

Use of xenograft compared to synthetic dermal substitute made of nanocellulose in patients with deep second-degree thermal burns, January 2022-July 2023

Enrique Antonio Chau Ramos^{1,2,a,b,c}; Guillermo Martin Wiegering Cecchi^{1,2,a,b,c,d}; Christian Alexander Chau Ramos^{3,e}

¹ Universidad de San Martín de Porres, School of Human Medicine. Lima, Peru.

² Clínica Javier Prado. Lima, Peru.

³ Clínica Skin Medical. Lima, Peru.

^a PhD in Medicine, master's degree in Plastic and Reconstructive Surgery; ^b Full member of the Plastic Surgery Section of Sociedad Peruana de Cirugía Plástica, Reconstructiva y Estética (Peruvian Society of Plastic, Reconstructive and Aesthetic Surgery); ^c Plastic surgeon; ^d Doctor of Medicine, specialist in Plastic and Reconstructive Surgery; ^e Plastic Surgery resident.

ABSTRACT

Objective: To compare scar formation between regenerated nanocellulose dermal substitutes and xenografts in patients with deep second-degree thermal burns. **Materials and methods:** A comparative, interventional, analytical, prospective and longitudinal study was conducted. We present the report of 60 cases evaluated in a private clinic in Lima, Peru, between January 2022 and July 2023. Patients aged 1 to 60 years without comorbidities were evaluated for wound healing from deep second-degree thermal burns within the first 24 hours of the accident. Both dermal substitutes were used in all patients. The study was authorized with informed consent. **Results:** An evaluation was conducted at 90 days, showing better scar formation with the synthetic dermal substitute made of nanocellulose compared to the xenograft. The results were evaluated using the Vancouver Scar Scale (VSS) (variables: vascularization, pigmentation, pliability, and height) and showed that the synthetic dermal substitute made of nanocellulose resulted in reduced redness and improved elasticity, which were the most favorable indicators. The importance of the study lies in evaluating the quality of scar formation with the use of two treatments for deep second-degree burns. **Conclusions:** It was evident that the synthetic dermal substitute made of nanocellulose is an important alternative that favors the quality of scar formation in burned areas. It has proved to be more efficient than xenograft when evaluated and compared across its four parameters using the VSS, an international tool for wound healing assessment. This efficient alternative for the treatment of second-degree burns promotes a better scar formation process, providing an adequate environment for optimal healing under improved conditions.

Keywords: Transplants; Biological Dressings; Tissue Donors; Burn Units (Source: MeSH NLM).

INTRODUCTION

Burns are the most severe type of biological aggression that the human body can experience and can be life-threatening due to the ongoing risk of sepsis. Late-stage scar formation leads to aesthetic and functional deformities ⁽¹⁻³⁾.

Deep second-degree thermal burns are a common type of injury in emergency departments. For this reason, dermal substitutes such as xenografts and synthetic nanocellulose substitutes are used to aid epithelialization. Due to their characteristics, they act as a barrier in infection prevention, have a metabolic function, and provide comfort to the patient through their malleability ⁽⁴⁻⁶⁾.

The aim is to compare the outcomes obtained with two dermal substitutes, since their timely use provides isolation and protection and optimizes wound healing when the substitute

is appropriately chosen. They also create an optimal environment that maintain the basic physiological conditions of moisture, warmth, oxygenation, and circulation. The purpose of this procedure is to preserve these conditions for 21 days, during which dressing changes are made once or twice, depending on the progression and characteristics of the healing process ⁽⁷⁻⁹⁾.

Wound healing is a physiological process that aims to restore the physical integrity of the skin through scar formation and is essential for maintaining homeostasis. This process comprises three phases: inflammatory, fibroplasia (proliferation), and maturation ⁽¹⁰⁾.

In recent years, plastic surgery has made significant advances in optimizing dermal substitute techniques. The importance of the present study lies in its aim to introduce new alternatives for wound healing through biological or synthetic substitutes that improve treatment

Corresponding author:

Enrique Antonio Chau Ramos
eachaur@gmail.com

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and promote rapid recovery, thereby facilitating patients' return to daily activities ^(11,12).

MATERIALS AND METHODS

Study design and population

An interventional, analytical, prospective, and longitudinal study was conducted. Sixty patients of both sexes, aged between 1 and 60 years, were included between January 2022 and July 2023. They were treated at the clinic's outpatient department, with a history of deep thermal burns occurring in the previous 24 hours, with characteristics consistent with second-degree burns and with less than 20 % of exposed dermis. Of these cases, three developed complications in the study ^(14,15).

Table 1. Scar assessment variables on the Vancouver Scale

	Pigmentation	Vascularity	Pliability	Height
0	Normal color	Normal	Normal	Normal
1	Hypopigmentation	Pink	Supple	Up to 2 mm
2	Hyperpigmentation	Red	Yielding	2 - 5 mm
3		Purple	Firm	Up to 5 mm
4			Banding	
5			Contracture	

Source: <https://raq.fundacionbenaim.org.ar/masoterapia-aceite-macadamia-vs-unguento-vitamina-a-y-d-en-areas-reepitelizadas-en-pacientes-pediatricos-quemados/>

A third person who was not involved in the treatment—a surgeon (observer) working at the same clinic and with 10 years of experience in burns care—evaluated the cases and provided the assessment scores. According to the observations, the physician did not know the site of application and the type of medical substitute used, in order to avoid any bias in the study.

