

Application of Stromal Vascular Fraction of Adipose Tissue to a Severe Big Toe Defect Caused by Third Degree Electrical Side Injury

Yusuf K. Çoban, MD

Preclinical research in full-thickness skin loss models shows that mesenchymal stem cells (MSCs) and adipocyte stem cells play important roles.^{1,2} MSCs, including bone marrow (BM-MSCs) and adipose-derived stem cells (ADCs), have an important role in acute and chronic wound healing and skin repair.³⁻⁵ Administration of ADCs is reported to increase adipoenzymes and increase type 1 and 3 collagen accumulation in mice.⁶ Skin cell therapies have become part of the treatment protocol for extensive burns. Evidence from laboratory, animal, and clinical trials supports the use of cell-based therapy as an important alternative or complementary therapy in the treatment of burn wounds. However, data demonstrating the potential and feasibility of cell-based therapy for burn treatment were obtained mainly from laboratory analyses, animal studies, case reports and observations of small groups of patients without appropriate controls.

Current clinical procedures include the use of autologous adipose stromal vascular fraction (SVF) containing ADCs. The first step in obtaining autologous fat SVF is to perform liposuction to collect adipose tissue. The collected material is called lipoaspirate and is then subjected to various shear techniques that include enzymatic digestion or mechanical centrifugation and filtration procedures that produce SVF as the final product. Autologous fat SVF includes a variety of cells, including MSCs, pericytes, vascular adventitial cells, preadipocytes, monocytes, macrophages, and red blood cells, as well as extracellular matrix and fibrous tissue.

High-voltage electrical injury can cause various damages to soft tissue, muscle, bone, and nervous system. Full-thickness burns on any part of the body require reconstructive surgery to maintain functional abilities. For big toe defects, flap transfer is a difficult task as reconstructive options are few. Combined therapies may be enough to treat small defects of the big toe, but larger defects are more complex and require innovative solutions.⁷ Here we present a case where ADCs were used to treat full-thickness burns of the big toe.

Department of Plasty and Surgery, Korfez Hospital, Edremit, Turkey

Correspondence address Yusuf K. Coban, MD, PlastySurgery Department, Korfez Hospital, Edremit, Turkey e-mail: ykenanc@yahoo.com

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CASE REPORT

While working on a power line, a 26-year-old man received a 10,000 V electric shock from a high-voltage power line and fell from a height of 1.5 m. He suffered third-degree burns on his right foot (Figure 1). He underwent a series of wound debridements and received treatment at previous medical facilities. Full-thickness burns were observed on the back of the patient's right foot, a granular skin defect and the big toe. In previous treatment sessions, debridement, a series of negative pressure wound treatments (Fava Incorporation, Turkey) and hyalomatrix were applied. Skin grafting to the entire area on the foot resulted in a soft tissue defect of the big toe. After the skin grafted area of the dorsal foot healed, the big toe defect continued (Figure 2). The patient was informed and consented to the treatment to be applied by using ADCs.

METHOD OF PREPARING SVF FROM LIPOSORPTION

Infraumbilical fat was collected while under local anesthesia. Lipoaspirate (60 ml) was subjected to stem cell filtration and fractions using the MyStem (TM, Italy) cell system.

The MyStem EVO kit includes a 1.8 mm blunt-tipped cannula with a 0.3 mm hole for tissue collection via liposuction. This closed sterile system also includes a fluid system with mesh filters, flexible collection bags and Luer key connections. Another part of the system is an independently standing plastic shell in the form of an hourglass.



Figure 1. Full-thickness burn on the thumb and partial thickness burns on the right foot.



Figure 2. Healing of the back of the feet and full-thickness burns on the thumb

The collected 60 ml of lipoaspirate was put into the MyStem EVO system, where it was split into two pieces that were processed separately. The blood/saline fraction was collected through the specified connector with a syringe. The tissue part is washed by adding 10-20 ml of sterile salt solution to the device. After lipoaspirate fluid separation, the residual tissue portion was removed from the device and subjected to the mesh filtration. The final product of this protocol includes a significant amount of blood-derived cells, nuclei cells, intact vessels, and a robust set of stromal fraction and cell components, and microfractionated adipose tissue clusters.

From the collected stem cell fluid, 6 ml was injected into the sides of the toe-toe knuckle, while 1.5 ml was injected into each quarter of the wound through 16-gauge needles. The system ensured that lipoaspirates were processed quickly (within 15 minutes) in a closed sterile device based on network filters and could therefore be used directly in the operating room.

This ADC administration was performed once during the course of treatment. The wound bandage was changed daily by applying physiological serum for 3 weeks. Within 2 months a well-granulated wound bed was obtained. Foot and thumb defect granulation (Figure 3a and b) was prepared and then skin grafting was performed in the thick of the split-thickness skin. Within two months, full epithelialization was achieved. There were no complications related to the big toe defect during the one-year follow-up. The patient is fully healed with durable skin coverage and stable wound formation.

ARGUMENT

MSCs are non-hematopoietic cells first identified by Friedenstein et al in 1973. While bone marrow is the main source of MSCs, it is also found in other tissues of the human body. Many reports describe the presence of MSCs in adipose tissues, umbilical cord blood, chorionic villi of the placenta, amniotic fluid, peripheral ca, fetal liver, lungs and even teeth that have peeled off. Previous studies have also used various names and abbreviations to describe the population of plastic-adhering cells – including adipose derived stem/stromal cells – isolated from collagenase digestions of adipose tissue.

(ASCs), adipose-derived adult stem cells, adipose-derived stromal cells (ADSCs), adipose stromal cells (ASCs), adipose mesenchymal stem cells, lipoblasts, pericytes, preadipocytes and processed lipoaspirate cells is. The International Society for Cell Application Technologies recommends ADSCs to identify an isolated, plastic-sticky, multipotential cell population. The 10 MSCs, including BM-MSCs and ADSCs, have shown great potential in acute and chronic wound healing and skin repair. Successful applications of adipose



Figure 3. (a) Granulated thumb defect. (b) Complete improvement was seen in 1 year of follow-up after the split-thickness skin graft.

SVF in the treatment of knee and hip osteoarthritis have been reported.^{11th}

In this report, we described the application of ADCs to a severe burn defect in the proximal phalangeal region of the big toe, which resulted in complete wound healing. The healing process was 2 months and sufficient granulation was achieved on the defect, obtaining a good vascular bed for the skin graft of split thickness. The time required for the entire procedure was shorter than the time required for lipoaspirate fluid isolation and collagenase digestion protocols. Furthermore, the processing steps were carried out in closed conditions, which has the advantage of reducing the risk of contamination.

Current clinical examples demonstrating the use of ADCs to treat full-thickness burn defects support that stem cell therapy is also a good treatment option for severe burn cases that require innovative solutions. Serial human clinical trials will be needed to in-depth examine the efficacy and safety of autologous fat SVF administration for burn treatment.

RESULT

With this study, we reported the application of separated lipoaspirate fluid cells using the MyStem EVO kit for the regenerative treatment of a compelling electrical burn defect that occurred in a small thumb. This treatment resulted in complete and stable wound healing. The non-enzymatic method of this system can be easily adapted to a one-step procedure in a clinical setting.

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