surgery. Important indications for a full-thickness skin transplant are primary coverage of deep skin defects after trauma or tumor excision and secondary plastic corrections of scars after deep 3rd and 4th-degree burns. Essential for proper healing of the FTSGs is the thinning of the skin to about 0.75- 1.2 mm so capillaries can grow from the wound bed into the graft [1, 2, 3, 4].

The need for thinning grafts is common for small transplants as well as for large grafts. Especially for large transplants, the removal of subcutaneous fat of the donor site is necessary for later low-tension wound closure. This subcutaneous fat then has to be removed before transplanting the skin. Until now the preparation of grafts in terms of thinning and defatting is performed with scalpels and scissors while stretched over a finger by surgeons themselves. Even for experienced surgeons, this involves a risk of damaging the graft or not preserving the exact thickness of the graft. This process is very time-consuming.

For this reason, we developed a relatively simple device that enables complete and safe defatting or thinning of the graft in the shortest possible time. The basis for this defatting unit are well-approved machines of the meat processing industry for debriding animal skins. In cooperation with skinner Mr. Dietmar Anti (MAJA / Kehl-Goldscheuer), we developed a device for defatting FTSGs within seconds to create an ideal graft.

Material and Methods

In the period 2017-2020, a series of experiments were carried out on both animal and human skin. Starting in 2017 with preliminary tests on animal skin, we developed a first prototype of the machine. The prototype was then tested on human skin in 10 test cycles, using accumulated skin from plastic surgery interventions. Several modifications were necessary until its final version.

The machine (LOMA - "LOFF MAJA") is made of stainless steel, can be disassembled into 10 numbered parts and meets the requirements for sterilization. The core of the LOMA is a crimper that is driven by a hand crank. The fat is separated by a sharp fixed blade. The cutting thickness can be adjusted in 3 heights: 0,6 mm, 0,8 mm, and 1 mm.

Process: The epidermal side of the graft to be defatted is placed on the carrier table and one corner of the graft is brought up to the crimper (A). By manually turning the crimper, the epidermal side of the graft is captured by the corrugation of the crimper and guided through the cutting edge (B). The process takes about 5 seconds. The result is a completely degreased graft, with more or less dermis, depending on the skin's thickness and position (C).

Figure 1: The upper subcutaneous tissue should be guided straight in the direction of movement at an angle of approx. 45° during cranking with very minimal uniform tension (A-C).

Results

Preliminary tests with a professional skinning machine and piglet skin

A TEM (table skinning machine) was used as the machine. The electric drive was replaced by a hand crank attached to the gearbox. By manually turning the crimper, the machine can be operated with care. The experiment was performed by a butcher with fresh suckling pigskin, as this is thinner than the skin of older pigs and comparable to human skin. The donor site was in the area of the lower abdomen, as the skin is very soft there. The skin was removed together with subcutaneous fat in the form of a 120mm x 50mm skin spindle. The rind was manually guided to the blade. The epidermis was captured by turning the crimper, the graft then pulled through the blade. However, the epidermis showed superficial cuts due to the sharp-edged ribs of the roller. An initial prototype of the machine has now been designed to meet the following requirements for defatting Full-thickness skin grafts (FTSG) in the operating theatre: The device must be able to be operated manually. Possibility to defatting large full-thickness skin grafts (FTSG), e.g. from the lower abdomen with a size of 20 x 20 cm. The surface of the crimper must ensure a safe grasp of the epidermis without injuring it.

Experiments with the first functional model and piglet skin

After completion of the first functional model, experiments with fresh piglet skin were conducted. The graft was completely and evenly degreased. Three different crimpers had been produced, each with a different corrugation on the surface. It was found that completely rounded edges of the corrugation did not sufficiently capture the graft, while sharp edges injured the epidermis. The ideal condition of the crimper corrugation was determined during the tests. This corrugation with customized rounded edges was used in the future.

Experiments with the first functional model and human skin

The very large pieces of skin after abdominal wall plasty were cut with scissors in such a way that skin spindles were created typically for full-thickness skin grafts (FTSG) of any size. The skins were completely degreased. The impressions from the crimper on the epidermal side were unproblematic and disappeared completely after 2 days. Series were carried out with different settings of the knife holder, with identical, reproducible results. The grafts can be degreased to almost any size. The cut surface is completely even and completely degreased. The cut surface of the separated fat shows that whitish dermis remains can be seen on it, i.e. the depth of cut was in the area of the dermis. Corrections were made to the first prototype: It turned out that the resistance while turning the crank was too high, so a gear transmission was necessary.

Experiments with an improved second functional model and human skin

The second functional model has a cutting width of 20 cm. This can be used to degrease transplants of any length with a maximum width of 15 cm. According to the authors' experience, this corresponds to the maximum size of removable full-thickness skin grafts (FTSG), e.g. in the lower abdomen from spina to spina. The crimper drive is equipped with a 2:1 ratio. This means that even wide transplants can be easily defatted by one person. The height of the frame has been optimized for comfortable use.

Experiments with an improved third functional model and human skin

The final device has a dimension of 38 cm width (without crank), 24 cm length, 23 cm height. The maximum cutting width is 20 cm (D-F). The crimper has a corrugation that is suitable for gripping the graft securely without damaging it. The impressions from the crimper on the epidermal side are unproblematic and disappeared completely after 2 days. In order to allow easy turning, the crank force was increased by a transmission (E).