The depth of a burn determines its severity. Second-degree thermal burns cause pain, redness, and swelling, affecting both the epidermis and the inner layer of the skin or dermis, and also cause erythema and blisters. In the cases of this study, the same treatment was performed on all patients, who had burns of equal depth. Burn severity was determined by assessing the percentage of body surface area affected by partial- and full-thickness burns.

Variables and measurements

Scar formation was assessed using the VSS, the most widely recognized instrument for evaluating scars. It includes four variables: vascularization, height, pliability, and pigmentation. In this system, the evaluator rates the scar based on their judgment ^(15,16).

This study compared the outcomes of two substitutes—synthetic nanocellulose and xenograft—over a three-month (90 day) period in order to evaluate the quality of scar formation in the affected areas. The importance of this research lies in identifying which graft represents an alternative with the potential for improved outcomes ^(12,16,17).

The patients underwent surgery, during which surgical debridement was performed with 0.5 % chlorhexidine solution. Both substitutes (funded by the study author) were then applied to 50 % of the burn area, after obtaining patient permission through informed consent. The dermal substitutes were used in patients with deep second-degree thermal burns within the first 24 hours after the accident.

The Vancouver Scar Scale (VSS) was used to assess and measure scar characteristics. It was developed to provide a standardized evaluation across several parameters in order to objectively determine scar severity, monitor response, and measure clinical outcomes. The scale assesses four main aspects of the scar (Table 1).

Due to its unique properties, the synthetic nanocellulose substitute acts as a protective barrier by providing a moist environment that promotes water balance, ensuring non-adherence and allowing for painless replacement while preserving the regenerated tissue ^(12,13,18) (Figure 2). In addition, it is easy to handle, non-adherent, tear-resistant, flexible, soft, semi-transparent, and features a smooth, hydrated surface, ensuring painless removal and excellent biocompatibility ^(12,19).

Statistical analysis

Differences in scar characteristics were considered statistically significant, taking into account pigmentation, vascularity, pliability, height, and the total score. The changes favored the dermal substitute technique ($p < 0.05$), based on the Mann-Whitney *U* test, which compares the medians and determines whether there is a difference in the variable between two groups.

Ethical considerations

The study was approved by the Institutional Review Board of the clinic, as well as by the director and the head of the Department of Plastic Surgery of the healthcare facility, on January 20, 2025.

RESULTS

The cases involved patients who presented with deep second-degree thermal burns and were treated with dermal substitutes within the first 24 hours. The substitutes were applied to different anatomical sites: the nanocellulose dermal substitute was used in 50 % of the injured areas, while the

xenograft was applied to the remaining 50 %. Dressing changes were performed at 21 days, and at three months (90 days) the outcomes related to scar formation—a natural tissue repair process—were evaluated. Scar formation was assessed with the VSS, a widely employed tool in clinical studies that provides an objective evaluation from both the patient and the observer ⁽¹⁴⁾.

The first case was a female patient with a deep second-degree thermal burn who was treated with a nanocellulose dermal substitute within the first 24 hours after the accident. Dressing changes were performed at 21 days (Figure 1). Epithelialization was satisfactory and favorable outcomes were achieved; improvements in the epithelialized areas were observed after 90 days (Figure 2).



Figure 1. Deep second-degree thermal burn caused by hot oil in a 40-year-old patient



Figure 2. Outcomes 90 days following the use of a nanocellulose dermal substitute

The second case involved a deep second-degree thermal burn. Treatment with a nanocellulose dermal substitute was initiated within the first 10 hours after the accident (Figure 3). Recovery was observed at 90 days (Figure 4).



Figure 3. Deep second-degree thermal burn caused by hot liquid in a 22-year-old patient



Figure 4. Outcome at 90 days

The third case was a 65-year-old female patient with deep second-degree thermal burns on the right hand (Figure 5). She was hospitalized, and a dermal substitute was applied to the injured area (Figure 6). At 90 days, epithelialization outcomes in the treated areas were observed (Figure 7).



Figure 5. Deep second-degree thermal burn within the first 24 hours after the accident



Figure 6. Nanocellulose dermal substitute applied within 24 hours



Figure 7. Epithelialization outcomes in the treated areas at 90 days. Improved healing was observed in the epithelialized areas.

Statistically significant differences in scar formation were observed in pigmentation, vascularity, pliability, height, and total score, favoring the nanocellulose dermal substitute technique, which yielded markedly better results ($p < 0.05$) (Figure 8).

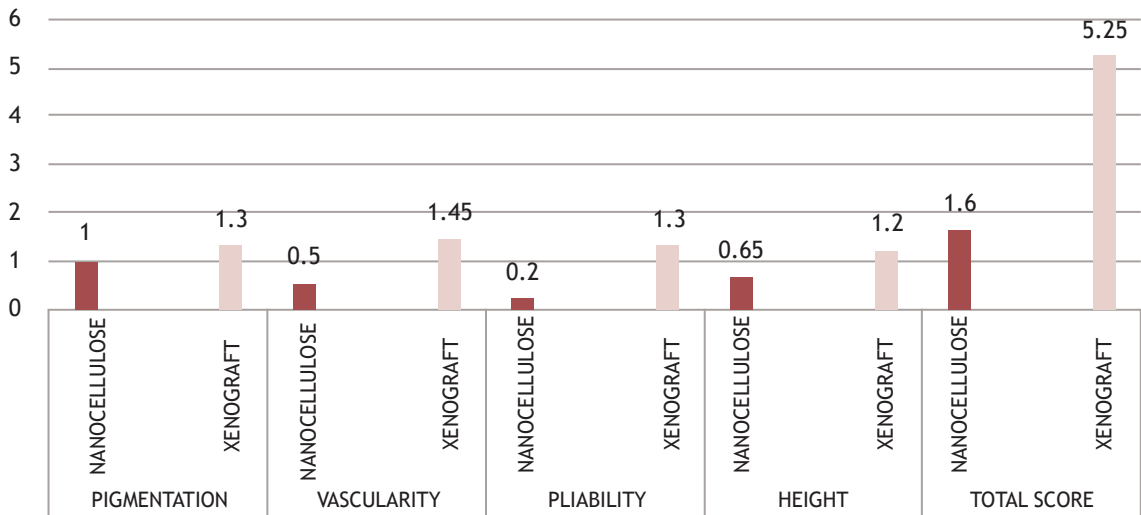


Figure 8. Results of the comparison between the two techniques according to the VSS

DISCUSSION

In the present study, epithelialization characteristics were assessed using two types of dermal substitutes: nanocellulose and xenograft. The results demonstrated that the nanocellulose dermal substitute yielded better outcomes in epithelialization. Furthermore, in cases where nanocellulose was used, the donor site exhibited more favorable characteristics compared to the site treated with xenograft.

The study conducted by Schiefer JL in 2022 on scar formation after burns highlights the significant impact on patients' quality of life. The nanocellulose dermal substitute, a novel and more cost-effective dressing, has been shown to reduce

pain, increase pliability, and accelerate healing time for partial-thickness burn wounds without causing infections. This dressing provided stable wound closure and demonstrated good cosmetic outcomes in follow-up examinations. When compared with the present research, this study showed similar results regarding the use of nanocellulose. Moreover, the same VSS parameters were applied for scar assessment: pigmentation, vascularity, pliability, and height ⁽²⁰⁾.

In another study, Schiefer, in 2021, compared the dressings SUPRATHEL and epicite hydro in a clinical trial. Infection, bleeding, exudate, dressing changes, and pain were evaluated.

The quality of scar tissue was subjectively assessed using the Patient and Observer Scar Assessment Scale (POSAS). Both treatments lasted 15 days without dressing changes. All wounds showed minimal exudation, and patients reported decreased pain, with the only significant difference between the two dressings observed on the day 1. There was no infection or bleeding in any of the wounds. Regarding scar assessment, both dressings were easy to use and highly flexible, created a safe healing environment, had similar effects on pain reduction, and showed good functional results ⁽²¹⁾.

The following study bears similarities to the present research, as it also compares dermal substitutes and reports satisfactory wound healing outcomes. According to Urbina G, in 2016, the use of synthetic dermal substitutes in the management of complex wounds has demonstrated the potential to achieve aesthetically and functionally adequate scar formation in burn injuries. This study contributes to expanding knowledge on the use of these dermal substitutes in injured areas, highlighting their benefits and possibility of reducing potential risks during the scar formation stage, while also achieving improved aesthetic and functional outcomes that allow patients to return to their daily activities ⁽²⁰⁻²²⁾.

Further studies are recommended to compare the scar quality achieved with the nanocellulose dermal substitute against other substitutes in the management of different types of injuries. Over time, plastic surgery has developed a variety of innovations to improve treatments and techniques for burns injuries. Therefore, it is important to explore new alternatives that promote wound healing and faster patient recovery ⁽²³⁾.

In this research, the benefits of nanocellulose dermal substitute were analyzed as a new alternative to cover affected areas and provide a suitable environment that promotes improved wound healing. The nanocellulose dermal substitute, designed for burn treatment and wound care, applies patented technology and consists of an organic nanocellulose structure, designed to be the same size as water molecules. This synthetic dermal substitute is composed of 95 % isotonic saline solution, which slowly hydrates burns over a prolonged period ^(12,23).

In conclusion, the nanocellulose dermal substitute represents an important alternative that promotes improved wound healing in affected areas. When assessed using the VSS, it proved to be more effective than the conventional xenograft.

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