The cutting thickness can be set to 0.6 mm, 0.8 mm and 1.0 mm. According to our measurements, the transplants actually have a slightly greater thickness. This is exactly within the required range of 0.8-1.2 mm.

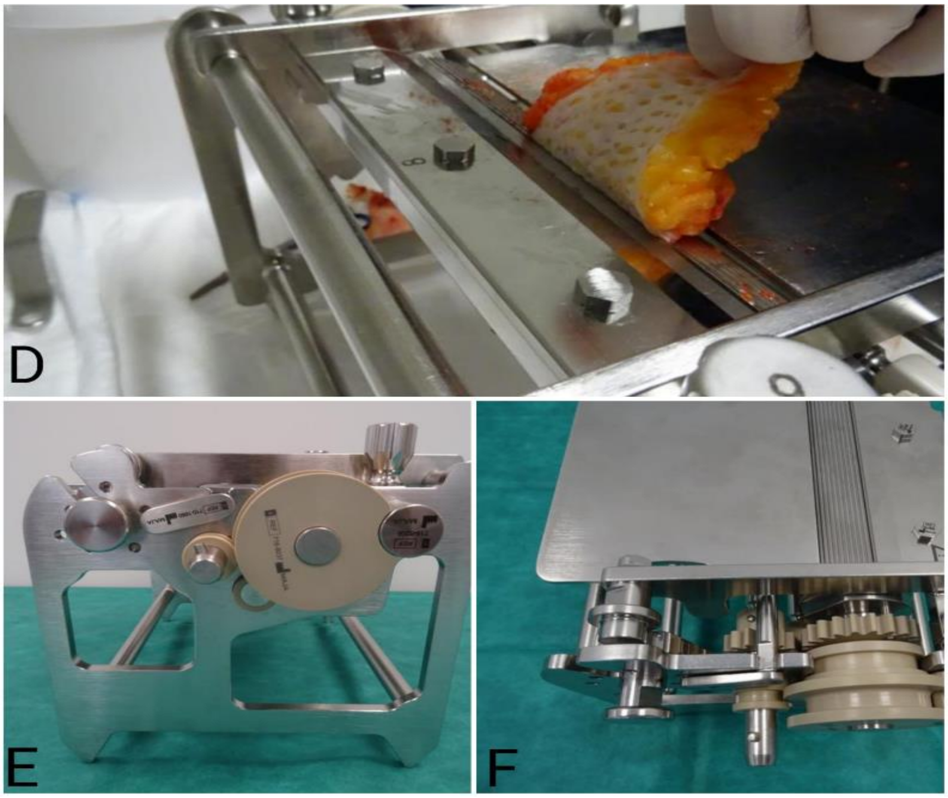

Figure 2: final device (D), lateral view (E), crimper from the machine (F)

Discussion

The precise defatting of FTSG is an essential condition for a proper growth-in of transplants by reducing the diffusion distance between the epidermis and the graft base. This important but simple work is carried out worldwide with scissors, whereby the graft is usually stretched over a finger. The procedure is time-consuming and requires a great deal of attention so that neither the surgeon's finger is injured, nor defects are cut into the graft.

Devices for full-thickness skin grafts (FTSG) defatting are not available on the market. For this reason, we have developed the LOMA transplant defattener described above. These are the advantages of the new device:

1. The defatting process is shortened by many times compared to manual preparation.
2. Precious operating time is spared.
3. The patient is under shorter anesthesia.
4. Defatting takes place independently of the thoroughness and patience of the degreaser, so defatting will usually be more accurate.
5. The cut surface is even and flat compared to the irregular surface after manual defatting. The surface is shown in the illustrations.

The risk of defects in the graft is minimized compared to manual preparation. Manual defatting frequently leads to perforations of the preparation, especially in the production of very thin grafts. When defatting with the LOMA device, we were only able to provoke a defect in the graft if the subcutaneous fat was pulled too strong during the cutting process. This should therefore be avoided at all costs.

The risk of injury to the surgeon's fingers is also minimized compared to manual defatting. If the sharp blade is handled properly - just like a dermatome blade - injury to the surgeon and operating staff should be ruled out.

The weight of the device can be mentioned as a disadvantage. The size resulted from the design, which was repeatedly modified by experiments. As the LOMA should perform as a wide-range defattener including preparations of large FTSGs, a smaller version was not practical

Conclusion

The defatting process with this new device is much faster than manual preparation and operating time is spared. Defatting becomes easier and more precise even without special surgical expertise. Moreover, the risks of defects and injury of the surgeon‘s fingers are minimized. Summarized the LOMA machine is a new invention to improve the process of a full skin graft transplantation.

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Conflicts of interest:

We have no conflict of interest to declare. Also there is no commercial interest in the device from all Authors. This statement is to certify that all Authors have seen and approved the manuscript being submitted. We warrant that the article is the Authors' original work. We warrant that the article has not received prior publication and is not under consideration for publication elsewhere. On behalf of all Co-Authors, the corresponding Author shall bear full responsibility for the submission.

Ethical approval: Not required.

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